United States Patent [19]

Sass

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[54] **METHOD AND DEVICE FOR HEATING AND FLANGING CIRCULAR DISCS**

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[73] Assignee: **Ottensener Eisenwerk GmbH**

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Sept. 29, 1971 Germany 2148519

[52] **U.S. Cl.** **72/69,** 72/342
[51] **Int. Cl.** **B21k 29/00**
[58] **Field of Search** 72/69, 86, 87, 342

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Attorney, Agent, or Firm—Hill, Gross, Simpson, Van Santen, Steadman, Chiara & Simpson

[57] **ABSTRACT**

Circular discs used for boiler bottoms are flanged by being clamped, one at the time, in a flanging device and then are rotated about their central axis to be first heated along their circumferential marginal zone by a heat inductor supplied with alternating current. The heat inductor is U-shaped so as to embrace the circumferential edge of said circular disc to cover both sides of the same over a sector-shaped area. The heated marginal zone of said central disc during its rotation is shaped into the desired flange by flanging rolls, preferably mounted opposite the location where the heat inductor is caused to heat the circular disc.

20 Claims, 13 Drawing Figures

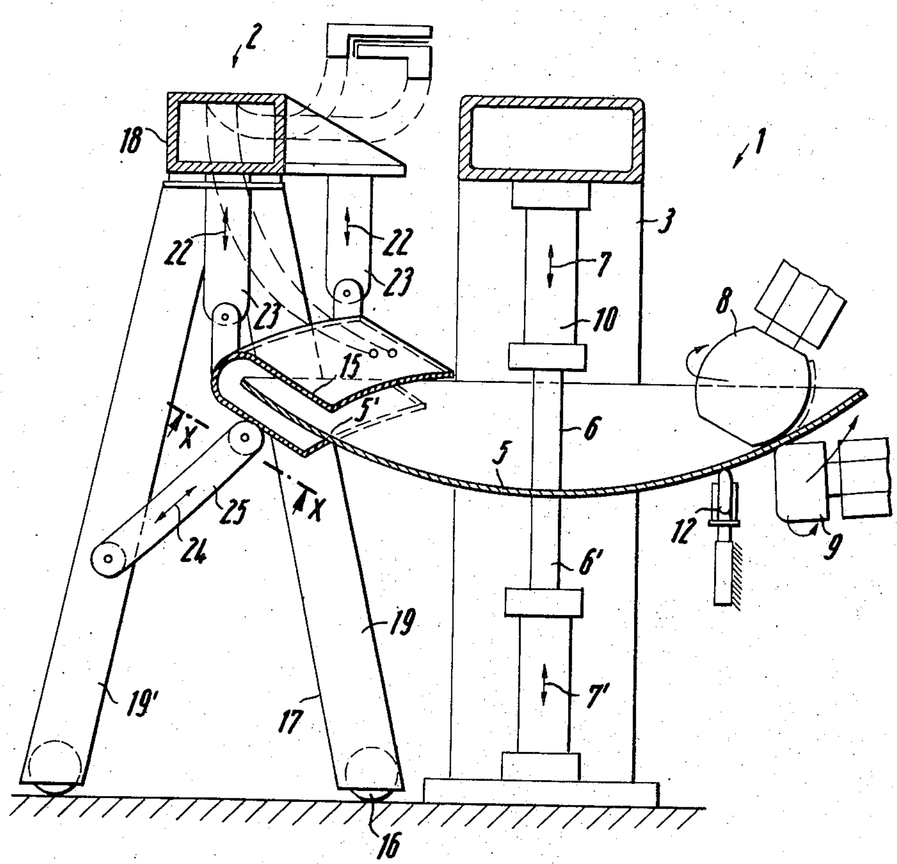

Fig. 1

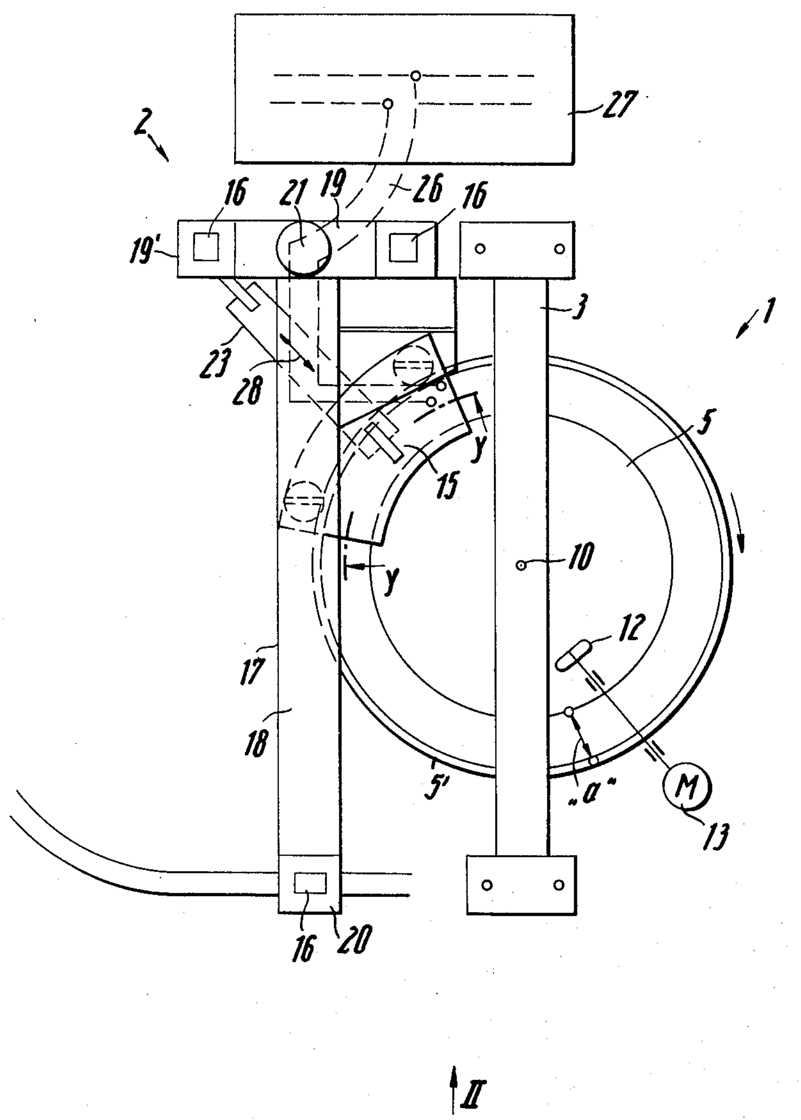

Fig. 2

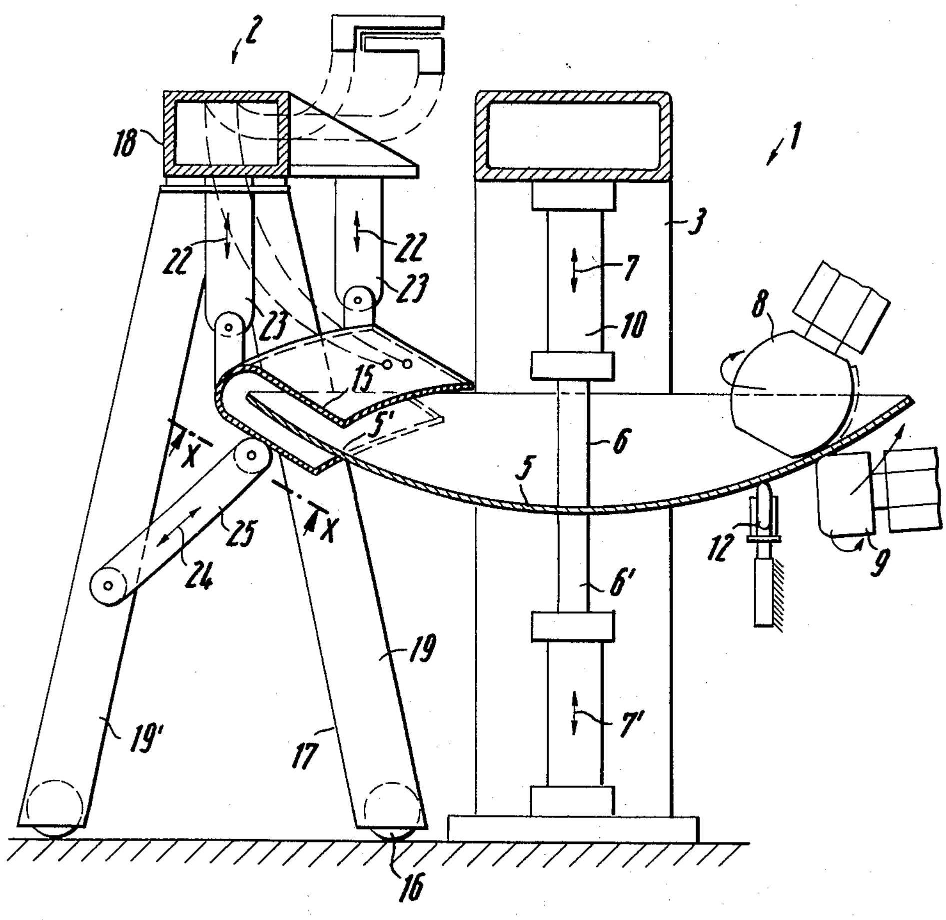

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Fig. 3

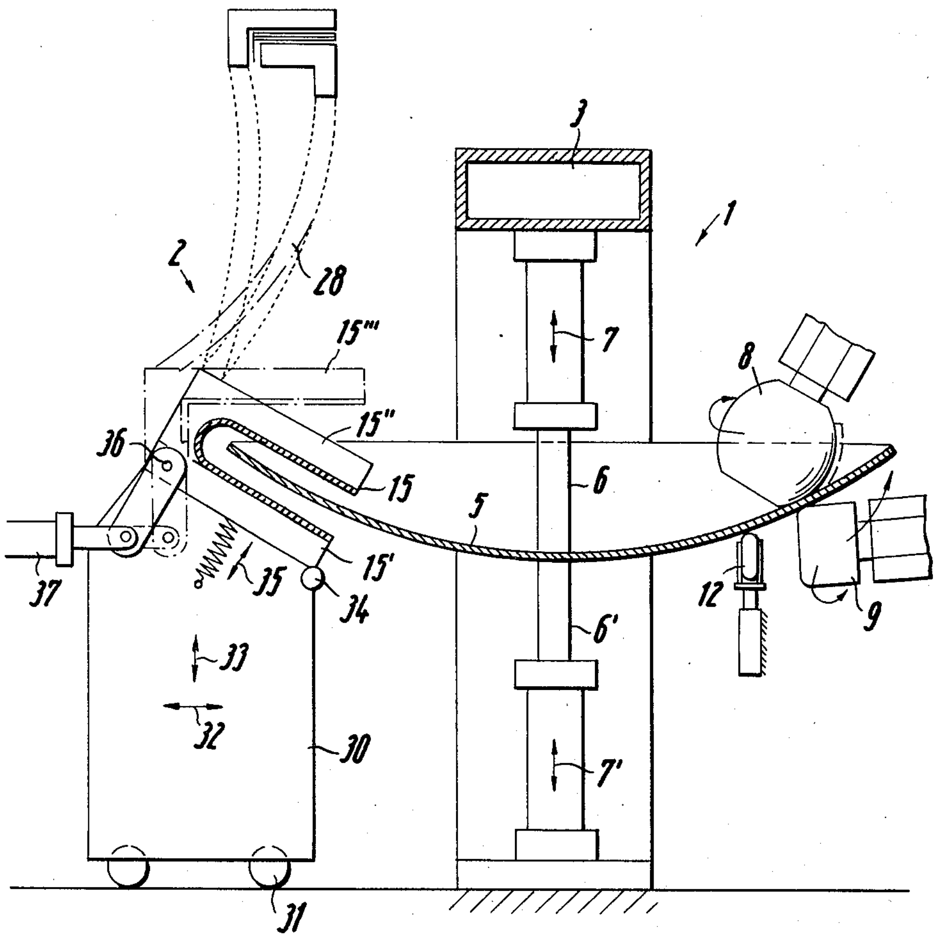


Fig. 4

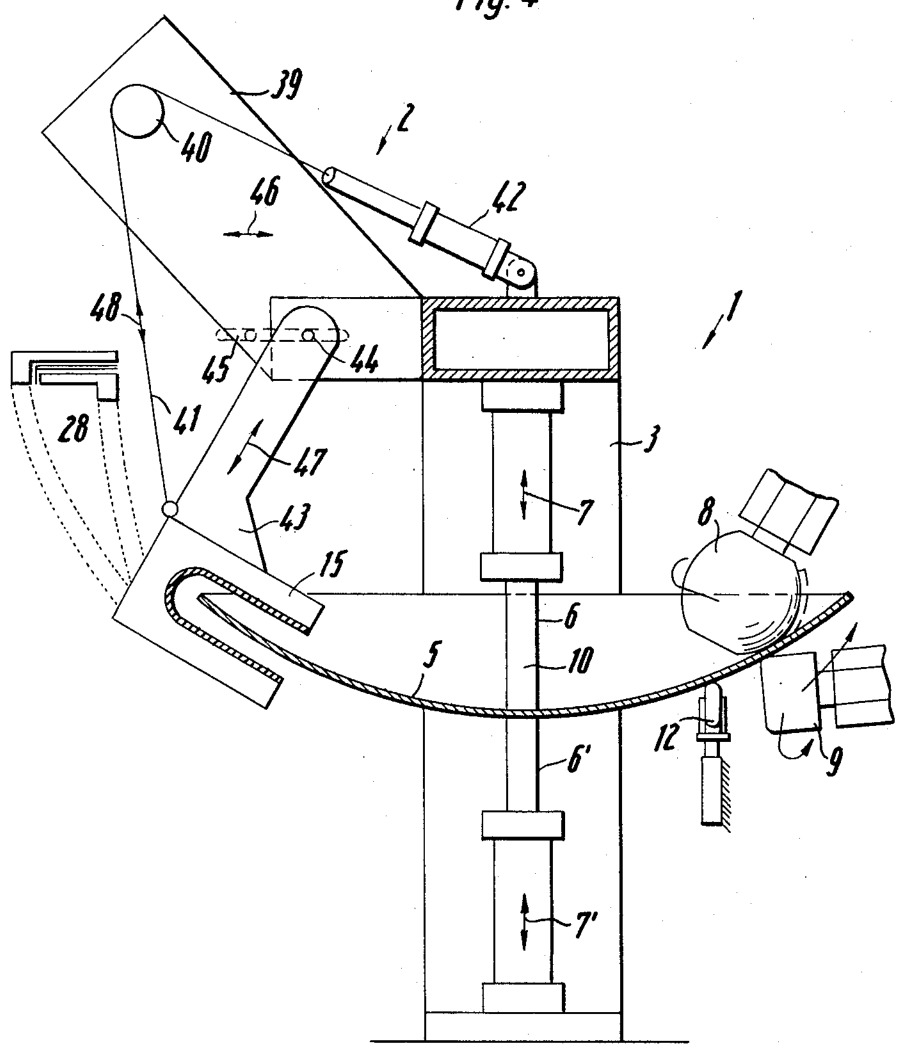


Fig. 5

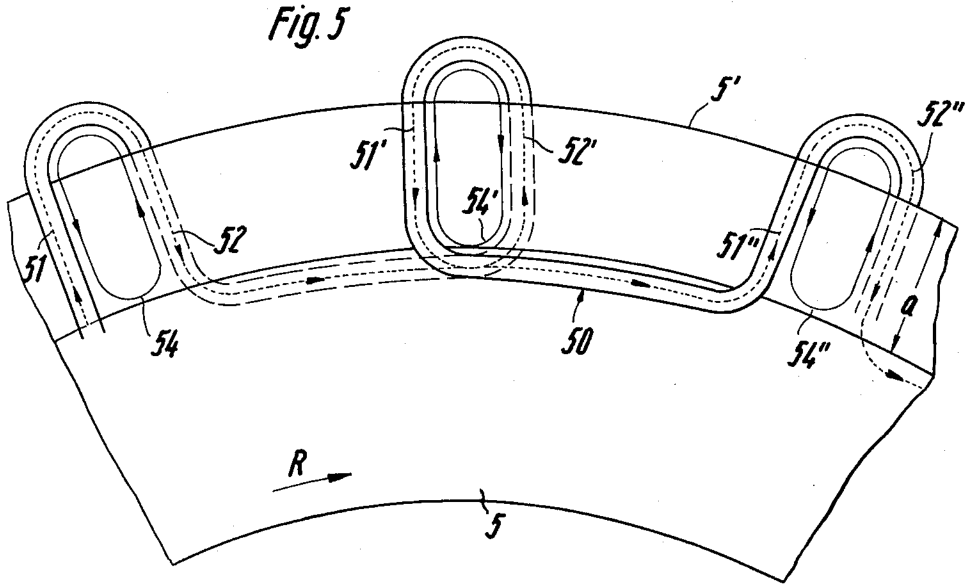
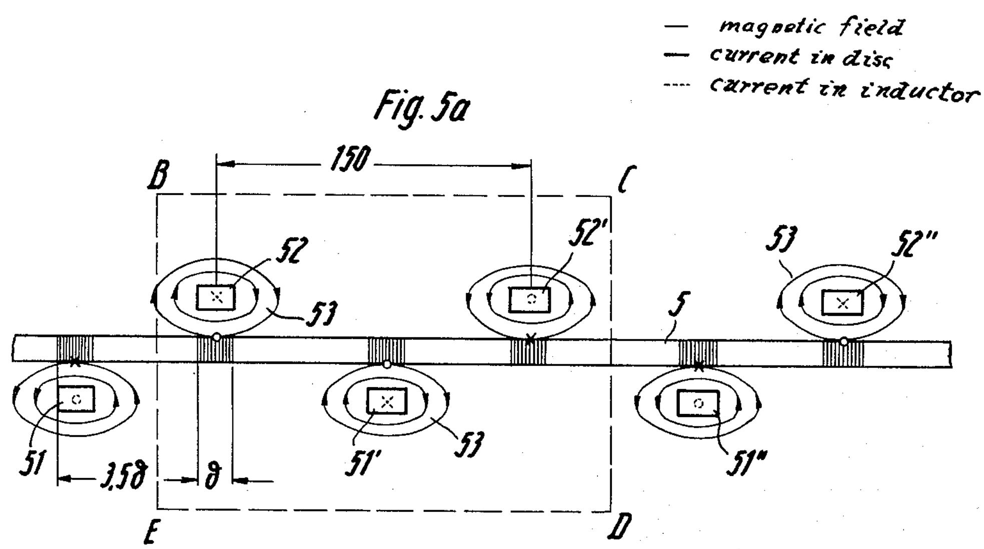

5'
52"
51'
52'
54'
52
51"
51
54
50
54"
a
R
5

Fig. 5a


— magnetic field
— current in disc
---- current in inductor
150
B
C
52
52'
53
52"
5
51
51'
51"
3.5δ
δ
E
D

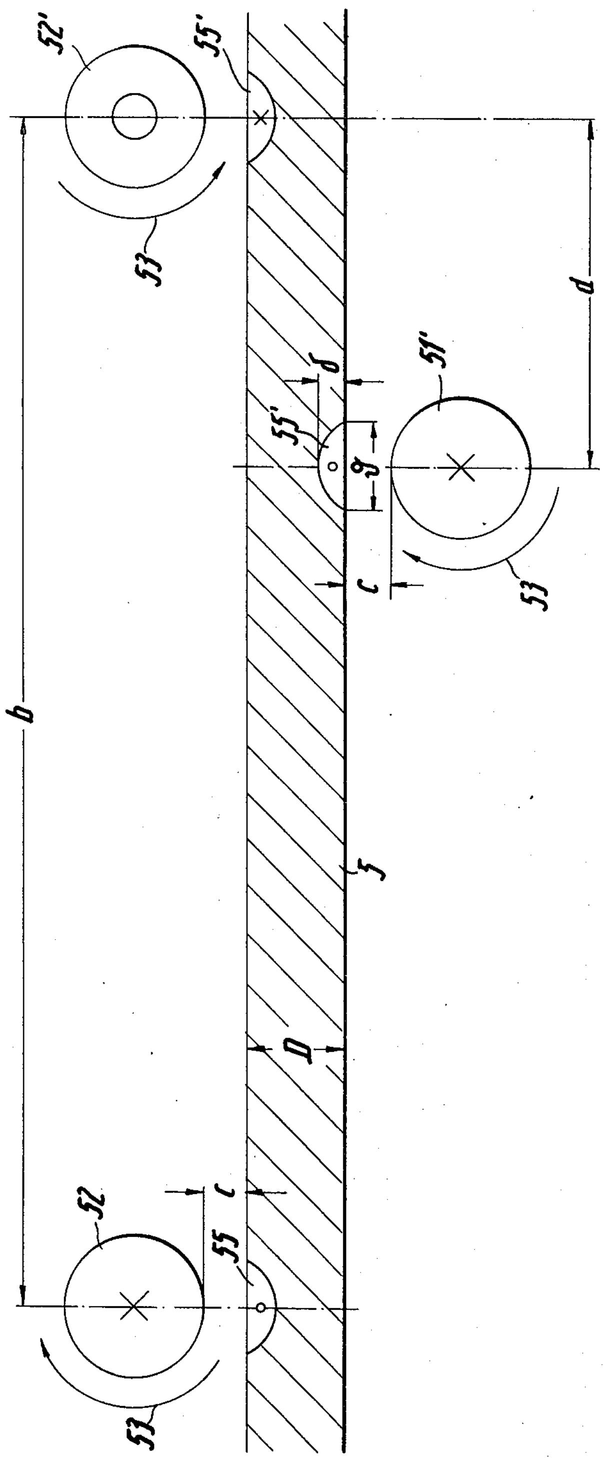
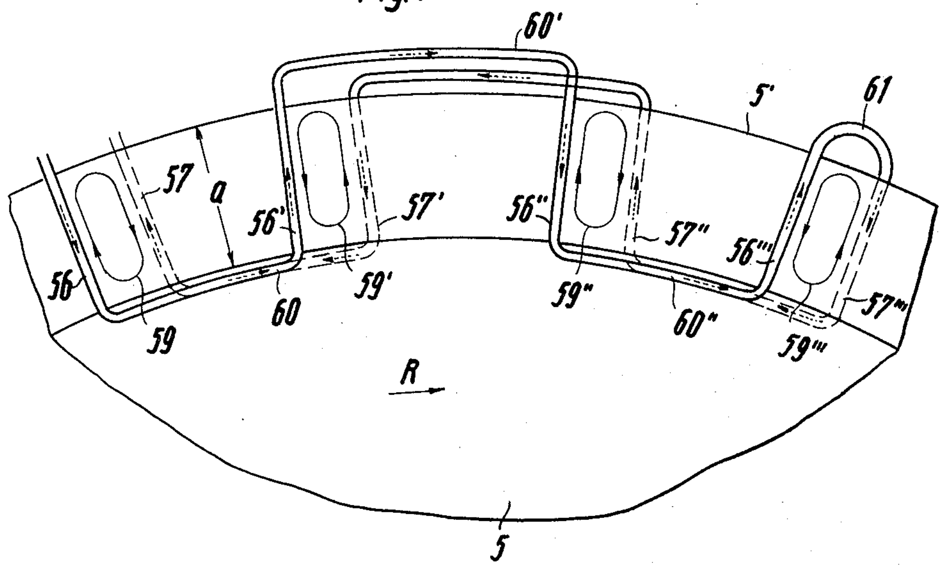


