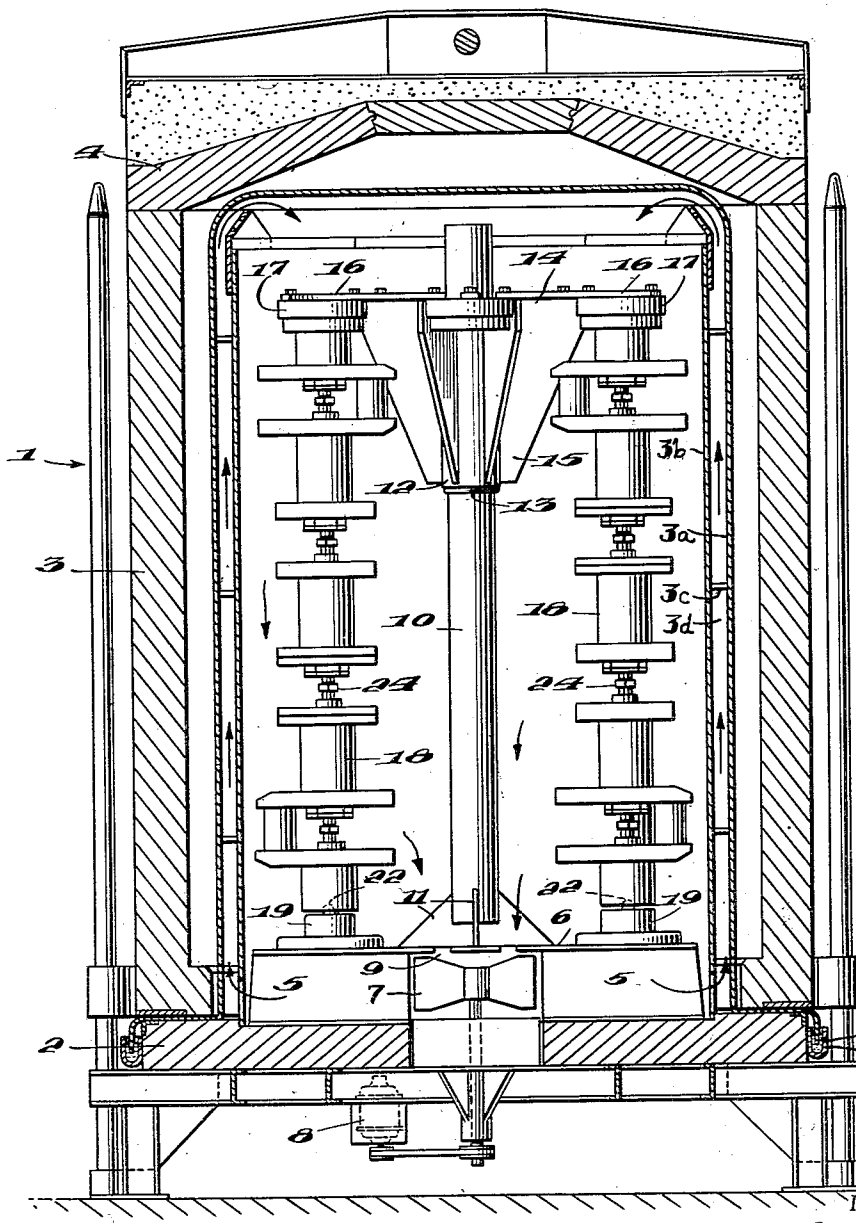
Aug. 20, 1957 R. E. LUDWIG 2,803,449

APPARATUS FOR NITRIDING CRANKSHAFTS

Filed Oct. 21, 1953 3 Sheets-Sheet 1

Fig. 1.



INVENTOR

Ralph E. Ludwig

BY Pierce, Scheffler & Parker

ATTORNEYS

Aug. 20, 1957 R. E. LUDWIG 2,803,449

APPARATUS FOR NITRIDING CRANKSHAFTS

Filed Oct. 21, 1953 3 Sheets-Sheet 2

Fig. 2.

