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METHOD OF JOINING TOGETHER METAL BODIES

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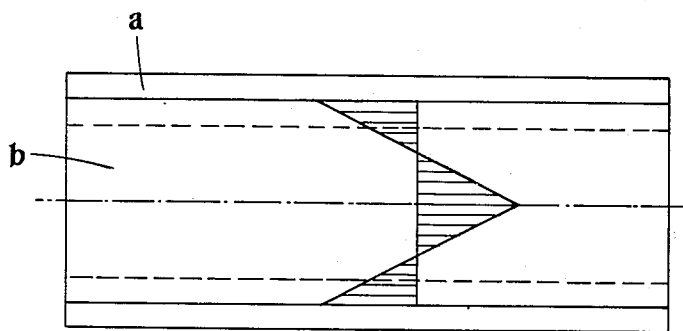


Fig. 1.

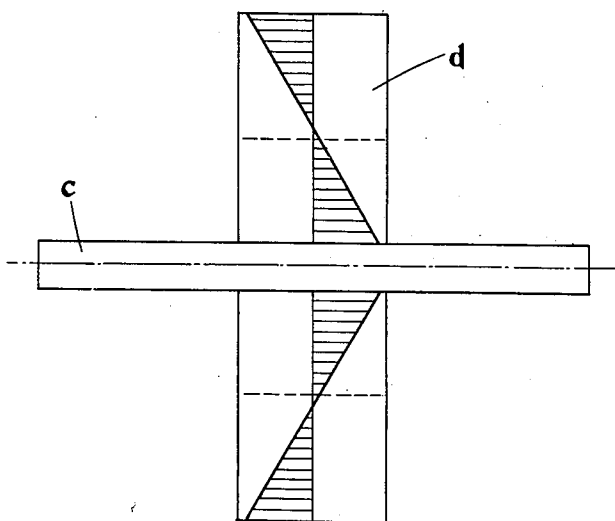


Fig. 2.

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METHOD OF JOINING TOGETHER METAL BODIES

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It is known to join together two bodies firmly by shrinking the outer body—or shell—embracing the inner body or core along part of its length and suitable surface depressions being formed at various position on the periphery. To enable, for example, a solid cylindrical bar or rod and a hollow cylinder to be joined together by shrinking, the core is formed with an enlarged external diameter and the shell with an enlarged internal diameter. According to this known method the shell is heated to a suitable temperature at the position where the shell is to be shrunk on to the core and is then slipped over the core and left to cool. While the metal is cooling, the two metal bodies as the result of pressure created are reduced in dimensions at the position of contact and a firm joint obtained.

In some cases it has been found to be a disadvantage that in order to produce a joint by shrinking, part of the metal must be heated to high temperatures.

There are cases in which it is required, for example, to shrink a ring on to a hardened bolt. Naturally, with the usual process a certain amount of annealing is unavoidable in the bolt at the gripping position, which annealing produces a local change in hardness and strength.

Further, experience has shown that if structural elements thus united—and therefore also the joint itself—are subjected to alternating stresses, the contiguous parts of the joint frequently have a strong tendency to fracture. It is clear that a change in structure limited in area, such as would arise, for example, in the bolt before referred to, would likewise assist in causing the fracture. This disadvantage, which may be caused by the heating of one of the parts forming the joint cannot be circumvented by present-day methods of shrinking.

The present invention relates to a method of joining together metal bodies in which one surrounds the other, in which the disadvantage referred to is avoided.

According to the invention the two metal bodies one surrounding the other are joined together by setting up internal stresses in one or both bodies and liberating the stresses wholly or in part at the position of contact by mechanical treatment such for example as metal turning or metal boring. A condition of natural stress is created in one of the parts to be joined, or in both parts, by known methods, such as by rapid cooling from high temperatures or treatment in the cold, this condition of stress being broken down at the forming of the joint to cause a change in dimen-

sions of one or both bodies at the position of contact and the creation of pressure or tensional stresses between the bodies, with the result that no heat is generated in the joint.

The method of the application is hereinafter described by way of example with reference to two constructional examples which are diagrammatically illustrated in the accompanying drawing.

Figure 1 is a longitudinal section through a shell and an inner core or shell and also shows the stress diagram over the section of the inner core or shell before treatment to form the joint.

Figure 2 is a section through an annular member or ring and a spindle also showing the stress diagram over the section of the ring before treatment to form the joint.

Let it be assumed that, as shown in Figure 1 it is desired to form a joint between an outer shell *a* and an inner shell *b*, the external diameter of the shell *a* being 300 mm., the internal diameter of the shell *b* being 210 mm., the thickness of the wall of the outer shell *a* being 25 mm., and that of the inner shell *b* 20 mm. Furthermore, let it be assumed that it is necessary to harden the outer shell *a* while the inner shell *b* is to be of soft metal. By means of the processes now in use it would not be possible to form such a joint perfectly as the action of heat on the outer metal shell *a* would change the strength required owing to the annealing action resulting from the heating of the outer shell *a*. According to the invention such a joint is produced, for example, in the following manner: The solid cylinder or core of soft iron of slightly above 250 mm. diameter, intended to form the shell *b* is chilled from 680° in water, so that after cooling tensional stresses are set up at the centre and pressure stresses on the outside. Thereupon the external diameter is lightly machined over and ground down to 250 mm. diameter. After hardening, the outer shell *a* is likewise ground on the inner surface, in such manner that it can quite easily be forced over the solid cylinder or core for the formation of the shell *b*. The shell *a* and solid cylinder, which are still loosely held together, are placed on the hollow tube bench and the solid cylinder or inner sleeve or core is bored out to the desired measurement of 210 mm. internal diameter. In the boring out the following takes place: On the removal of the metal from the solid cylindrical core the tensional stresses in the zones of the core are partly removed and as a consequence the pressure stresses, which maintained equilibrium with

