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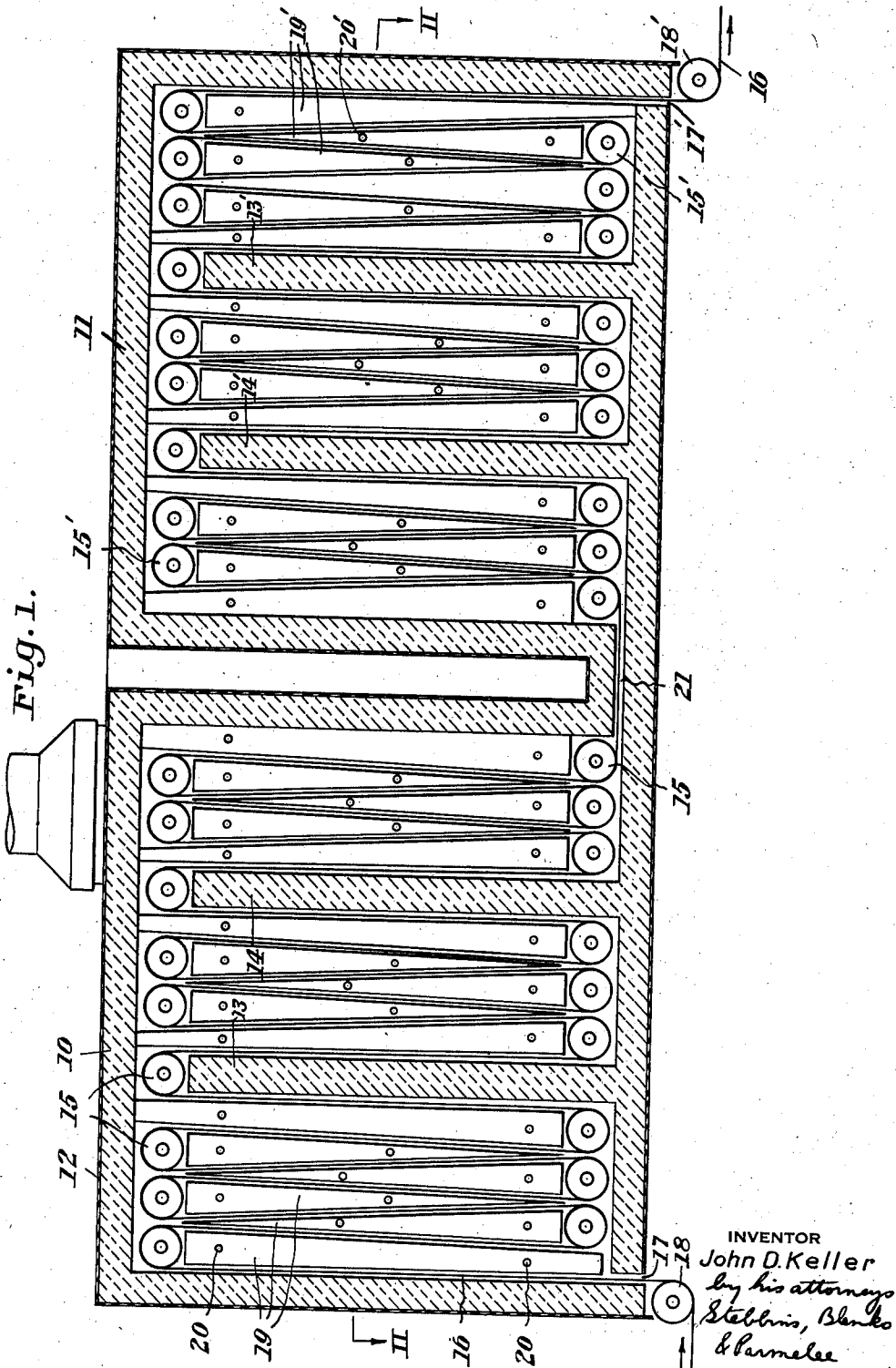
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2,232,391

