FIG. 1
PRIOR ART

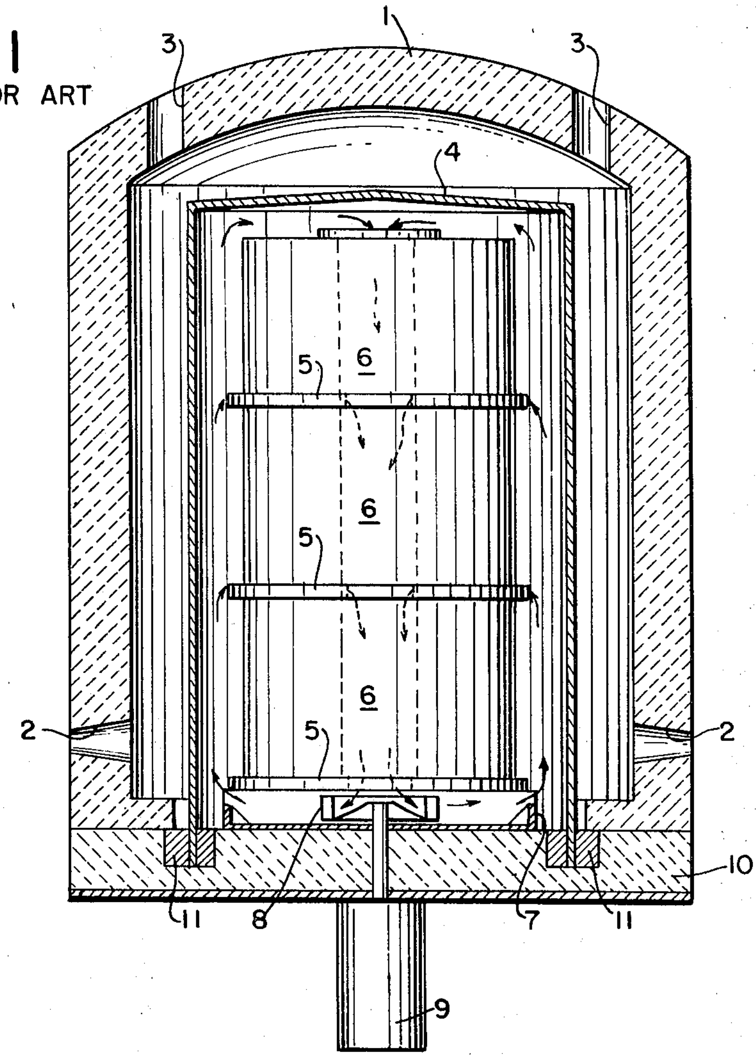
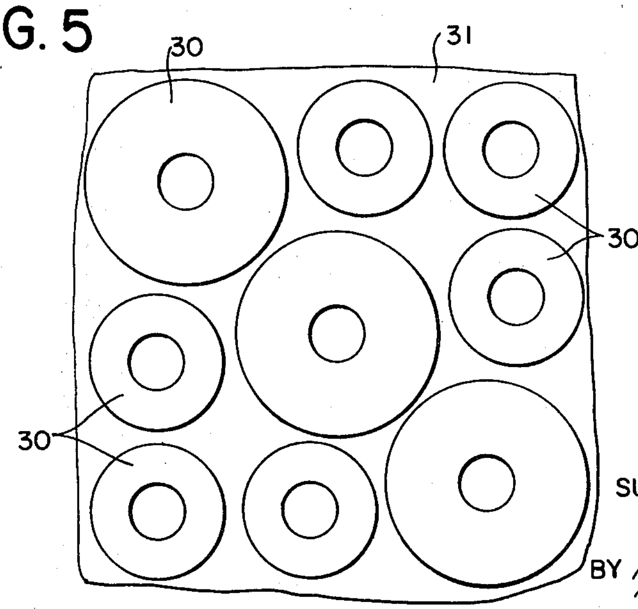


FIG. 5



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June 23, 1970 SUKEHARU ENDO 3,516,649

