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METHOD OF MAKING FLANGED CYLINDER LINERS

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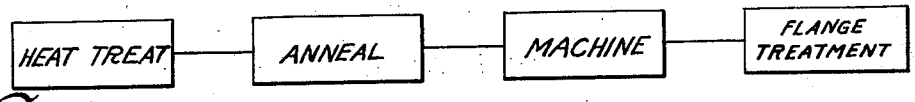


Fig. 1

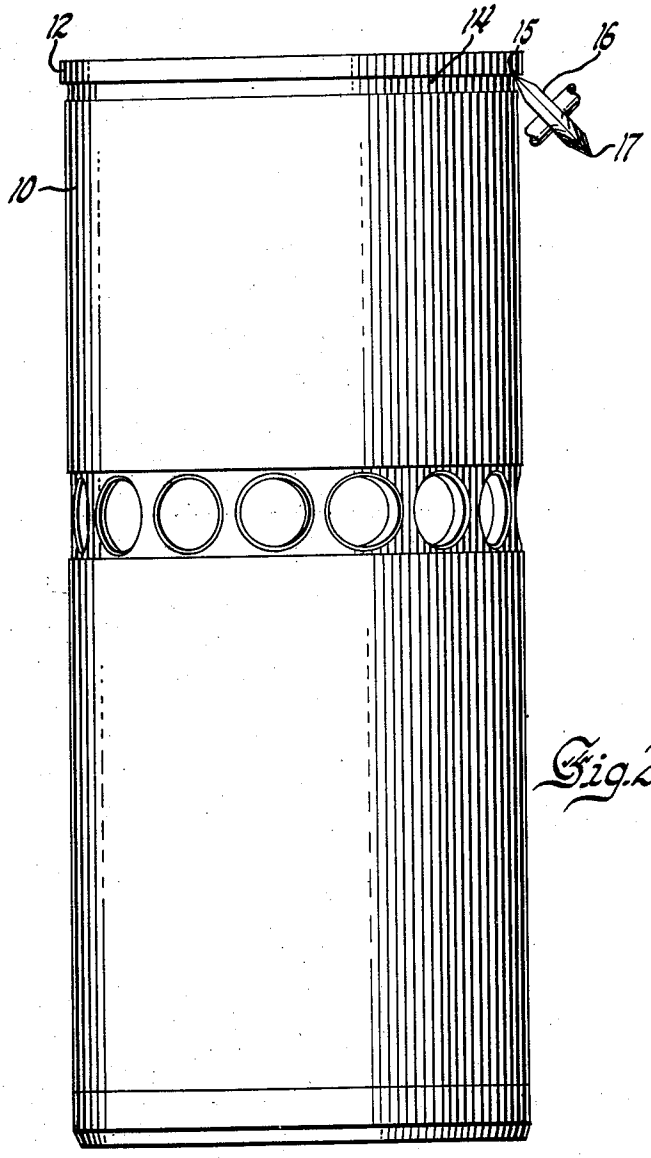


Fig. 2

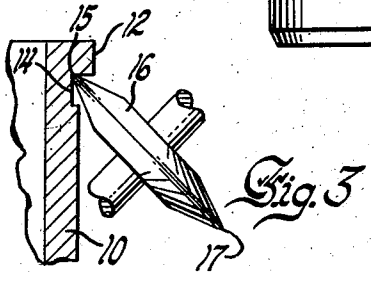


Fig. 3

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METHOD OF MAKING FLANGED CYLINDER LINERS

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5 Claims. (Cl. 148—2)

This invention relates to a method of making flanged cylinder liners.

In the past there has been a large amount of breakage of flanged cylinder liners formed of cast iron, such for example as used in Diesel engines. This breakage commonly takes place at a point where the flange joins the main or barrel portion of the cylinder liner. Accordingly the primary object of the present invention is to provide a process of making cast iron flanged cylinder liners having increased strength whereby breakage is substantially reduced or eliminated.

Other objects and advantages of the present invention will become more apparent as the description proceeds.