METHOD AND APPARATUS FOR ANNEALING STRIP

Filed June 20, 1939

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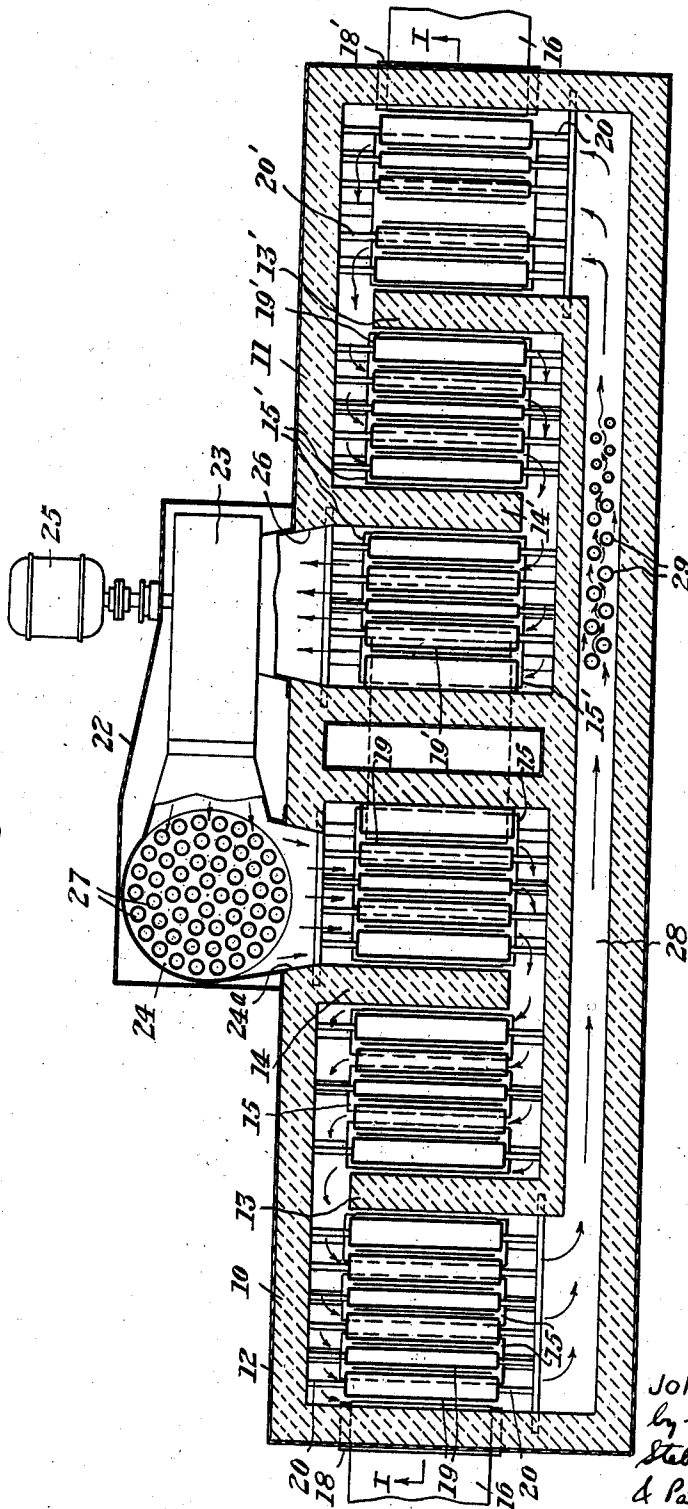
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Fig. 2.



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Fig. 4.