Fig. 6

Fig. 7



— magnetic field
— current in disc
--- current in inductor

Fig. 7a

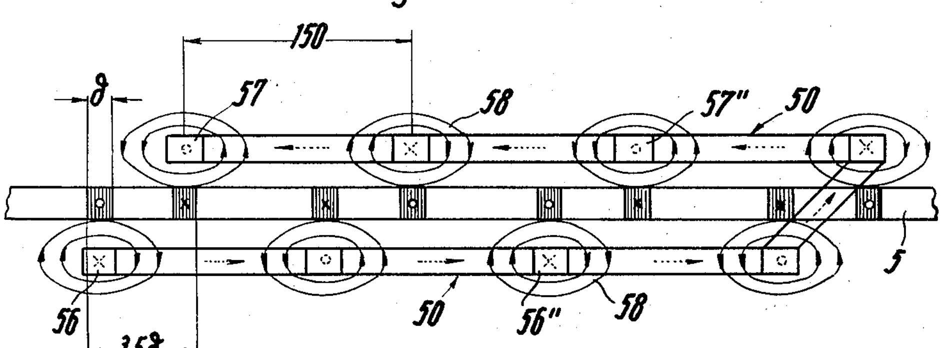


Fig. 8

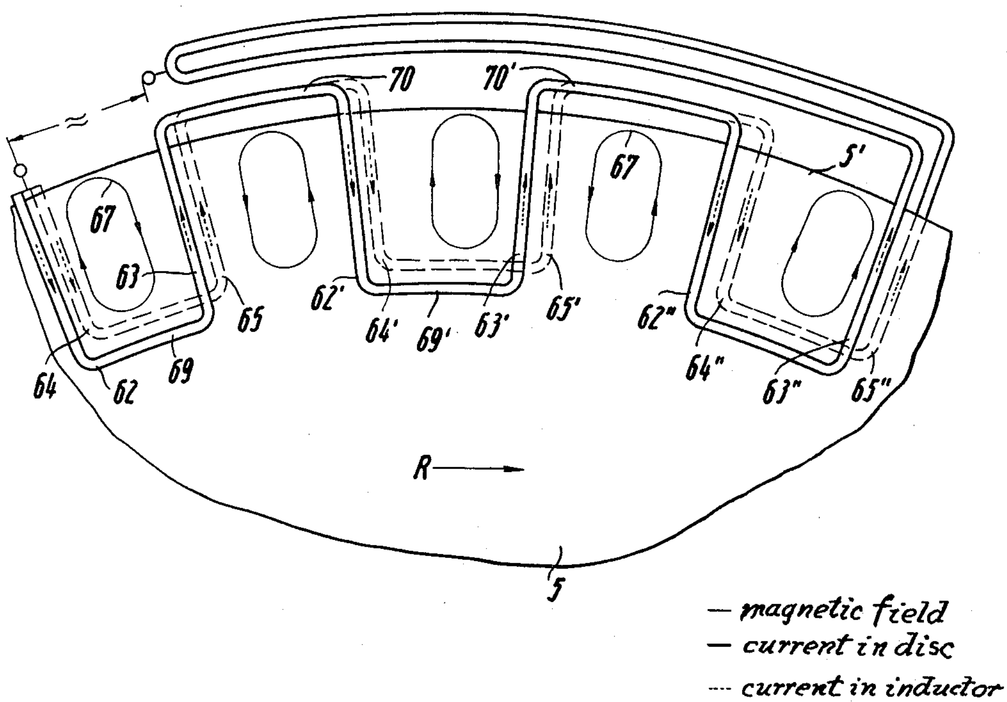

70
70'
5'
67
67
63
65
62'
64'
69'
63'
65'
62"
64
62
69
64"
63"
65"
R
5
— magnetic field
— current in disc
---- current in inductor

Fig. 8a

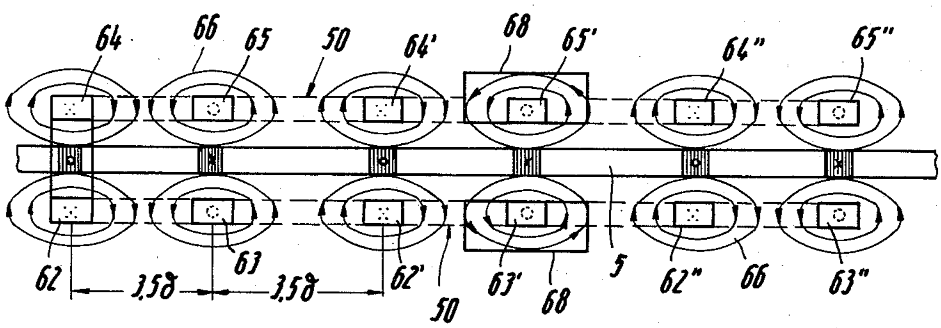

64
66
65
50
64'
68
65'
64"
65"
62
3,5δ
63
3,5δ
62'
50
63'
68
5
62"
66
63"

Fig. 9

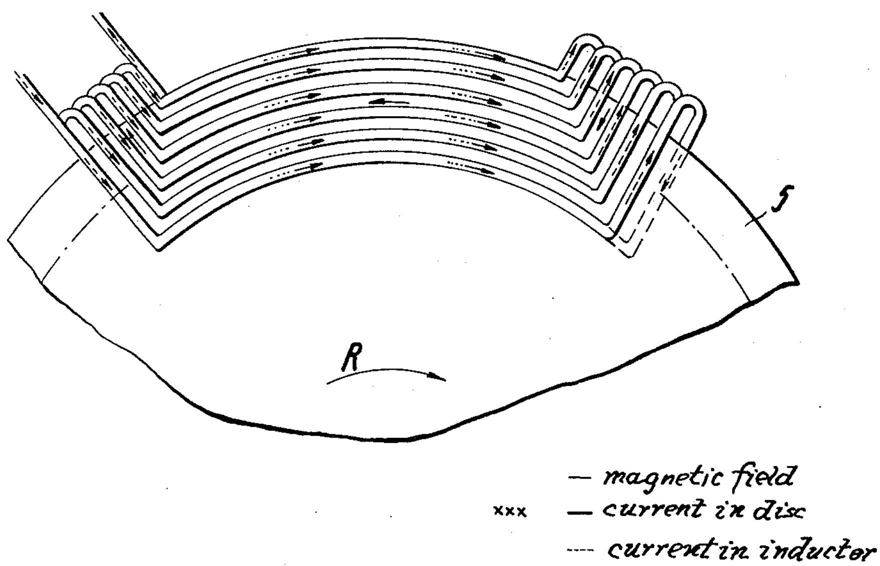
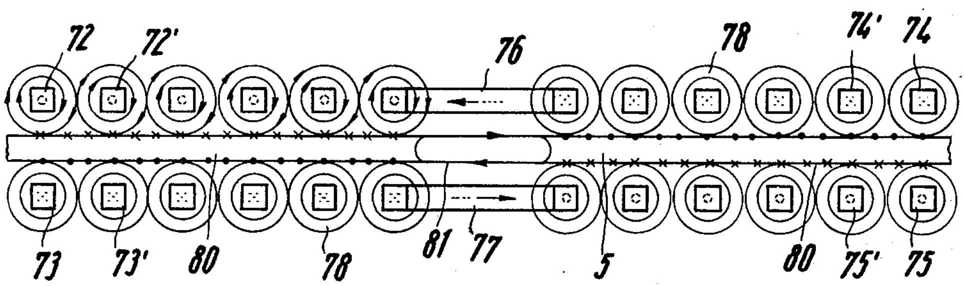

5
R
— magnetic field
××× — current in disc
---- current in inductor

Fig. 9a


72
72'
76
78
74'
74
73
73'
80
78
81
77
5
80
75'
75

METHOD AND DEVICE FOR HEATING AND FLANGING CIRCULAR DISCS

The invention relates to a method of heating and for flanging or pressing of circular discs, particularly used for boiler bottoms made of ferritic or austenitic material.