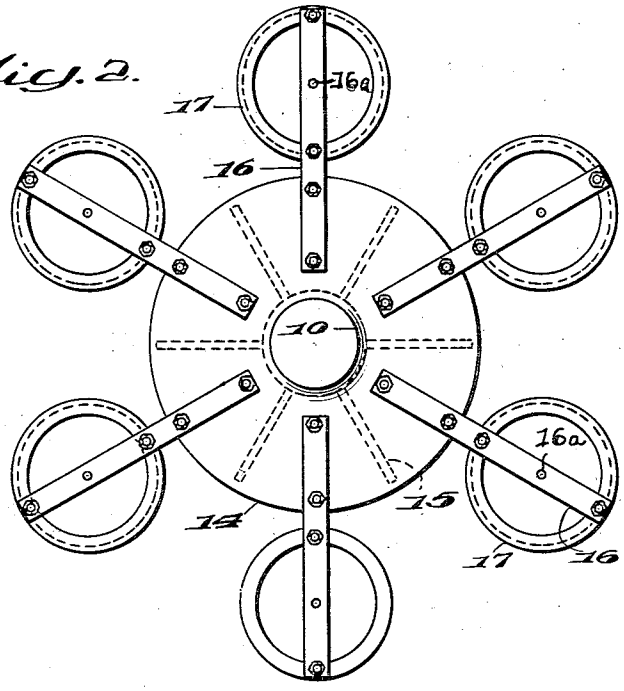


Fig. 3.

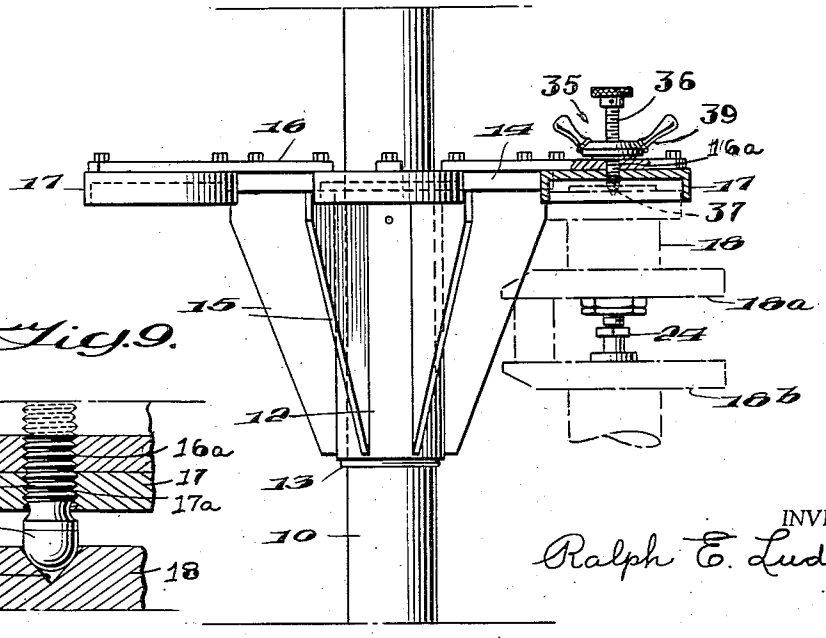


Fig. 9.

INVENTOR
Ralph E. Ludwig

BY Pierce, Scheffler & Parker
ATTORNEYS

Aug. 20, 1957 R. E. LUDWIG 2,803,449

APPARATUS FOR NITRIDING CRANKSHAFTS

Filed Oct. 21, 1953 3 Sheets-Sheet 3

Fig. 7.

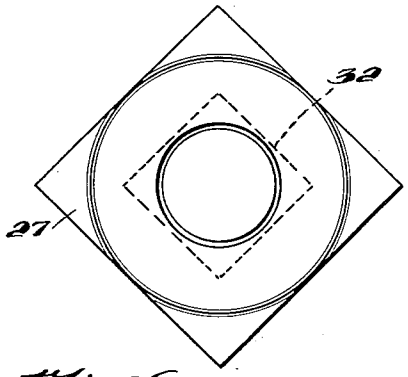


Fig. 4.

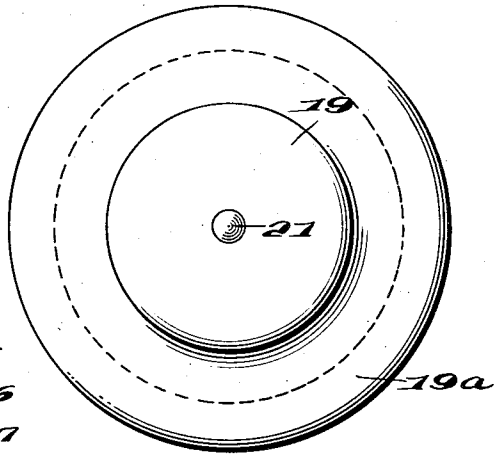


Fig. 6.