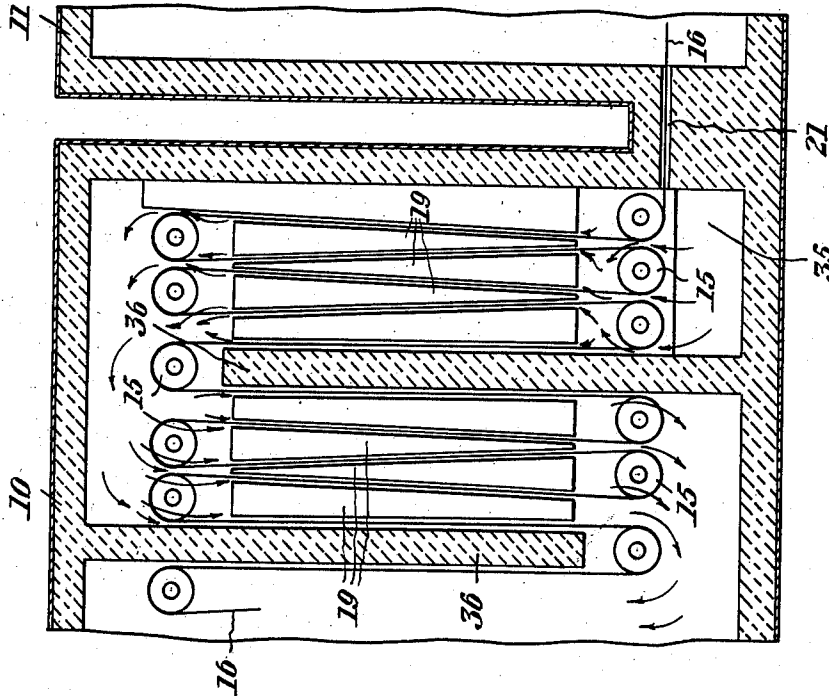
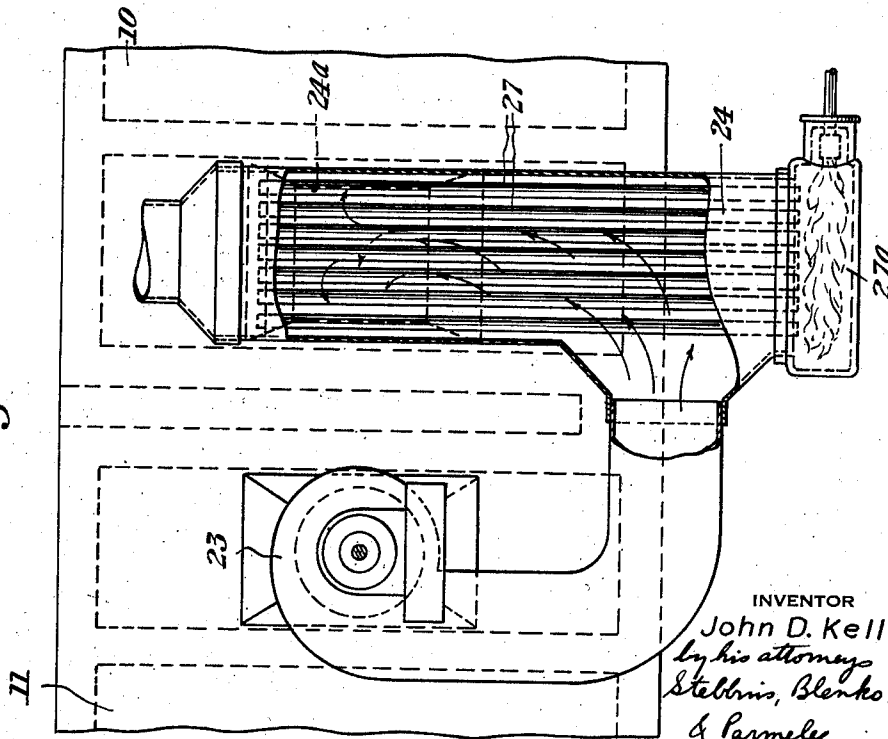


Fig. 3.



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METHOD AND APPARATUS FOR ANNEALING STRIP

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6 Claims. (Cl. 266—3)

This invention relates to the processing of flat rolled metal stock and, in particular to the annealing of cold rolled steel strip.