Circular discs for boiler bottoms are worked or deformed in a cold condition, provided the wall thickness permits this. Circular discs having a greater wall thickness heretofore were heated in its entirety in a furnace and then pressed in a die. This method is, however, very expensive and the transportation of the red-hot discs is complicated.

In the manufacture of containers or container parts made of aluminum it is known to employ a local heating by an electrical induction heating without interrupting the rolling pressure operation. This method, when employing work pieces made of an aluminum alloy, apparently has the purpose to avoid that the work piece remains a longer period of time at a higher temperature prior to the deformation and when this is done one avoids an outward diffusion of the copper, and furthermore the compression of the material and the increased strength produced by the rolling operation is maintained. This known method employed with aluminum has, however, the disadvantage that with a continued deformation during the flanging operation the cross-sectional form of the marginal zone of the circular disc changes constantly and accordingly an adjustment of the inductor to this cross-sectional form is almost impossible. An insufficient adjustment or adaptation of the inductor to the cross-sectional form of the marginal zone of the circular disc results, however, in a poor degree of efficiency of the inductor. Furthermore, the rotative speed of the circular disc which is determined by the rolling pressure operation is low and therefore the heat dissipation toward the center of the circular disc is substantial so that heat losses and distortions of the circular discs are produced.

Heat inductors which operate with alternating current are known per se. It is also known in the art to employ heat inductors for heating of articles which are deformed later.

It is an object of the invention to effect an inductive heating with the greatest possible efficiency and to avoid extensive losses in the action of the magnetic field. This is accomplished in that the circular disc at first is slightly predeformed in a cold condition, then is centrally clamped, and thereafter is rotated about its center axis and thereby is heated in the range of its marginal zone by an alternating current inductor which impinges the circular disc over a sector-shaped area so that the marginal zone can now be flanged; thereafter the circular disc is again released from its clamping engagement.

In this manner the heating operation is separated from the deformation operation. A change in the cross section of the marginal zone of the circular disc does not occur during the heating operation. For this reason the inductor can be well adapted to the cross-sectional form which remains always the same. A further possibility of adaptation to the quality of the material and to the thickness of the material is provided by the application of alternating current whose frequency is changed. Furthermore, the rotative speeds of the circular disc during the heating on one hand and during the deformation on the other hand may be different from each other. The rotative speed during the heating is so selected that the time period between two heating periods during the passing of the respective area of the marginal zone of the circular disc through the inductor is so short so that the heat dissipation toward the center of the circular disc between the two heating periods is neglectable. In accordance with the invention the rotative speed and the feed of the induction heat may be adjusted with respect to each other that the marginal zone of the circular disc is sufficiently heated, for instance to a temperature of 800° C, while the center zone of the circular disc remains practically cold, for instance below a temperature of 100° C.

Even though the separation of the heating operation from the deformation in accordance with the invention may be constructed in various manners, for instance in that the circular disc may be moved or pivoted from the effective range of inductor into the flanging tool, the preferred method in accordance with the invention comprises that first the inductor is moved into the range of the marginal zone of the circular disc and after completion of the heating operation is moved away from the same, whereupon the flanging tool is put into operation.

At any rate, the circular disc in this manner, in spite of the separation of the two mentioned operations from each other, remains in the same device and after heating is deformed or flanged in the same device.

A device for practicing the above-described method steps comprises a flanging machine and an inductor unit whose inductor is adjustable with respect to the circular disc and in which the heating effect is variable.

It is also an object of the invention to provide the inductor unit with a portable pedestal which is separated from the flanging machine and may be rolled toward the circular disc and away from the same, whereby the inductor is mounted on this pedestal in a manner to be adjusted in vertical direction and also in angular direction.

This arrangement has the advantage that the entire inductor unit comprises a separate part of the entire arrangement. For deforming smaller boiler bottoms, in which a heating of the bottoms is not necessary, the mentioned heating unit would stand aside. Nevertheless, one has the possibility to serve two alternating operating flanging machines with a single condenser-control box so that an improved exploitation of the installed arrangement is attained.

Another object of the invention is to arrange the inductor unit on a carriage which is separated from the flanging machine and may be moved toward and away from the circular disc, whereby the carriage is adjustable in vertical direction while the inductor is hinged and angularly adjustably secured to said carriage.

In this last-mentioned arrangement in which the inductor is hinged the carriage movement of the inductor toward and away from the circular disc, after the heating of the same, is simplified.

Finally the inductor unit may be provided with a pivoted arm which is adjustable in its length and is rotatable about a horizontally slidable pivot pin, whereby this pivoted arm carries the inductor and is operable by a cable secured to an arm fixed on the frame of the flanging machine. This arrangement requires a simple constructional display and requires no bottom for the inductor unit, and permits a very simple electric cable connection.

The inductor may cover about one-fourth of the circumference of the circular disc. The mentioned coverage of the circular disc by the inductor depends upon the time period necessary for the heating operation. If the boiler bottom is to be heated within a relatively short period of time, then the inductor is supplied with a higher amount of energy. In order to maintain a constant energy density on the circular disc it is necessary to cover the disc over a greater area. During normal heating periods the coverage of the circular disc amounts to about one-fourth of its circumference in the range of the heating zone.

The inductor embraces the margin of the circular disc with two spaced parallel legs so that on both sides of the circular disc induction currents are produced. One leg of the inductor may be arranged to be pivoted away or toward the circular disc in order to speed up the operation of the device when introducing a new circular disc or after the heating operation has been completed and in order to facilitate the deformation of the annular zone by the flanging tool.

The condenser-control box may be equipped with means for adjusting the frequency of the alternating current flowing to the inductor to a predetermined value.

For the purpose of generating the induction heat the present invention makes use of the knowledge that a magnetic field extends circularly around an electric conductor through which an electric current passes in accordance with the Maxwell Rule. If an alternating current passes through the conductor, then the direction of rotation of the magnetic field changes with the frequency of the alternating current. In accordance with the invention the marginal zone of the circular disc is subjected to the changing direction of rotation of a circularly moved magnetic field. This has the result that an electric current is induced in the marginal zone of the circular disc and this electric current effects a heating of the mentioned marginal zone. In the present case a movement of the circular disc in this magnetic field is not necessary in view of the employment of an alternating current, but a movement of the circular disc would be required when only a direct current would flow through the conductor for the purpose of inducing an electric current. In the present case, the rotative movement of the circular disc is solely used for the purpose of moving the entire marginal zone through the inductor in order to keep the induction heat as far as possible away from the center of the circular disc.

In accordance with the above discussion, the inductor of the present invention comprises a continuous conductor forming loops which are open toward the center of the circular disc. This construction of the inductor makes it possible to conduct induction heat to the sheet metal of the circular disc in a very simple manner to both of its sides, namely from below and from above, and it is also possible to arrange the loops of the conductor for this purpose in different manners.