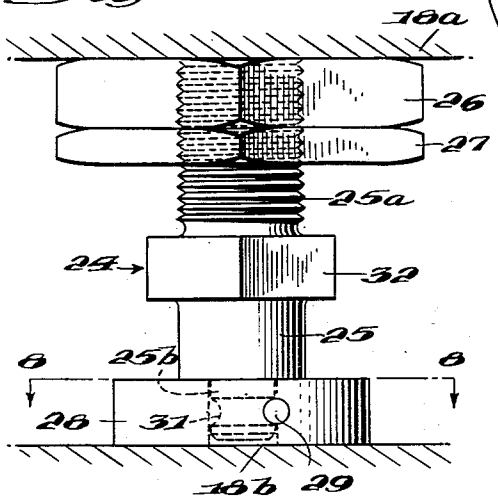


Fig. 5.

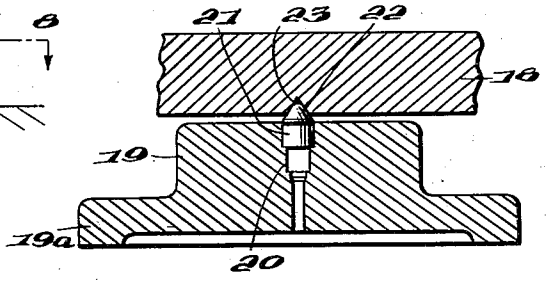
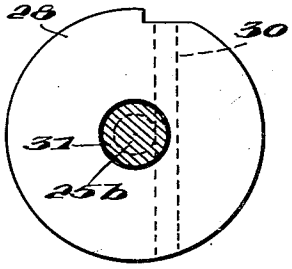


Fig. 8.



INVENTOR
Ralph E. Ludwig

BY Pierce, Scheffler & Parker
ATTORNEYS

United States Patent Office 2,803,449 Patented Aug. 20, 1957

2,803,449

APPARATUS FOR NITRIDING CRANKSHAFTS

Ralph E. Ludwig, Brokenstraw Township, Warren County, Pa., assignor to National Forge & Ordnance Company, Irvine, Pa., a corporation of Delaware

Application October 21, 1953, Serial No. 387,500

5 Claims. (Cl. 266—5)

The present invention relates to surface hardening of ferrous metals and more particularly to an improved apparatus for nitriding large sized crankshafts such as those used in diesel engines designed for locomotive and other uses.

If a crankshaft can be made without any residual stresses present after completion, the shaft will obviously be a stronger one since it is not already partially weakened by the residual stresses. If, in addition, it is possible to add to this stress-free condition the improvement which can be obtained by nitriding the crankshaft, also without introducing any out of line residual stresses, the result is a still better crankshaft.

In brief, the improved apparatus to which the appended claims are directed is comprised of a support for one or a plurality of crankshafts by which the latter are held in a vertical, on-end position within a nitriding furnace in a completely passive condition. Jacks or the equivalent placed along the axis of the crankshaft at the throw-sections, i. e. at the bearing portions for the connecting rods, make the crankshaft into practically a solid column and hold it rigid along its axis during the entire nitriding operation, thereby eliminating any tendency toward bending while in the vertical position. The effect of the nitriding is to "lock" the crankshaft permanently in this passive condition so that when the jacks are removed the crankshaft does not develop any residual stresses.

The apparatus constituting the invention will be more clearly understandable from the following detailed description of a preferred embodiment thereof and the accompanying drawings wherein:

Fig. 1 is a view in vertical section showing a furnace for nitriding and the novel means for supporting the crankshaft in a vertical, passive condition;

Fig. 2 is a top plan view, drawn to an enlarged scale, showing the detailed structure for supporting the upper end of the crankshaft;

Fig. 3 is an elevation of the support structure in Fig. 2;

Figs. 4 and 5 are enlarged plan and vertical sectional views showing details of the pivotal, preferably ball-point support structure for the lower end of the crankshaft;

Fig. 6 is an elevation of the jack unit employed at each throw section of the crankshaft;

Fig. 7 is an end view of the jack;

Fig. 8 is a transverse section of the jack on line 8—8 of Fig. 7; and

Fig. 9 is an enlarged sectional view of a detail.