ANNEALING FURNACE FOR COIL MATERIAL

Filed June 18, 1968 4 Sheets-Sheet 2

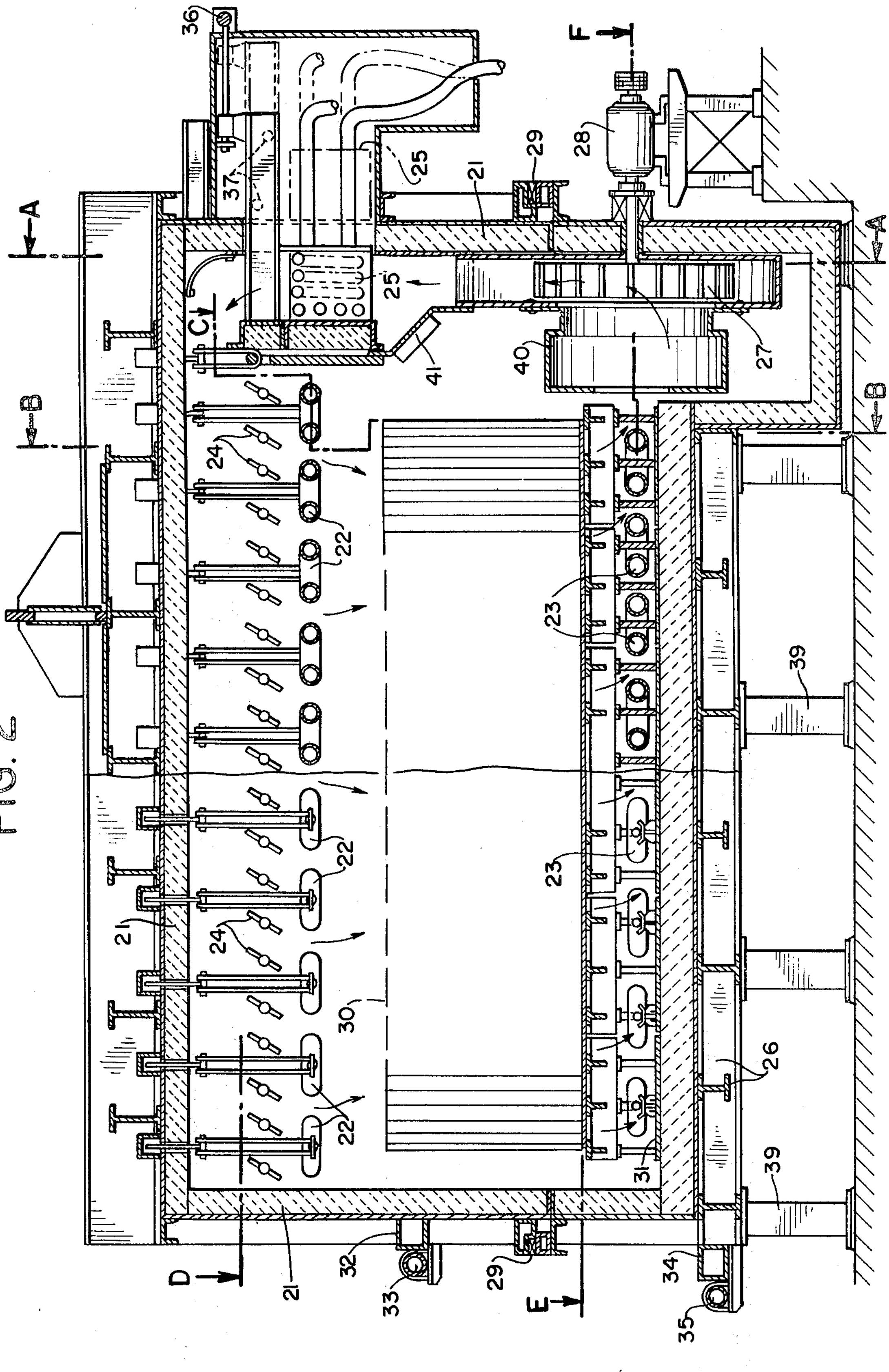
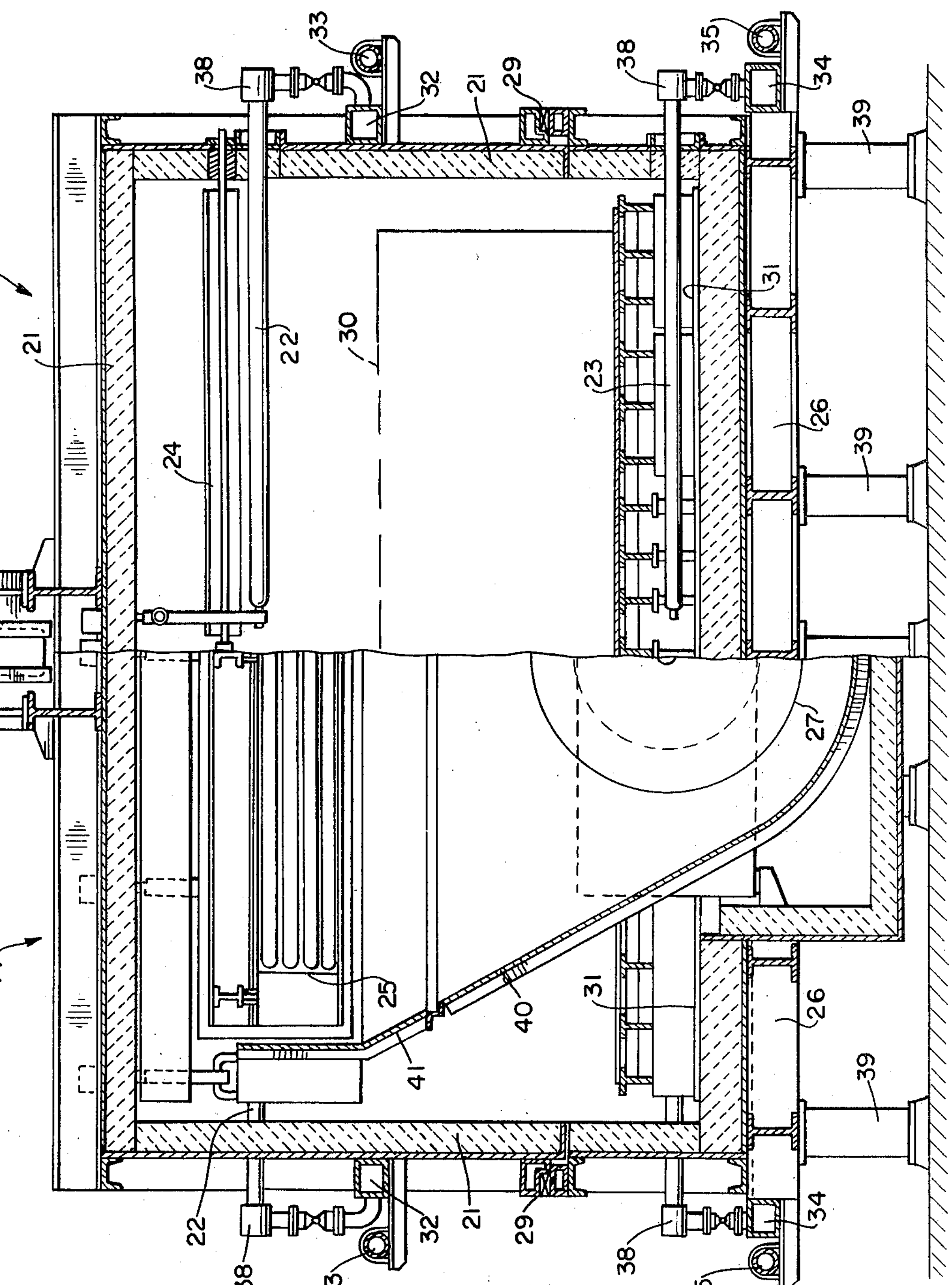


