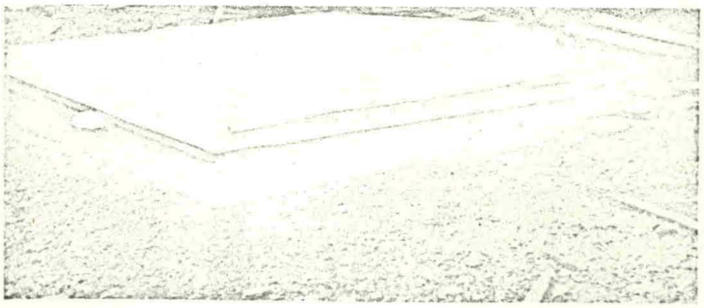
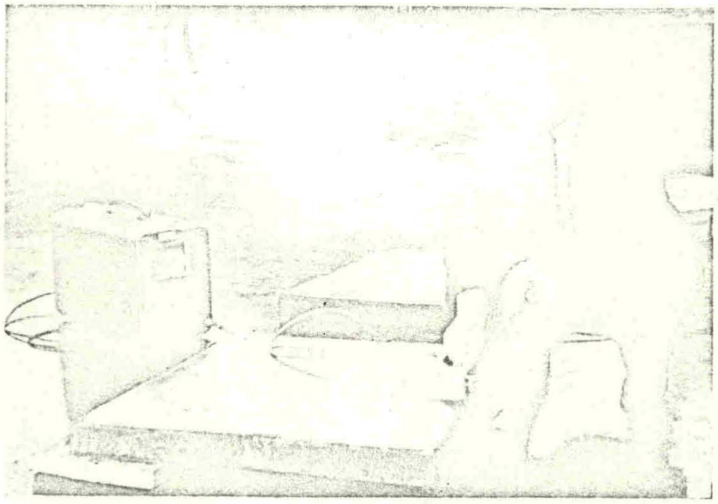


25 Arrangement for explosive cladding [3 ft-(1 m) square steel base with ½ in-(12·7 mm) thick aluminium bronze.]



26 Testing the finished product.

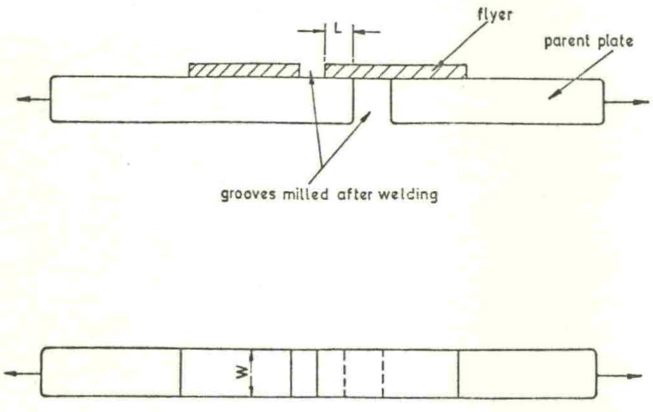
the specimen will bend through 180° without failure of the bond. De Maris gives data for fatigue tests on cantilever specimens of *Inconel* welded to ASTM A-302-B FbQ steel; the fatigue results lay between the S/N curves for the two materials before cladding, and the fractures did not initiate at the interface. With other combinations he noted a slight weakening of the flattened and stress-relieved clad material compared with the steel of the parent plate, but he attributed this to a reduction in hardness of the steel. Gelman *et al.* clad constructional steel with other steels and in general found a reduction of fatigue strength, which was, however, improved by a subsequent heat-treatment. Banerjee carried out repeated tension fatigue tests on stainless steel clad to steel; the results are shown in Fig. 31, where it will be seen that the fatigue strength of the clad plate is marginally greater than that of either stainless steel or mild steel. He obtained similar results for brass clad to steel. Banerjee also considered thermal fatigue by subjecting clad plates of stainless and mild steel and brass and steel to 10 cycles of heating and cooling. Each specimen was cycled to a different maximum temperature and then side shear tests were carried out. A very slight reduction in shear strength of the specimen subjected to 10 cycles of 15 to 700° C (288 to 975 K) was noted, but this could have been attributed to recrystallisation.

A problem with explosively or conventionally clad plate is the non-destructive testing of the plate to establish weld integrity. Very few techniques are available and perhaps the only one readily available is ultrasonics, though Dewy[50] shows an isothermal plot of poorly bonded nickel plating on steel established by a thermographic method which might be applicable to clad plate. Addison *et al.*[44] concluded that ultrasonic inspection is the most promising method; they submerged the plate in water between the transmitter and receiver rather than adopting the more normal reflection technique in which the crystal operates as a transmitter and receiver. Banerjee[49] carried out ultrasonic testing of plates and showed that it was possible to detect areas of poor bond or no bond. He could not detect a cast interlayer or an undesirable intermetallic compound at the interface. It must be concluded that the inspection of either roll-clad or explosively clad plate can only reveal areas of no bond, but not areas of weak bonding caused by unfavourable metallurgical conditions.

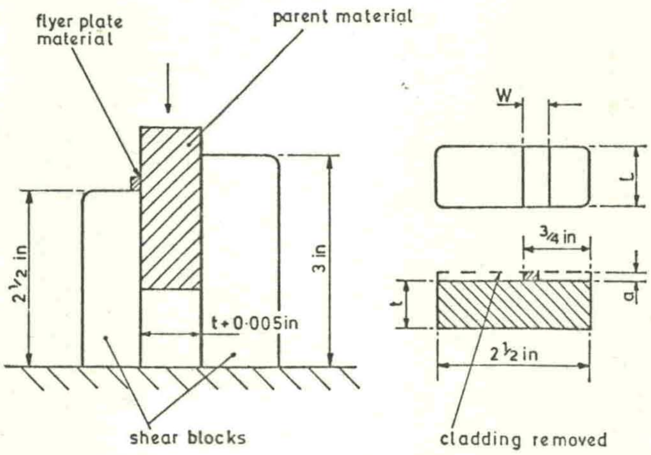
III. Tube welding

The cladding of the inner surfaces of tubes and cylinders was mentioned at about the same time by Philipchuk,[1] Wright and Bayce,[20] Carlson,[23] Holtzman and Cowan,[21] and later by Dalrymple and Johnson.[51] Philipchuk used an outer tube knurled at the bore and supporting an inner tube with a smooth outer surface, as shown in Fig. 32. The other workers adopted the arrangement shown in Fig. 33.

The application of explosive welding of tubes to tube plates has only recently been mentioned by Crossland *et al.*,[52] Chadwick



27 Specimen for tensile shear test on cladded plate.



28 Shear tests on clad plate. Test-specimens: $t > 2W$; $W = 1\frac{1}{2}a$.

in	0·005	¾	2½	3
mm	0·127	19·1	63·5	76·2