With reference now to the drawings and in particular to Fig. 1, the furnace in which the nitriding is to take place is indicated at 1 and is partly conventional in construction insofar as the present invention is concerned, the construction including the usual floor 2, side walls 3 and a top 4. Resting upon the floor is a spider type of support comprising a plurality of webs 5 arranged radially on edge and which carry a horizontal annular

plate 6. A fan 7 driven by motor 8 is located in the central opening 9 of the support spider and serves to circulate the nitriding gas in the furnace over the articles to be nitrided.

In order to establish a prescribed path for circulation of the nitriding gas it will be seen that the furnace includes an inner, double-walled bell comprising an outer cylindrical bell 3*a* closed at the top, and an inner wall 3*b* spaced therefrom by brackets 3*c* to establish an annular space 3*d*. The lower end of space 3*d* communicates with the outer ends of the ducts established between adjacent plates 5 and hence the gas delivered by the fan 7 will pass radially outward through the spaces between plates 5, enter and rise upwardly through annular space 3*d*, and then pass downwardly through the interior of the inner wall 3*b* in contact with the bearing surfaces of the crankshafts to be nitrided to the intake of fan 7. To prevent loss of gas from the bell 3*a*, the lower edge of the latter terminates below the surface of an annular body of sealing liquid 3*e* contained in an annular trough 3*f*.

The remaining construction, namely the particular support illustrated for holding one or more crankshafts in the vertical position and in a passive condition during the nitriding process is not conventional but rather forms the basis of the present inventive concept to which the appended claims are directed. The novel support includes an upright cylindrical shaft 10 disposed centrally of the annular plate 6 and which is attached at its lower end to the latter by two pairs of plates 11 extending at right angles to one another. As shown more clearly in the enlarged views of Figs. 2 and 3, a sleeve 12 is slidable downwardly on the upper end of shaft 10 to a position of rest against a stop collar 13 on the shaft and is provided with an upper, horizontal end flange 14 which is reinforced by a plurality of radial webs 15 extending from the under side of flange 14 to the outer surface of sleeve 12.

A plurality of arms 16 extend radially from flange 14 and each of these arms carries at its outer end an inverted cup 17 adapted to receive one end of the multiple throw crankshaft 18 to be nitrided. In the present embodiment six such cups 17 are provided and consequently as many as six crankshafts may be nitrided simultaneously. In Fig. 2 only two crankshafts positioned in cups 180° apart have been shown in order not to unduly complicate the drawing. It will be understood however that more or less than six cups illustrated may be used if desired.

As seen from Figs. 2, 3 and 9, each of the arms 16 is provided with a drilled and tapped hole 16*a* concentric with a center, tapped hole 17*a* in the holding cup 17 adapted to receive a centering device 35 comprising a threaded shank 36 having a rounded center 37 on its lower end adapted to enter and establish a circular line contact with the lathe center 38 at the upper end of crankshaft 18. A rotatable wing nut type locking assembly 39 threaded on shank 36 is used to lock the shank against rotation.

For each cup 17 there is provided directly below the same on the plate 6 a pedestal 19 shown more clearly in Figs. 4 and 5. Pedestal 19 has a bottom flange 19*a* in the interest of better lateral stability and is provided with an axial bore 20 establishing a recess for seating a center 21, the upper end of which is preferably rounded at 22 to establish a circular line contact and is adapted to enter the lathe center 23 formed axially in the lower end face of the crankshaft as indicated in Fig. 5. Each pedestal 19 is so located on the plate 6 that the center 21 will be in vertical alignment with the upper center 37 in arm 16 thus establishing a vertical axis through

these centers parallel to the shaft 10 for support of the crankshaft.