According to a first embodiment of the invention, the conductor loops embrace the edge of the circular disc alternately in the form of a "U" and in the form of a helical turn, whereby the loop arms extend radially over the width of the marginal zone and have a distance *d* from each other and a comparatively larger distance of the loops which are spaced from each other a distance *d*. Each loop forms in this manner a heating sector within the inductor so that a larger diameter between the loops avoids a mutual influence or interference. Each loop induces in the sheet metal of the circular disc a closed electric circuit whose length in radial direction of the circular disc is larger than in circumferential direction. An inductor of this construction is very simple and can easily be installed in an inductor frame. An extension of the inductor circumference is possible without difficulties for the purpose of adaptation.

In accordance with a second embodiment of the invention the loops extend radially over the width of the marginal zone and are uniformly offset with respect to one another in circumferential direction and are formed by a conductor positioned on both sides of the circular disc and running from one side of the circular disc toward the other backwards. The loop arms have a distance *d* from each other and the loops have a distance *b* from each other. In the present case the form of the loops according to the size and distance from each other is the same as above-mentioned, but owing to the path of the conductor on one side of the circular disc and back and forth on the other, this particular arrangement is particularly suitable for a foldable inductor. Of course, in the last-named arrangement one has to expect increased ray losses because the direction of the current owing to the adjacently disposed conductors are different on the edge of the circular disc.

According to a third embodiment of the invention the loops of the conductors extend radially over the width of the marginal zone of the circular disc and are formed uniformly and positioned mirror-like. On both sides of the circular disc the conductor extending back and forth has loop arms which have a distance *d* from each other and the loop arms are covered by ferrous shielding sheets.

The form of the loop is substantially the same as in the previously described embodiments, but the intensity of the induced electric circuits is substantially greater because each loop arm, namely above and below the circular disc, comprises a conductor through which a current flows in the same direction. The effect obtained is amplified by the mentioned ferrous shielding sheets causing a concentration of the magnetic field.

The mentioned ferrous shielding sheets are also necessary in avoiding a mutual influencing of the conductors which extend in axial direction of the circular disc.

According to a fourth embodiment of the invention the loops embrace the edge of the circular disc only in the range of the inlet and outlet in a U-shaped manner and extend radially toward the inlet and outlet over the width of the marginal zone while in circumferential direction on both sides of the circular disc the loops are connected with conductor sections. In this arrangement are not induced as heretofore electrical circuits in the circular disc whose length in radial direction is greater than in the circumferential direction, but the induced electric circuits extend now predominantly in the circumferential direction of the circular disc, and then induced current flows with a limited penetration depth on the one side of the circular disc and then back towards the other side. The distance of the conductor which in this case forms a loop and extends in circumferential direction on both sides of the circular disc is compared with the opposite conductor relatively small, so that the one conductor interferes with the magnetic field of the other conductor and weakens it. This makes it known in a amplified manner and leads to a limited heat supply to the marginal zone of the circular disc when the latter consists of a ferretic material and the heating temperature reaches the Curie point at which the material looses its magnetic property. After the Curie point has been reached the penetration depth in the magnetic steel is much greater than below this point and the induced currents in the work piece are largely compensated. Furthermore, owing to radiation the portion of the induced energy is lost. This last-named arrangement is suitable, therefore, for an automatically operating temperature limitation at circular discs made of ferretic material so that it is assured that the temperature of 800° C may not be exceeded. The heated material therefore cannot become overheated.

In all above-mentioned embodiments of the invention it is advisable to provide an insulation against heat radiation which may occur when the circular disc is heated.

The invention will now be described in greater detail with reference to a number of embodiments having reference to the accompanying diagrammatic drawings. In the drawings:

FIG. **1** illustrates a device in accordance with the invention in a top elevation view.

FIG. **2** illustrates the device of FIG. **1** in a side elevation view in the direction of the arrow II in FIG. **1.**

FIG. **3** illustrates a modified device in a view similar to FIG. **2.**

FIG. **4** illustrates another modification of the device of the invention.

FIGS. **5** and **5***a* illustrate the construction of an inductor in accordance with the invention.

FIG. **6** illustrates the area B, C, D and E indicated in FIG. **5***a* in an enlarged scale.

FIGS. **7** and **7***a* illustrate a second embodiment of the inductor in accordance with the invention.

FIGS. **8** and **8***a* illustrate a third embodiment of the inductor in accordance with the invention.

FIGS. **9** and **9***a* illustrate a fourth embodiment of the inductor of the invention.

Referring to the FIGS. **2, 3** and **4**, the device of the invention comprises first of all a flanging machine **1** provided with flanging rolls **8** and **9** and an inductor unit **2.** The flanging machine **1** is provided with a frame-like main gate **3** in its center. The inductor unit **2** is mounted opposite the flanging rolls **8** and **9.** Between the inductor unit **2** and the flanging rolls **8** and **9** a circular disc **5** is disposed in the main gate **3** and is clamped in position between two vertically disposed hydraulically operated bilaterally impinging pistons provided with dies **6** and **6'** which engage this center of the circular disc **5.** The latter by means of the mentioned pistons and dies **6** and **6'** may be clamped in position in the gate **3** at any desired height as is indicated in the FIGS. **2, 3** and **4** by the arrows **7** and **7'.**

Each one of the flanging rolls **8** or **9** effect a rotative movement of the circular disc **5** during the deforming or flanging operation, whereby the circular disc **5** is rotated about the vertical axis of rotation **10,** while the clamping dies **6** and **6'** hold the circular disc in position at the desired level. The flanging rolls **8** and **9** may be moved toward and away from the axis of rotation **10** as is indicated by the arrows. A supporting roll **12** may be urged against the cold portion of the circular disc by a motor **13** (FIG. **1**) in known manner. This portion of the device is independent from the inductor unit **2** and has always the same construction while the inductors **15** may have different constructions. In other words, in all modifications of the invention the device which deforms the marginal zone of the circular disc is always the same. The inductor unit **2** is that part of the entire arrangement which permits a movability or adjustability of the inductor **15** relative to the circular disc **5.**

Referring to the FIGS. **1** and **2,** the inductor unit **2** is equipped with a portable pedestal **17** having traction wheels **16** so that the unit **2** may be moved independently from the flanging machine **1** and is separated from the latter. The pedestal **17** has mounted thereon an inductor **15** adjustable in vertical direction and in angular direction. The pedestal **17** is provided with a horizontally extending beam **18,** one end of which is rotatable about a vertical pivot axis **21** and has two downwardly spreading legs **19** and **19'** and another leg **20** rigidly connected with the other end of the beam **18.** The legs **19, 19'** and **20** are provided at the lower ends with traction wheels **16** so that the three-legged pedestal may be moved parallel to a plane containing the spread legs **19** and **19'** and the horizontal beam **18** may be pivoted around the pivot axis **21.** In this manner the beam **18** according to its working position may be adjusted to suit the diameter of the circular disc **5** and may be moved toward and away from the same and its rest position or inoperative position may be moved completely outside the range of the circular disc **5** in the plane of the spread legs **19** and **19'.**

The inductor **15,** for the purpose of being brought in cooperation with the boiler bottom to be formed, is attached to the horizontal beam in such a manner that it may be adjusted in vertical direction and also in angular direction. The vertical adjustment is accomplished by two horizontally spaced and vertically disposed electrically operated adjusting spindles **23** movable in the direction of the arrows **22,** while the angular adjustment of the inductor **15** in the directions indicated by the arrows **24** is effected by an electrically operated adjusting spindle **25.** In place of the electrically operated adjusting spindles one may also employ, for instance hydraulically operated piston elements. The upper ends of the vertical adjusting spindles **23** are fixedly attached to the horizontal beam **18,** while the adjusting spindle **25** is pivotally connected with the spread legs **19, 19'.** The inductor **15** is pivotally connected with the adjusting spindles **23** and **25.** Accordingly, the inductor **15** may be adjusted in all directions.