Reference is herewith made to the accompanying drawing in which:

Figure 1 is a flow line diagram illustrating a process in accordance with one embodiment of the present invention.

Figure 2 is an elevational view of a flanged cylinder liner showing a roller in engagement with a fillet between the flange and main portion of the cylinder liner.

Figure 3 is a fragmentary view, partly in section, showing on an enlarged scale the roller in engagement with a fillet beneath the flange of the cylinder liner.

The flow line diagram of Figure 1 illustrates steps of processing cylinder liners in accordance with one embodiment of the present invention. A cast iron cylinder liner casting is first made by any suitable or conventional casting method. Illustrative examples are sand casting and centrifugal casting. The cast iron is of any suitable gray iron composition and preferably is an alloy cast iron. An example of a very satisfactory alloy gray cast iron is one consisting of 3.25–3.50% carbon, 2.00–2.25% silicon, .50–.80% manganese, 1.00–1.50% copper, .30–.50% chromium, .10–.25% nickel, .12% max. sulphur, .25% max. phosphorus and the balance iron. After casting the liner is rough machined by any suitable means generally to the shape desired in the final product but somewhat oversize.

After the liner has been rough machined it is subjected to a heat treatment to harden the same. The hardening heat treatment consists in heating the liner to a temperature above the critical to completely austenitize the liner and thereafter quenching to harden the same. After being hardened the liner is then reheated to a tempering temperature. A typical treatment is to austenitize at or about 1600° F., quench for one minute in a salt bath at 475° F., then air cool for about 1½ hours, and thereafter reheat at a tempering temperature of about 400° F. for about 1 hour. While a tempering temperature of 400° F. gives optimum results higher and lower temperatures may be employed. For example, a tempering temperature range of about 350° F. to 425° F. has proven satisfactory. The tempering treatment relieves strains and stresses set up during hardening and should at most reduce the hardness only slightly. A hardened and tempered liner of the composition of the specific alloy gray iron given above should have a minimum hardness of 45 Rockwell C.

After the hardening and tempering heat treatments the flanged end of the cylinder liner is given an annealing heat treatment at a temperature close to but below the critical temperature. The annealing temperature is on the order of 1000° to 1400° F. The annealing treatment is applied only to the flanged portion of the liner and the parts closely adjacent thereto. This annealing operation preferably is carried out by means of an induction heating means which confines the heating to the flange and closely adjacent portions of the liner. The heating requires only a few seconds. The liner with the annealed flange is then air cooled to room temperature in a time of about 30 minutes. The annealed area of the flange should have a hardness not greater than 40 Rockwell C. In most instances the annealed zone should not extend more than ¾" below the flange. After the annealing operation the liner is finish machined to final form and size. The lower surface of the liner flange is then treated as by cold rolling or otherwise.

Referring especially to Figure 2 there is shown a cast iron cylindrical liner **10** having a flange **12** at one end. Underneath the flange there is an undercut groove **14**. A fillet **15** is formed between the upper portion of the wall of the groove and the lower surface of the flange. After the cylinder liner has been hardened and tempered, its flange annealed and the liner finish machined, the fillet **15** is subjected to a treatment which slightly cold works the surface of fillet **15**. Most satisfactory results are obtained when the fillet is subjected to a rolling treatment as by means of a roller **16**. The roller is formed with a radius periphery **17** conforming with the shape of the fillet **15**. A typical roller is one having a diameter of 2 inches with an .015" radius periphery. The radius of the roller periphery must be small enough to contact the radius or fillet **15** beneath the liner flange. A presently preferred procedure is to rotate the cylinder liner at a speed of 160 R. P. M., feed the roller **16** into the groove **14** and the radius periphery **17** into contact with fillet **15** and apply a spring pressure loading of 160 pounds to the roller for a time of about five seconds. The roller is then backed off. The breaking strength of flanged cylinder liners under these conditions is about 70,000 pounds as compared with breaking strengths of 40,000 for similarly sized liners formed by prior methods. Other roller loads, both lower and higher than 160 pounds, may be employed. For example, the fillets have been rolled satisfactorily with roller loads as low as 60 pounds and as high as 250 pounds. At the lower loads longer times of treatment may be employed and at the higher loads shorter times may be used. While the rolling process is currently preferred because of ease of control, short time of treatment required, high tool life obtained and the high and uniform strengths obtained, the fillet may also be given a cold worked surface by shot peening, mechanical peening, etc.