As stated in the introductory part of this specification, the novel technique according to the present invention was developed particularly for the nitriding of very heavy crankshafts such as those used in large diesel engines. When stood on end, the crankshaft tends to sag at the throw sections due to its great mass thus giving rise to internal stresses which detract from the optimum straightness effect sought to be obtained during the nitriding action. The present invention provides a means for eliminating all sag in the throw sections to the end that crankshaft will remain in a rigid, completely passive condition free from all stresses while it is being nitrided. In particular, jacks 24 are provided at each of the throw sections of the crankshaft and these are aligned along the axis of the crankshaft as shown in Fig. 1 so that the latter becomes practically a solid, rigid column and the total weight is supported on the lower ball-point mounting.

One suitable jack construction is shown in detail in the enlarged views of Figs. 6–8. There the body of the jack is seen to be comprised of a shank portion 25 threaded at its upper end 25*a* to receive nuts 26, 27, the outermost of which is purposely made very large so as to provide a plane surface of large area for contact with one side 18*a* of a throw section of the crankshaft. The inner nut 26 is made as large as nut 27 to provide a good locking action after the jack has been set to the proper length. The lower end 25*b* of shank 25 is reduced in diameter to receive a plate 28 adapted to engage the opposite side 18*b* of the throw section, and plate 28 is retained on the shank end 25*b* by means of a dowel pin 29 which passes through a transverse bore 30 in plate 28 so located with respect to a peripheral groove 31 in shank end 25*b* that pin 29 lies also in groove 31 to thereby prevent any displacement of plate 28 axially upon shank end 25*b*. However plate 28 while retained against axial movement is nevertheless free to rotate relative to shank 25 since dowel pin 29 can move around the groove 31. The central portion of shank 25 is provided with a polygonal section 32 for receiving a wrench by which to turn shank 25.

After the crankshaft 18 is lifted to its general position in the furnace and set upon the center 22 in pedestal 19, the shank 36 of centering device 35 is screwed into hole 16*a* of arm 16 until the round and hardened lower end 37 comes into intimate contact with the upper center hole 38 of the crankshaft. The shank 36 is then locked in this position by screwing down the wing nut assembly 39 until the latter locks frictionally against the upper face of arm 16. The crankshaft 18 is now free to revolve in the lightly adjusted upper and lower centers in a true vertical position. The jacks 24 are then put into place between the surfaces 18*a*, 18*b* of each throw section of the crankshaft and adjusted, in sequence, by turning the shank portion 25 with intermittent rotation of the crankshaft by hand and simultaneous indication of the straightness of the main bearings of the crankshaft by a series of .0001" indicator (not shown) secured in axially spaced relation along the main, vertical supporting shaft 10. In this manner, the jacking necessary between the crank throws in order to position the crankshaft in a vertical position with zero runout, when rotated, can quickly be accomplished. The crankshaft then, although in vertical position, is in the exact position as regards straightness that it would be in if lying on a complete set of main bearing supports in a horizontal position representative of the position which the crankshaft would assume when lying in its main bearing supports in the crankcase of the engine. After all jacks for one crankshaft have been adjusted for zero runout, the crankshaft is now a rigid column, and it is no longer necessary to retain the upper centering device 35. The cup 17 will retain the crankshaft in a substantially vertical position and the centering device 35 can then be shifted to the next arm 16 and the process of crankshaft erection repeated, etc. until all crankshafts have been erected.

All of the crankshafts will then be in a passive and stress-free but rigid condition ready for optimum nitriding. After the crankshaft is positioned in absolutely straight position and jacked up in a solid column in this position, a stress relieving action takes place before actual nitriding of the crankshaft surface commences. This stress relieving action is accomplished by a slowly rising temperature in the furnace bell up to approximately 900° F., at which temperature disassociation of the anhydrous ammonia gas begins to take place, so that even though a crankshaft may possibly be slightly out of alignment, it may be so stressed by the action of the jacks between the crank arms that it can be brought back into true alignment and the stresses necessary to do this subsequently relieved by the rising temperature up to 900° F. before the nitriding action begins to take place, the crankshaft all the while being held in a true and straight position. That is to say that the crankshaft in all cases just prior to nitriding action is completely stress relieved in its present position and would at this time or any later time after nitriding, lie in true alignment and passive in the engine bed. The actual nitriding is itself conventional, being carried out with an ammonia gas at a temperature of approximately 950°–1050° F. The effect of the nitriding is to fix this rigidity so that when the jacks are removed after complete cooling to room temperature is carried out within the furnace, there will be no movement, i. e. sag in the crankshaft itself. That is to say, after the jacks are removed, the finished crankshaft will have no residual stresses to cause any mis-alignment of the crankshaft in service.