The inductor **15** has a U-shaped cross section forming spaced upper and lower jaws between which extends the marginal area of the circular disc in such a manner that the inductor **15** covers a sector of the circular disc of an area of about 60° and a depth which corresponds to the width *a* of the marginal zone **5'** to be heated. The particular construction of the inductor **15** and the arrangement of the conductors within the same will be described hereinafter.

The feed of the electric current to the inductor **15** is effected by a conductor strap **26** (FIG. **1**) which leads from a condenser-control box **27** to the inductor unit **2.** From the conductor strap **26** flexible medium frequency cables **28** lead to the inductor terminals. It should be noted that for the purpose of adjusting the inductor it is not necessary to separate the electrical connection leading to the condenser-control box **27**.

The condenser-control box **27** is arranged laterally off the entire arrangement. The energy transformation is effected by a static frequency transformer which for the purpose of a better efficiency is capable of supplying electric current to two devices one after the other.

During the heating period all open portions of the circular disc **5** may be covered by means preventing heat radiation which improves the efficiency. The covering means for this purpose are conventional and may be easily removed and therefore are not particularly illustrated.

The inductor unit **2** illustrated in FIG. **3** is also separate from the flanging machine **1** and comprises a portable inductor carriage **30** adjustable as to its height and on which the inductor **15** is so attached that it may be adjusted in angular direction. The inductor carriage **30** is provided with traction wheels **31** which are adjustable in vertical direction so that the inductor carriage may be moved in the direction of the arrows **32** and **33**. The inductor **15** is arranged pivotally adjustable at the upper end of the inductor carriage **30** in such a manner that it may be adjusted about a horizontal axis **34** in the direction of the arrow **35**. In the present instance the inductor **15** is provided with a lower jaw or leg **15'** and an upper jaw or leg **15''** which both are pivotally connected with each other about the axis **36**, and may be provided with respect to each other by means of an electrically or hydraulically operating mechanism **37**, so that the inductor jaws may be able to open or close. **15'''** illustrates the position of the upper jaw of the inductor **15** when it is open. This open position of the upper jaw is employed when the unit **2** is moved toward the flanging machine for the deformation operation. Both inductor jaws **15'** and **15''** are electrically connected with each other as will be explained hereinafter.

Concerning the flanging machine **1** and the current supply to the inductor unit **2**, the same conditions prevail as described in connection with the FIGS. **1** and **2**. In the modification of FIG. **3**, however, the medium frequency cables **28** are so flexible that they move with the upper inductor jaw **15''**.

In the embodiment of the arrangement of the invention as illustrated in FIG. **4** the inductor unit **2** is provided with a rigid arm **39** which extends inclined upwardly from the gate **3**. This arm **39** projects away from the axis of rotation **10** of the circular disc **5** and is provided at its upper outer end with cable sheave **40** guiding a cable **41** one end of which is connected to a piston rod belonging to a hydraulic lifting cylinder **42**, while the other end of the cable is connected to the lower end of the pivot arm **43** which adjacent the attachment of the end of the cable **41** has mounted thereon the inductor **15**. The pivot arm **43** is provided at its other end with a pivot pin **44** whose position may be horizontally adjusted, in that, for instance the rigid arm **39** is provided with a horizontal slot **45** so that by means of a not-illustrated electrical or hydraulic drive the pin **44** may be moved horizontally in the direction of the arrow **46**. Furthermore, the pivot arm **43**, as indicated by the arrow **47**, may be varied in its length or, in other words, this portion of the pivot arm **43** is telescopically constructed and by means of an adjusting spindle may be made longer or shorter. Finally, the movement of the cable **41** as effected by the lifting cylinder in the direction of the arrow **48** may be so accomplished that the position of the inductor **15** is adapted to the position of the circular disc **5**. The lifting cylinder **41** with the cable **41** thereon has the purpose to remove the inductor **15** after the heating of the marginal zone of the circular disc **5** so that the device may be provided with another circular disc.

The FIGS. **5** to **9***a* explain the arrangement of an electric conductor within the inductor. The conductor is basically designated by **50** and in all embodiments of the invention is arranged on the inner walls of the jaws of the inductor **15** and is positioned partly and alternately on the upper and lower inductor jaws in the form of loops which are open toward the center of the circular disc.

The FIGS. **5** and **7** to **9** illustrate the position of the conductor according to a sectional view along the line X—X in FIG. **2** viewed in the direction of the two arrows. The contour of the inductor and the inductor walls are also not shown, but the circular disc **5** and its outer edge **5'** are illustrated and the parts of the conductor **50** which in viewing direction are disposed behind the circular disc **5** and are illustrated in dotted lines. The direction of movement of the circular disc **5** is indicated by an arrow R. The FIGS. **5***a* and **7***a* to **9***a* illustrate a sectional view along the dash perimeter lines in the FIGS. **5** and **7** to **9** but in another scale and viewed in the direction of the arrows *y—y* in FIG. **1**, so that for instance a conductor shown in FIG. **5***a* above the disc **5** appears in FIG. **5** in dotted lines, because as already explained, FIG. **5** illustrates a view from below toward the disc **5**. (See also FIG. **2**).

In the arrangement of FIGS. **5** and **5***a* the looped arms **51** and **52**, **51'** and **52'**, and **51''** and **52''** designate each a loop in which a looped arm is arranged opposite each side of the circular disc **5**. The magnetic fields which move around the looped arms with alternating rotating direction are designated by **53** and the direction of rotation which is produced is indicated by arrows. The electric circuits which are induced by the individual looped arms **51**, **52**, etc. in the circular disc **5** are indicated by **54**, **54'** and **54''** and the depth of their penetration into the material of the disc is indicated by **55**, **55'** and **55''**.

FIG. **6** illustrates an areal portion B–C–D–E of FIG. **5***a* in an enlarged scale. In addition to the reference numerals which are the same as used in the FIG. **5***a*, the following references are employed in FIG. **6**:

θ=the width of penetration } of the induced electric current into the material of the disc
δ=the depth of penetration }

χ=the direction of the electric current of the induced current in the direction toward the center of the disc.

σ=the direction of the induced current in the direction from the center of the disc. The direction of the current in the corresponding conductors is then reversed.

D=the thickness of the sheet metal of the disc.

d=the distance of the arms of one loop.

b=the distance of the loops from each other.

c=the distance of the looped arm from the upper and lower face of the disc, respectively.

The optimum relation d/θ or D/δ is 3.5.

At a frequency of $f = 2$kHz, b is about 150 mm, $d = 40$ mm and $c = 12$ mm. At smaller frequencies these distances are greater.

For the arrangement according to FIGS. **5** and **5***a*, δ is considered a measurement for the depth of penetration, whereby the current in the disc flows radially in the surface of the circular disc.

In order that the operating currents which flow in opposite direction do not compensate each other, but effect a heating of the disc, it is necessary to maintain a predetermined minimum distance between the conductors. ($d = 3.5\ \theta$)

The depth of penetration of these arrangements is principally dependent upon the width of the water-cooled copper conductor and its distance c from the circular disc, i.e., the greater the distance c is between the conductor and the disc the smaller will be the depth of penetration δ at a constant width of the conductor.

In the arrangement illustrated in the FIGS. **7** and **7***a* the conductor **50** with the looped arms **56, 56', 56''** and **56'''** and the conductor sections **60, 60'** and **60''** therebetween extends below the circular disc **5** and with the looped arms **57, 57', 57''** and **57'''** and the corresponding conductor sections extend in circumferential direction above the disc. Owing to the looped arms **56, 57,** etc. which are offset with respect to each other below and above the disc **5** and extend substantially radially and their magnetic fields **58,** there are induced electric circuits **59, 59'** and **59''** in the sheet metal of the disc. At the reversing point **61** of the conductors **50** is provided a deflection. The dimensions of the loops and their distances from each other are the same as in the arrangement according to FIGS. **5** and **5***a*. Nevertheless, in the conductor sections extending in circumferential direction and which are at a shorter distance from each other particularly at **60'** and wherein the direction of the currents in both conductor sections is different one has to expect higher stray field losses, but this particular arrangement is particularly well-adapted for a pivotally mounted inductor.