The invention results in improving the static strength of flanged cast iron cylinder liners by a combination of annealing and a cold working method. The phenomena of increasing static strength by surface cold working methods have not previously been considered possible so far as we are aware. Our process requires cold working after the flanged portion has been annealed in order to obtain the improved cast cylinder liners in accordance with the invention. Best results are obtained when the flanged liners are finish machined after the annealing treatment and before the step of cold rolling (or otherwise cold working) the fillet below the flange on the cylinder liner.

Various changes and modifications of the embodiments of our invention described herein may be made by those skilled in the art without departing from the principles and spirit of the invention and we do not intend to limit the patent granted thereon except as necessitated by the prior art.

We claim:

1. The method of making a flanged cylinder liner of cast iron which comprises heating said flanged cast iron liner to an austenitizing temperature, quenching said heated cast iron liner to harden the same, tempering said hardened cast iron liner by reheating to a tempering temperature, then annealing only the flange portion and closely adjacent portions by reheating these portions to a temperature substantially above said tempering temperature and below the critical temperature of said cast iron, cooling said annealed cast iron liner, and then cold working the surface of the cylinder liner at the junction of the flange and the external cylindrical wall of the liner.

2. The method of making a flanged cylinder liner of cast iron which comprises casting the iron into cylindrical shape, rough machining the cast iron liner, heating said cast iron liner to an austenitizing temperature, quenching said heated cast iron liner to harden the same, tempering said hardened cast iron liner by reheating to a tempering temperature, then annealing only the flange portion and closely adjacent portions by reheating these portions to a temperature substantially above said tempering temperature and below the critical temperature of said cast iron, cooling said annealed cast iron liner, finish machining said liner and then cold working the surface of the cylinder liner at the junction of the flange and external cylindrical wall of the liner.

3. The method of making a flanged cylinder liner of cast iron which comprises casting the iron into cylindrical shape, rough machining the liner substantially to final shape but somewhat oversize and with a filleted groove at the junction of the external wall of the liner and flange, heating said cast iron liner to a temperature above the critical to austenitize the same, quenching said heated cast iron liner to harden the same, tempering said hardened cast iron liner by reheating to a tempering temperature, then annealing only the flange and closely adjacent portions including said fillet by reheating to a temperature on the order of 1000°–1400° F., finish machining said cast iron liner, and cold working the surface of the annealed fillet.

4. The method of making a flanged cylinder liner of cast iron which comprises casting the iron into cylindrical shape, rough machining the cast iron liner approximately to final shape but somewhat oversize and with a filleted groove at the junction of the external wall of the liner and flange, heating said flanged cast iron liner to a temperature above the critical to austenitize the same, quenching said heated flanged cast iron liner to harden the same, tempering said hardened flanged cast iron liner by reheating to a temperature on the order of 350°–425° F., then annealing only the flange and closely adjacent portions including said fillet by reheating to a temperature on the order of 1000° to 1400° F., finish machining said flanged cast iron liner, and cold working the surface of said annealed fillet by pressure applied thereto by a roller closely engaging said groove.

5. The method of making a flanged cylinder liner of cast iron which comprises heating said flanged cast iron liner to an austenitizing temperature, quenching said heated liner to harden the same, tempering said hardened liner by reheating to a tempering temperature, then annealing only the flanged portion and closely adjacent portions by reheating these portions to a temperature above said tempering temperature, cooling said annealed liner, and thereafter cold working the surface of the cylinder liner only at the junction of the flange and the external cylindrical wall of the liner.

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