FIG. 2

ANNEALING FURNACE FOR COIL MATERIAL

FIG. 3



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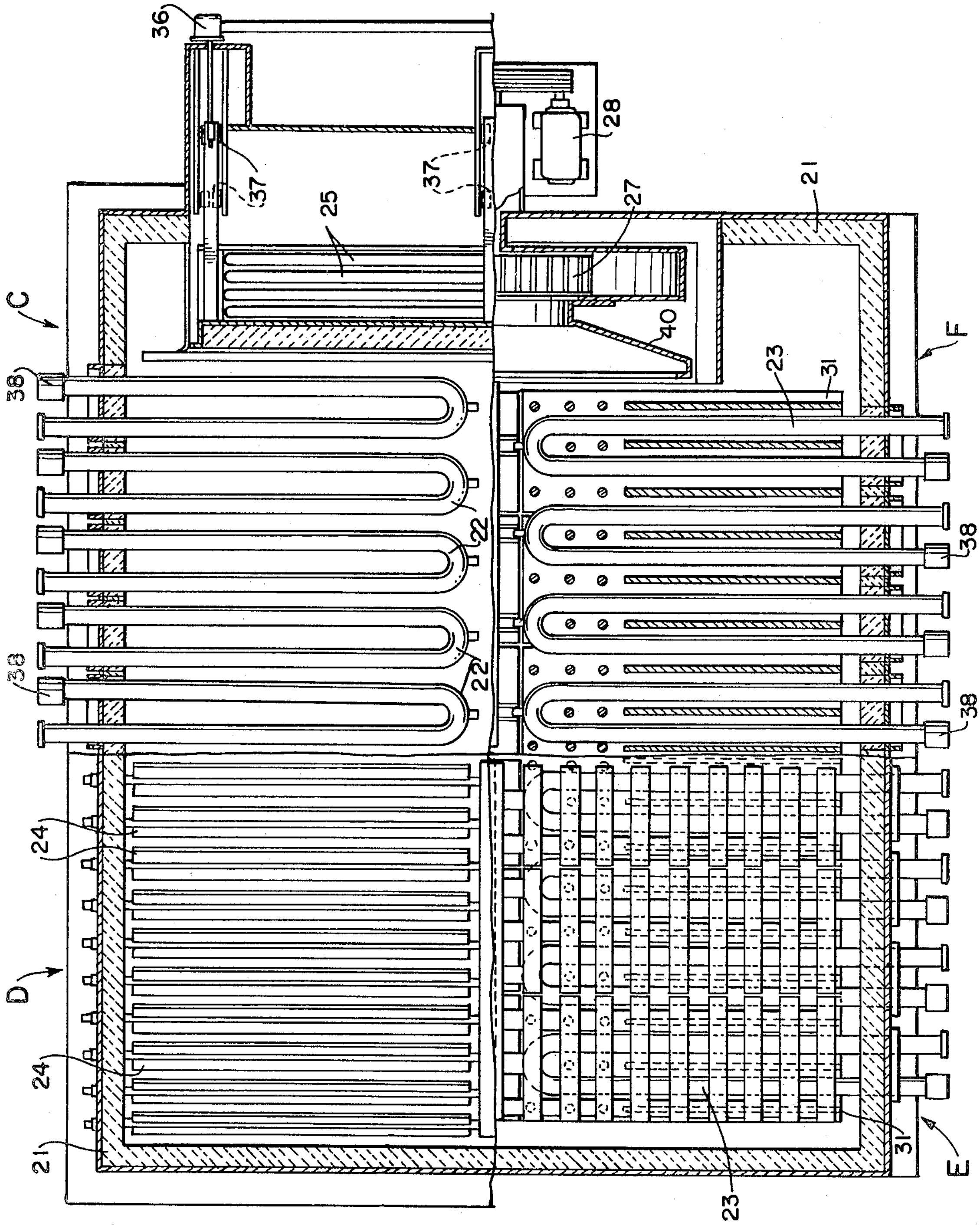

FIG. 4

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ANNEALING FURNACE FOR COIL MATERIAL

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Int. Cl. F27b *11/14*
U.S. Cl. 263—40 1 Claim

ABSTRACT OF THE DISCLOSURE

The present invention relates to an annealing furnace. In the furnace, coils covered with a heating cover are directly heated by radiant tubes arranged on both top and bottom.

An object of the present invention is to improve the batch type coil annealing furnace for cold-rolled steel sheet.

According to the prior art, this kind of batch type annealing furnace uses an inner cover with which to protect the work, that is heated indirectly by heating the said inner cover externally.

To be more precise, burners or radiant tubes or in some cases heating elements are used for heating the said inner cover that heat the protective gas circulated in the said inner cover that transfers heat to the coil ends that further transmit heat to its central part by conduction.

Since the heat transmission to the coil center enlists conduction, heating speed is naturally confined by the thermal conductivity of the material to be heat-treated.