Another advantage inherent in the nitriding is that the bearing surfaces of the crankshaft will be hardened so that the amount of bearing wear becomes practically negligible.

Still another advantage gained from nitriding is that the fatigue strength of the crankshaft is considerably increased especially in those areas where the greatest use stresses are concentrated, e. g. at the fillets formed by the junction of the main and pin journals with the cheek plates, thus increasing the factor of safety for any particularly designed crankshaft and making it possible to obtain greater horsepower from the presently designed engine.

In conclusion it will be understood that while a preferred embodiment of the invention has been described and illustrated, minor changes may be made in the construction and arrangement of the components which form the novel support for the crankshaft.

I claim:

1. The combination in a furnace for nitriding multiple throw crankshafts of means for supporting said crankshaft in a vertical position therein, said supporting means comprising a center engaged with the lower end face of said crankshaft at the axis thereof, means in vertical alignment with said center engaging the upper end of said crankshaft for holding the latter in a vertical position, and jack means disposed at the throw sections of said crankshaft and in alignment with the axis of said crankshaft to establish a solid column from one end to the other of said crankshaft, said jacks being adjusted in length prior to nitriding to remove any sag existing at said throw sections.

2. The combination in a furnace having a lower horizontal support surface for nitriding multiple throw crankshafts of means for supporting said crankshaft in a vertical position therein, said supporting means comprising a shaft extending upright from said horizontal support surface within the furnace, a pedestal on said support surface disposed laterally of said shaft and having an upwardly extending center adapted to engage the lower end of said crankshaft at the axis thereof, means

in vertical alignment with said center and carried by said shaft at the upper end thereof adapted to engage the upper end of said crankshaft for holding the latter in a vertical position, and jack means disposed at the throw sections of said crankshaft and in alignment with the axis of said crankshaft to establish a solid column from one end to the other of said crankshaft, said jacks being adjusted in length prior to nitriding to remove any sag existing at said throw sections.

3. The combination in a furnace having a lower horizontal support surface for nitriding multiple throw crankshafts of means for supporting said crankshaft in a vertical position therein, said supporting means comprising a shaft extending upright from said horizontal support surface within the furnace, a pedestal on said support surface disposed laterally of said shaft and having an upwardly extending center adapted to engage the lower end of said crankshaft at the axis thereof, a sleeve mounted on the upper end of said shaft, centering means carried by said sleeve and in vertical alignment with said pedestal center adapted to engage the upper end of said crankshaft for holding the latter in a vertical position, and jack means disposed at the throw sections of said crankshaft and in alignment with the axis of said crankshaft to establish a solid column from one end to the other of said crankshaft, said jacks being adjusted in length prior to nitriding to remove any sag existing at said throw sections.

4. The combination in a furnace having a lower horizontal support surface for nitriding multiple throw crankshafts of means for supporting said crankshaft in a vertical position therein, said supporting means comprising a shaft extending upright from said horizontal

support surface within the furnace, a pedestal on said support surface disposed laterally of said shaft and having an upwardly extending center adapted to engage the lower end of said crankshaft at the axis thereof, a sleeve mounted on the upper end of said shaft, an inverted cup carried by said sleeve and provided with a threaded opening in vertical alignment with said pedestal center, an upper centering device threaded into the opening in said cup adapted to engage the upper end of said crankshaft for holding the latter in a vertical position, and jack means disposed at the throw sections of said crankshaft and in alignment with the axis of said crankshaft to establish a solid column from one end to the other of said crankshaft, said jacks being adjusted in length prior to nitriding to remove any sag existing at said throw sections.

5. A crankshaft support as defined in claim 4 wherein said sleeve carries a plurality of said cups arranged symmetrically about the axis of said sleeve, each cup being cooperative with a pedestal center thereunder whereby a plurality of crankshafts may be supported in the manner defined for nitriding simultaneously.

References Cited in the file of this patent

UNITED STATES PATENTS

702,620	Bole	June 17, 1902
974,218	Wells	Nov. 1, 1910
1,513,974	Ehn	Nov. 4, 1924
2,109,083	Campbell	Feb. 22, 1938
2,294,829	Bridges et al.	Sept. 1, 1942
2,457,631	Bennett	Dec. 28, 1948