In the embodiment of the invention illustrated in the FIGS. **8** and **8***a* the arrangement of the conductor within the inductor insofar is similar as in FIGS. **7** and **7***a* in that in both these cases the conductor runs loop-shaped on one side of the circular disc in one direction and then back on the other side rearwardly, but the loops on both sides of the circular discs are in the last-mentioned embodiment not offset with respect to each other. The looped arms **62** and **63**, etc. form lower loops and the looped arms **64, 65**, etc. form upper loops. The magnetic fields are indicated by **66** and the induced electric circuits in the circular disc **5** are indicated by **67** and ferritic shield plates are indicated by **68.** The latter are employed for the purpose of improving the guidance of the magnetic field and to concentrate the same onto the circular disc. At **69, 70** and **69', 70'**, respectively, the current flow in the two closely adjacent conductor sections is in the same direction. Accordingly, there is no stray field loss.

In the embodiment of the invention illustrated in the FIGS. **9** and **9***a* the radially extending looped arms **72** and **75** are arranged closely together. These looped arms form loops which are arranged in the same radial plane on the other side of the circular disc so that for instance arm **72** forms with **73** and **74** with **75** each a loop and with the assistance of magnetic fields **78** form electric circuits **80** extending in radial direction, while the conductor sections **76** and **77** induce electric circuits **81** extending in circumferential direction.

In the arrangement illustrated in FIG. **9** the electric current during heating of the circular disc flows in the conductors on the lower side of the circular disc in circumferential direction and then goes backward on the other side of the disc. Below these conductors are formed depth of penetrations on both sides of the circular disc.

Since the depth of penetration among others is dependent upon the frequency of the electric current, it follows that a predetermined frequency the thickness of the circular disc is D = 3.5 δ. (At an optimum result.) This means that with the most frequently heated circular discs having a thickness of not more than 50 mm a relatively high frequency (such as 1,500 to 2,000 Hz) would have to be employed. For the purpose of generating high power outputs by means of static transformers one employs at the present state of development high powers at low frequencies (500 to 1,200 Hz). If one operates the inductor illustrated in FIG. **9**, for instance with 1,000 Hz, then the optimum relation D = 3.5δ becomes unfavorable, so that the currents flowing in the circular disc are partially compensated. This has the result that at the relatively large radiation surface of the circular disc and the smaller electric current heat losses an automatic temperature limitation is obtained.

What I claim is:

1. Method of heating and flanging of circular discs, particularly boiler bottoms made of ferritic and austenitic materials, comprising the steps of slightly prebending the circular disc when in a cold condition, then clamping it centrically and rotating it about its center axis and during said rotation heating the marginal zone of said circular disc by an alternating current inductor whose heat impinges sector-shaped areas of said marginal zone and then flanging said heated marginal zone after the completion of said hearing.

2. Method according to claim **1,** in which the rotative speed of the circular disc and the supply of induction heat are so correlated to each other that the marginal zone of said circular disc is heated to a temperature of substantially 800° C, while the central zone of said circular disc remains at a temperature below 100° C.

3. Method according to claim **1,** in which the inductor is caused at first to move from the exterior into the marginal zone of said circular disc and after having heated said marginal zone is again moved outwardly from said marginal zone, whereupon said heated marginal zone of said circular disc is flanged.

4. Device for the heating and flanging of discs particularly of kettle bottoms of ferritic or austenitic material, comprising means for mounting the disc on the device and for rotating the disc, an inductor unit for cooperation with the perimeter of the disc, inductor moving means cooperable with said inductor permitting radial adjustment of the inductor into and out of operating relationship with said disc, said inductor having means for alterating its heating effect, and means for forming flanging on the disc after the inductor has heated the perimeter of the disc and after said inductor moving means has moved said inductor out of operating relationship with the disc.

5. Device according to claim **4,** in which said inductor moving means comprises a portable pedestal which is separated from said flanging means and adapted to be moved toward and away from the same and means for adjusting said inductor on said pedestal in vertical direction and in its angular position. (FIGS. 1 and 2).

6. Device according to claim 4, in which said inductor moving means comprises a portable carriage which is separated from said flanging means and adapted to travel toward and away from the same, means for adjusting the height of said carriage, and means for mounting said inductor angularly adjustable on said carriage. (FIG. 3).

7. Device according to claim 4, including an arm fixed on said flanging means, an extensible lever arm pivoted with one of its ends to a pivot pin which is mounted for horizontal adjustment on said flanging means, said inductor being attached to the other end of said lever arm, a cable sheave on said fixed arm, and an adjustable cable extending from said flanging means and over said sheave to said lever arm for adjusting the position of said heat inductor with respect to said circular disc.

8. Device according to claim 4, including a condenser-control box spaced from said device and a flexible conductor line connecting said box with flexible conductor (28) leading to said heater inductor.

9. Device according to claim 4, in which said heat inductor covers substantially one sixth of the circumference of said circular disc.

10. Device according to claim 4, in which said heat inductor is U-shaped in cross section and that said circular disc is placed with its marginal zone between the two legs of said U-shaped inductor.

11. Device according to claim 4, in which said heat inductor is U-shaped in cross section and that said circular disc is placed with its marginal zone between the two legs of said U-shaped inductor, and means for pivotally attaching one leg (15'') of said U-shaped inductor (15) to its base permitting an opening and closing of the same.

12. Device according to claim 8, including means in said condenser-control box for adjusting the frequency of the alternating current supplied to said heat inductor.

13. Device according to claim 4, in which said heat conductor is provided with a continuous conductor (50) forming loops which are open toward the center of the circular disc to be worked upon.

14. Device according to claim 13, in which said loops alternately embrace U-shaped the edge of said circular disc and also in the form of a helical turn, said loops extending over the width of the marginal zone of said disc and the arms thereof being spaced from each other.

15. Device according to claim 4, in which said heat conductor is provided with a continuous conductor (50) forming loops which are open toward the center of the circular disc to be worked upon, said loops extending with straight legs radially with respect to the width of the marginal zone of said circular disc and being uniformly offset in circumferential direction of said disc and being placed to face opposite sides of said circular disc.

16. Device according to claim 4, in which said heat conductor is provided with a continuous conductor (50) forming loops which are open toward the center of the circular disc to be worked upon, said loops extending with their straight legs radially with respect to the width of the marginal zone of said circular disc and being uniformly and homologously disposed to face opposite sides of said circular disc and spaced from the surfaces of the latter.

17. Device according to claim 4, in which said heat conductor is provided with a continuous conductor (50) forming loops which are open toward the center of the circular disc to be worked upon, said loops extending only in the range of the entrance and the exit of said circular disc and embrace U-shaped the edge of said circular disc and increase gradually in radial length over the width of the marginal zone, said loops being connected with each other by conductor sections extending circumferentially and spaced from both sides of said circular disc.

18. Device according to claim 4, including insulation means for reducing the loss caused by heat radiation from the heated circular disc.

19. The method for the heating and flanging or pressing of discs, particularly of kettly bottoms of ferritic or austenitic material, in which the discs are slightly precurved in cold condition, centrally clamped or inserted and are rotatable about the centric axis, characterized in this, that during the rotational movement, solely the area of the edge zone is first heated by means of an alternating current inductor annularly or sector-shaped, respectively, acting on the edge zone, and the flanging tool entering into action solely after termination of the heating and removal from the edge-zone-area to effect flanging of each of the thus heated discs.

20. The method of claim 1 further characterized in that the speed of rotation and the supply or feed of the induction heat are so coordinated with respect to one another, that the edge zone is heated sufficiently to, for example, 800° C., while the middle zone of the disc to the contrary remains practically cold below 100° C, for example.

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