the tensional stresses in the core, are liberated; the consequence is that the external diameter is increased. As the boring out is continued an ever-increasing part of the tensional forces in the core, which now becomes the inner shell *b*, is removed and the core is pressed against the outer shell *a* owing to the increase in the external diameter of the inner sleeve *b*. After the completion of the boring out to 210 mm. diameter it was found possible in a practical test of this nature to ascertain whether a perfect joint was produced without the two parts being heated in any way. By means of a parallel test, in which the inner shell or core was bored out in the absence of the outer shell it was found that the free increase in diameter of the inner shell or core during boring out amounted to about 0.2 to 0.3 mm. The inner surface of the inner shell or core *b* after the boring operation is shown in dotted lines.

A second example is illustrated in Figure 2. A bar *c* of hardened metal and of a circular cross-section of a diameter of 30 mm. is to have applied thereto an annular member or ring *d* to be fixedly mounted on it. To connect the ring *d* and bar *c* together by a wedge, though not impossible, involves great expense, and the cutting of a groove always means a weakening of the machined part (notch danger). It is, moreover, not possible to draw the ring *d* on hot by the usual shrinking process, as the heat would produce a change in the texture of the metal and therefore a change in hardness or tensile strength at the position at which shrinking takes place. According to the invention the ring *d* of constructional machine steel of 50 gauge thickness, which has an external diameter of about 150 mm. is heated to 650° and is sprayed with water on the outside to reduce the temperature. Before this treatment the ring *d* is pierced with a hole of 29.5 mm. diameter. After this heat treatment the hole in the ring *d*, which is now cold, is easily turned and ground out so that the ring can be easily slipped on the bar of Martensite *c*. The whole is then chucked on the lathe and the ring *d* is turned on the outside to the desired dimension of 70 mm. diameter. In the operation of turning, the external zones to which are imparted pressure stresses as the result of chilling, are removed. Consequently tensional stresses are liberated near to the hole and the effect is to cause the hole to decrease in diameter. With every turning of the external zones the joint becomes more and more secure. Thus, for example, by applying pressure on a press shortly before the final dimension of the ring *d* is reached it can be ascertained that by applying a predetermined load of 5000 kg. the ring *d* can no longer be slipped off from the bar *c*. The external edges of the annular member or ring *d* after machining are shown in dotted lines. The experiments described, which represent only certain methods of carrying out the invention, indicate that joints that can be used in the art are obtained by means of the new process without the bodies to be joined being themselves heated.

It is preferable to proceed as follows if it is required to produce a joint in accordance with the process of the invention:

Before forming the joint, the two parts—core and shell,—may be carefully prepared and exact-

ly fitted one inside the other, the surfaces of the two parts being carefully examined and cleaned, so that the joint when completed will be free from faults and of uniform strength all round.

The invention is not applicable only to fitting surfaces that are flat or cylindrical; by means of the process according to the invention, parts can be joined to threaded surfaces (nut and bolt) or other fitting surfaces. The joint according to the invention is principally applicable to cases in which part of the joint may not be heated owing to the nature of the substance being treated. In this connection not only are constructional elements having a hard grain to be considered, but also those possible cases in which the heating of constructional parts would change their magnetic, electrical and other properties.

Naturally the joint according to the invention may be produced by changing the shape of both elements (core and shell). This is possible, for example, where two rings are to be joined together. In both bodies there is produced, for example, a condition of stress with tensional stresses in the inner zones and pressure stresses in the outer zones. The two bodies having been machined on their contacting surfaces and fitted one inside the other, the hollow body (for example a ring) is bored out, the external diameter being increased; the outer body is machined or ground on the outside and at the same time contracts. Both changes of shape, namely the expansion of the core and the contraction of the outer body, operate to form a rigid joint between the two elements.

I claim:

1. A method of joining together two metal bodies one around the other by setting up internal stresses in the inner body, then bringing the bodies together and liberating the stresses in the inner body wholly or in part for the purpose of creating stresses between the two bodies at the position of contact by the removal of the inner zones of the inner body in a metal working operation.

2. A method of joining together two metal bodies one around the other by setting up internal stresses in both bodies, assembling the bodies and liberating the stresses in the bodies after assembling by a metal working operation for the creation of pressure stresses in the inner body and tensional stresses in the outer body at the positions of contact.

3. A method of joining together two metal bodies one around the other by setting up internal stresses in the outer body, then assembling the bodies and liberating the stresses in the outer body wholly or in part for the purpose of creating stresses between the bodies at the position of contact by the removal of the outer zones of the outer body in a metal working operation.

4. A method of joining together two metal bodies one around the other by setting up internal stresses in both bodies, then bringing the bodies together and liberating the stresses in the inner and outer body wholly or in part for the purpose of creating stresses between the two bodies at the position of contact by the removal of the inner zones of the inner body and of the outer zones of the outer body.

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