The annealing of ferrous strip has been carried on heretofore by placing the material in the form of either coils or sheets, within a protective cover, heating it to the desired temperature and subsequently permitting it to cool slowly. The time required by this process is considerable so that the cost of the necessary apparatus, per ton of hourly or daily capacity, is quite high. A further objection is that all portions of the coil or stack, are not heated to precisely the same temperature whereby the material lacks uniformity after processing.

I have invented a novel method and apparatus for annealing strip which overcome the aforementioned objections by providing equipment that can be installed at relatively low cost, for heating and cooling the material in single thickness or strand form, whereby the time required for completely processing a given length of strip is greatly reduced as compared to that which has been necessary heretofore.

In a preferred embodiment, the apparatus of my invention comprises heating and cooling chambers provided with means for conducting strip therethrough successively in strand form. These means are preferably in the form of rollers between which the strip is looped back and forth for continuous movement through the chambers. I also provide means for circulating gas through the chambers to heat and cool the strip passing therethrough, respectively. Heat-exchangers disposed adjacent the chambers alter the temperature of the gas entering the chambers so that the desired heating or cooling takes place therein.

The following detailed description of a preferred embodiment of the apparatus refers to the accompanying drawings in which

Fig. 1 is a longitudinal, vertical, central section through the heating and cooling chambers with parts thereof shown in elevation;

Fig. 2 is a sectional view taken substantially along the plane of line II—II of Fig. 1; line I—I of Fig. 2 indicates the plane on which the section of Fig. 1 is taken;

Fig. 3 is a side elevation such as would be seen by looking from the top of Fig. 2, partly in section and partly broken away; and

Fig. 4 is a partial view similar to Fig. 1 showing a modification.

Referring now in detail to the drawings, heating and cooling chambers 10 and 11 are so disposed relative to each other as to facilitate the

passage of strip from one to the other. The chambers 10 and 11 are preferably constructed of refractory insulating brick assembled within an enclosure composed of sheathing plates 12 and suitable frame members (not shown). Baffles 13 and 14 extend inwardly from opposite sides of the heating chamber for a purpose which will appear shortly. Guide rollers 15 are journaled adjacent the top and bottom of the chamber 10 and are so disposed as to convey a strip 16 trained therearound, continuously through the chamber, each point on the strip traversing a plurality of loops as it advances through the chamber. The rollers 15 are journaled in suitable bearings (not shown) which may conveniently be supported on the framework of the enclosure for the chamber 10. If desired, means may be provided for driving all or some of the rollers 15.

An entrance slot 17 adjacent one end of the chamber permits the strip 16 to be drawn around a guide roller 18 and thence around the rollers 15. Baffles 19 of suitable shape which may conveniently be composed of sheet metal having the necessary resistance to high temperatures, extend between the rollers at the top and bottom of the chamber and are supported on bars 20 extending therethrough and embedded in the chamber walls. As clearly shown in Fig. 1, the baffles 19 define narrow passages for the runs of the strip between opposed rollers 15.

The cooling chamber 11 is similar in construction and arrangement to the heating chamber 10 and a detailed description thereof is unnecessary for that reason, the elements of the cooling chamber being indicated by the numerals applied to corresponding elements of the heating chamber with a prime affixed. As shown in Fig. 1, the heating and cooling chambers are connected by a passage 21. After traversing both the heating and cooling chambers, the strip emerges through a slot 17' at the end of the latter and passes around a guide roller 18' to a coiler or other take-up means, i. e., pinch rolls or the like.

An enclosure 22 on one side of the chambers 10 and 11 which may be composed of light plate, houses a blower 23 and a heat-exchanger 24. The blower is driven by a motor 25. A converging connection extends to the intake of the blower 23 from an outlet 26 formed in the side of the cooling chamber 11. The heat-exchanger 24 discharges through a diverging connection into an inlet 24a formed in the side of the heating chamber 10. The heat-exchanger 24 may be of any suitable type so long as it prevents contamination

tion of the atmosphere of the chambers by combustion gases, but in the embodiment illustrated it is of the surface type and includes a plurality of vertically extending heat-exchange tubes 27.