In order to reduce the overall heating cycle, it will be required, of necessity, to accelerate the heating of coil ends up to a desired temperature.

The conventional furnace has the disadvantage of taking extremely long hours to heat the coil ends up to a prescribed temperature, because the coil ends are heated indirectly through the inner cover and the protective gas which requires a long time to transfer the necessary calorie.

The conventional furnace heat-treats 3–4 coils stacked in the inner cover usually. For this reason, it has another disadvantage of inviting stickings on the lower coils due to weight of coils, especially in case of very thin strip coils, causing a poor yield.

On the other hand, if one coil only is heat-treated to avoid the above demerit, it will degrade productivity and cost much.

Therefore, if a single-stack coil can be heated rapidly at its both ends, it could cause higher yield with less cost.

The so-called speed cycle furnace developed a few years ago is a furnace to heat and anneal a single-stack open coil by direct radiant tubes, and is not intended for heating tight-coil uniformly.

In this conventional furnace, the radiant tubes are arranged only on the upper part of the coil.

The heating capacity of coil annealing furnace is expressed by dividing a charge weight by the time required for heating the coil center up to a specified temperature, provided that coil temperatures be held within a specified range.

It should also be noted that the coil end temperature must not be increased beyond the upper limit of the prescribed temperature range because, it could otherwise cause the work to be degraded.

In the meantime, the heating speed is diversely affected by the coil end temperature because heat transmission is carried out by conduction through coil ends.

Accordingly, to increase heating capacity is bound to be

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the only means in which the coil end temperature can attain a level much closer to the upper limit of the appoint temperature range without loss of time.

The object of the present invention is to uniformly heat up the coil ends by means of radiant tubes provided on both the upper and lower parts of the coil.

Since the heating furnace of the present invention is of the direct radiation type using a radiant tube as against the conventional method in which protective atmospheres are used without exception for heating coils by convection, its heating speed is very high and uniform heating can be ensured if the radiant tubes can be arranged close to the coil ends.

Detailed hereunder is the present invention with reference to the accompanying drawings in which:

FIG. 1 shows a conventional coil annealing furnace.

FIG. 2 shows a section illustrating the construction scheme of the annealing furnace according to the present invention.

FIG. 3 shows sections A—A and C—C in FIG. 2.

FIG. 4 shows sections as viewed from the directions C, D, E and F, respectively.

FIG. 5 is an illustrative drawing showing the relationship between coil and plenum chamber located inside the annealing furnace according to the present invention.

As can be seen in FIG. 1, the conventional coil annealing furnace is composed of: diffuser **7** having circulating fan **8**, convector plates **5** and coils **6** piled alternately in 3 to 4 stacks on the said diffuser **7**, base **10** and inner cover **4** put on the said base **10** to seal out open air, motor **9** for driving the said circulating fan **8**, sand seal **11** to seal the said inner cover **4**, heating cover **1** to be put on the above-mentioned inner cover **4** at the time of heating the said coil **6**, and burner **2** located at the lower part for heating the said inner cover **4**.

In this system, the said inner cover is filled up with protective gas that is circulated in the arrow direction by the said fan **8** and given heat from the said cover **4** and communicates heat to the ends of the said coil **6** in the course of passing through the said convector plates **5**.

Namely, in the conventional coil annealing furnace, the coil **6** is heated through the two media, the inner cover **4** and the protective gas.

As illustrated in FIG. 1, since the coil **6** should take a considerably large compressive force due to their self-weight because coils are piled in 3 to 4 stacks, coil ends and convector plates **5** might be welded.

This failure is liable to occur especially in case of thin coil.

Part **3** appearing in the figure indicates a chimney provided on the heating cover **1**.

Shown in FIGS. 2–4, 6 and 7 is the coil annealing furnace according to the present invention to improve the conventional type.

According to the present invention, the annealing furnace is provided with various means: plenum chamber **31** in which radiant tubes **23** may be installed on the base **26** (coil **30** to be installed on the said chamber **31** as shown by way of example in FIG. 5), circulating fan **27**, base **26** provided with the said fan **27** on its side wall, heat exchanger **25** which can be taken as far out as the outlet on the upper part of the said circulating fan **27** at the time of cooling operation, ducts **40**, **41** made of heat resistant steel connecting the said chamber **31** and the said heat exchanger **25** to the said fan **27**, heating cover **21**, radiant tubes **22** provided on the ceiling of the said heating cover **21**, baffle **24** for rectifying the stream of protective gas, seal mechanism **29** to be used for the said heating cover **21**, motor **28** for driving the said circulating fan **27**, upper air manifold **32**, upper gas manifold **33**, lower gas manifold **35**, lower air manifold **34**, worm type reduction gear **36**, support rollers **37** for the said heat exchanger **25**, burner **38** and furnace floor support column **39**.

In this system, the ends of coil **30** can be directly heated by the radiant tubes **22** installed on the heating cover **21** as well as by the radiant tubes **23** installed on the base **26**.

These upper and lower radiant tubes **22** and **23** are temperature-controlled independently of each other, whereby both the upper and lower ends of coil can be protected from being overheated and can also be maintained at a constant temperature.

Since the coil ends are heated directly by radiation, the temperature rise of the coil **30** is made quick, resulting in the reduction of heating time.

When the furnace operation enters the cooling cycle, the combustion is stopped and the heat exchanger is put in the furnace to cool down the circulating gas which cools the coil **30**. This cooling method has an extremely shortened cooling cycle as compared with the conventional method in which the inner cover is air-cooled, because it uses water cooled pipes in its heat exchanger.

On the other hand, since the coil annealing furnace according to the present invention can be large-sized, it can accommodate various coils. Therefore, there is no limit to the coil dimensions and no decline in processing capacity due to limitation to charge weight.

In addition, there is no fear of sticking because coil bottom takes as small a weight as ⅓–¼ of the total weight by the virtue of a single-stack system.

This involves that the coil annealing furnace according to the present invention is most suited to the heat treatment of very thin coil.

As will be clear in the foregoing, since the coil annealing furnace according to the present invention is able to heat-treat a single-stack coil directly by radiant tubes arranged uniformly on both the upper and lower sides of the coil without inner cover, its heating time is sharply reduced as compared with the conventional annealing furnace, and its temperature uniformity is excellent.

In addition, because the load applied on the bottom of the coil is reduced to ⅓–¼, there is no fear of incurring sticking even on a very thin strip coil.

Furthermore, since the present furnace is equipped with the movable heat exchanger, the cooling cycle is also reduced by a large margin, which in turn mitigates overall heat processing.

This means quick delivery, high productivity and low housing height because of low furnace height.

Since the present furnace dispenses with consumables such as an inner cover, material handling is greatly alleviated and manpower can be reduced to the minimum, resulting in a most economical operation.

What is claimed is:

1. A furnace adapted to anneal coils, comprising a plenum chamber defined by a base and a heating cover, a first set of radiant heating pipes mounted over the base and in close proximity thereto, a second set of radiant heating pipes mounted beneath the top of the cover and spaced above the first set of radiant heating pipes, adjustable baffles mounted in a zone between the top of the cover and the second set of radiant heating pipes, a blower mounted in the chamber at about the level of the first set of radiant heating pipes, a first duct communicating with the blower and opening in close proximity to an extremity of the first set of radiant heating pipes, a second duct communicating with the blower and opening below the level of the second set of radiant heating pipes, a heat exchanger adjustably mounted in an opening through the heating cover, the heat exchanger being reversibly adjustable from a position in close proximity to an extremity of the second set of radiant heating pipes and with an extremity of the heat exchanger being in communication with the opening of the second duct and an opposite extremity of the heat exchanger being in communication with the zone between the top of the cover and the second set of radiant heating pipes to a position in which the heat exchanger is retracted from the chamber, the blower being substantially axially aligned with the first duct and a plane passing through the first set of radiant heating pipes and being substantially radially aligned with the second duct, and means for supporting a plurality of coils, in side by side relationship and with their axes upright, between the first and second sets of radiant heating pipes, whereby rotation of the blower is adapted to circulate a gas up through the second duct, past the heat exchanger when it is in its non-retracted position, above the second set of radiant heating pipes, downward with the assistance of the baffles to and through the coils and finally past the first set of radiant heating pipes and through the first duct back to the blower.

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