5 A burner 27a adjacent the lower ends of the tubes 27 supplies hot combustion gases to the interior thereof, thereby heating them. It will be apparent that the gas composing the atmosphere in the heating chambers 10 and 11 will be
10 circulated in the direction of the arrows and heated on passing through the bank of tubes 27 composing the heat-exchanger 24.

A passage 28 connects opposite ends of the heating and cooling chambers. A heat-exchanger 15 29 is disposed in the passage adjacent the entrance to the chamber 11. This exchanger may also be of any suitable type, but as illustrated, comprises a plurality of tubes between which the gas passes prior to entering the cooling chamber.
20 Cooling fluid of any desired type is circulated through the tubes 29 by appropriate means.

In operation, the apparatus shown serves to heat the strip 16 progressively to the desired temperature and then cool it by convection. The
25 strip may conveniently be fed into the apparatus from a coil supported in an uncoiler or the like. The chambers 10 and 11 are provided with removable wall sections (not shown) to permit a strip to be initially trained around the rollers 15
30 and between the baffles 19. After threading the first strip, succeeding coils will be secured together as by welding, stitching or the like, so that a continuous passage of the strip through the apparatus is obtained without the necessity of re-
35 threading.

A protective atmosphere is maintained within the chambers 10 and 11, being supplied thereto by appropriate connections from a suitable source of non-oxidizing gas.

40 The heat-exchanger 24 is preferably operated in such manner that the gas entering the inlet 24a is at a temperature of about 1350° F. This gas passes between the baffles 19 and around the baffles 13 and 14 and thus has repeated intimate
45 contact with the runs of strip between opposed rollers 15. The baffles 13 and 14 cause all the gas delivered to the heating chamber to make several complete passes across the multiple loops in which the strip is supported in the chamber.
50 The baffles 19 prevent the gas from passing between adjacent runs without having intimate contact therewith.

The strip entering the heating chamber and
55 advancing progressively therethrough is gradually raised to the temperature of the gases entering the chamber. I utilize the counter-current principle by causing the gas at its maximum temperature to impinge on the strip at the maximum temperature of the latter. The gas, after
60 losing some of its heat to the strip on the first pass through the multiple runs, has repeated contact therewith on successive passes and impinges on the cold entering strip after the gas temperature has been somewhat reduced.

65 After the gas has made the several passes through the runs of strip in the heating chamber and lost most of its heat, it flows through the passage 28 and is further cooled by the heat-exchanger 29. The cooled gas then makes repeated passes through the runs of strip supported in the cooling chamber 11 before returning to the blower 23. As in the heating chamber, the counter-current principle is utilized by causing
70 the gas at its minimum temperature to engage

the strip which is at the minimum temperature. A portion of the heat absorbed by the strip as it passes through the heating chamber is thus recovered therefrom by the gas impinging thereon in the cooling chamber so that after the apparatus has been operating a short while, only a relatively small amount of heat will be required to make up for that lost through the furnace walls and to the heat-exchanger 29.

10 After being heated to the desired temperature in the heating chamber, the strip is cooled in the cooling chamber by the repeated contact of the gas forming the atmosphere within the chambers and the temperature of the strip is thereby reduced to a value at which oxidation thereof does not proceed rapidly in the air, before it reaches
15 the exit slot 17' and emerges into the open.

The number of strands or loops of strip in each pass of the heating and cooling chambers may vary from the arrangement shown in the drawings. Each pass, furthermore, may be divided
20 by one or more horizontal partitions to cause the gas to flow back and forth repeatedly through each pass before entering the next one.

A modified arrangement of passes is shown in
25 Fig. 4, wherein the gas enters the heating chamber at 35, flows upwardly around baffles 19, around a baffle 36 and downwardly around further baffles 19, and so on. This construction differs from that of Figs. 1 to 3 in that the several
30 passes of the gas through the heating and cooling chambers take place along substantially vertical paths, instead of transversely along substantially horizontal paths. In the modified construction, the inlet to the heating chamber is
35 near the bottom or top thereof as shown.

As will be apparent from the foregoing description and explanation, the invention provides a simple yet effective method and apparatus for
40 continuously annealing strip. Since the material is heated and cooled in single thickness or strand form, it is rapidly raised to the desired temperature and cooled therefrom. A relatively large hourly or daily capacity is thus obtained and the cost of the apparatus per unit of capacity is
45 much lower than that of conventional annealing apparatus. The fuel cost is also reduced since a portion of the heat initially absorbed by the strip is recovered therefrom in the cooling stage. The entire apparatus is made gas-tight by suitably welding the sheathing plates 12 and a slight positive pressure is maintained on the gas within the chambers 10 and 11 to prevent the infiltration of the atmosphere. Since the slots 17 and
50 17' must be kept open, this means that the supply of non-oxidizing atmosphere to the chambers must be continuous. The heat-exchanger may, if desired, be enclosed within the refractory walls of the furnace.

60 The rollers may be provided with scrapers and their surfaces may be either highly polished nickel chromium alloy or similar metal to which the metal of the strip has little tendency to adhere, or a softer material such as copper or Monel metal.

Although I have illustrated and described but a preferred embodiment and practice of the invention, it will be recognized that changes in the apparatus and procedure disclosed may be made
70 without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. Apparatus for annealing strip comprising heating and cooling chambers, means for con- 75

ducting strip successively therethrough, means for circulating gases through said chambers successively, and a heater having heat-exchange surfaces for heating the gases, said means and said heater being so positioned and connected to said chambers that the gases are withdrawn from the cooling chamber and pass through the heater prior to entering the heating chamber, said heater being adapted to prevent contamination of the circulating gases by extraneous gases.

2. In a method of annealing strip, the steps including passing strip in strand form continuously through a chamber, looping the strip up and down in said chamber while advancing it generally along a predetermined path, circulating gas repeatedly in a generally horizontal direction across said path, and bringing the gas into contact with heat-exchange surfaces prior to its entry into said chamber, thereby heating the strip to a substantially uniform temperature across its width, substantially solely by convection in its passage through the chamber.

3. Annealing apparatus including a chamber, means including spaced rolls for looping strip back and forth in said chamber and conducting it progressively therethrough in strand form, a heater adjacent said chamber having heat-exchange surfaces for heating gas, and means for circulating gas through said heater and chamber to heat the strip to annealing temperature substantially solely by convection, said heater being so constructed and arranged as to prevent contamination of the gases circulating therethrough by extraneous gases.

4. Annealing apparatus including a chamber, parallel rollers disposed in said chamber in spaced relation and near the top and bottom thereof, over which strip is adapted to travel back and forth in loops and be thereby conveyed progressively therethrough, gas-heating means

adjacent said chamber having heat-exchange surfaces, and means for circulating gas through said gas-heating means and chamber whereby to heat the strip to annealing temperature by convection, said gas-heating means being so constructed and arranged as to prevent contamination of the gases circulating therethrough by extraneous gases.

5. Annealing apparatus including a chamber, vertically spaced rolls for guiding strip looped up and down in said chamber and conducting it progressively therethrough in strand form, means adjacent said chamber for heating gas, means for circulating gas through said heating means and chamber to heat the strip to annealing temperature substantially solely by convection, and a substantially vertical baffle wall extending substantially the full height of said chamber and from one side thereof across substantially the full width thereof between adjacent loops toward the other, but terminating short of the other side thereby causing the gas to make a plurality of generally horizontal passes transversely through a plurality of adjacent loops of strip.

6. Annealing apparatus including a chamber, rollers disposed in said chamber in vertically spaced relation adapted to convey strip up and down therein and progressively therethrough, substantially vertical baffle walls extending from both sides of the chamber and across substantially the full width thereof between adjacent strands of spaced loops of strip but terminating short of the other side, gas-heating means adjacent said chamber, and means for circulating gas through said gas-heating means and around the baffle walls in the chamber whereby to subject the strip to a plurality of horizontal transverse passes by said gas and heat it to annealing temperature substantially solely by convection

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