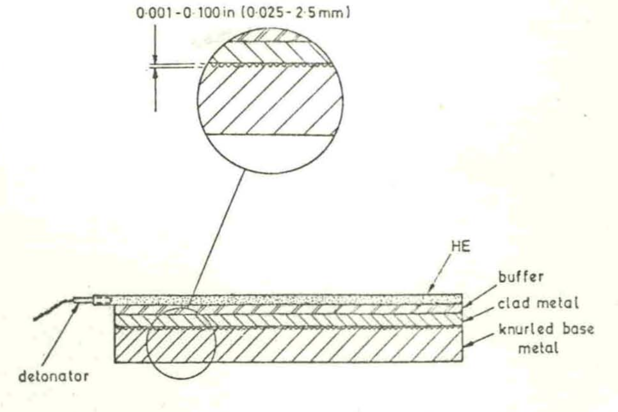
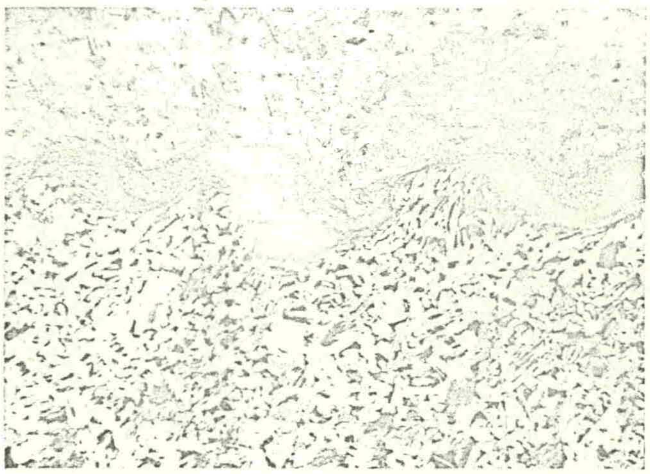
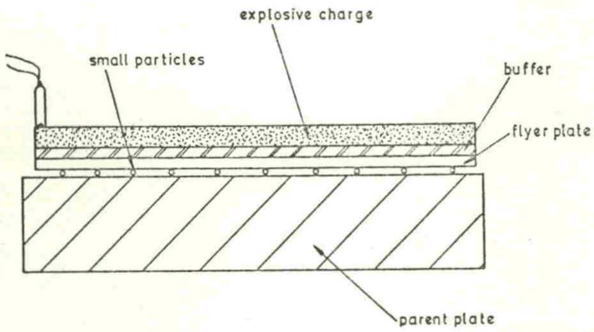


[*Courtesy Amer. Soc. Tool Manuf. Eng.*

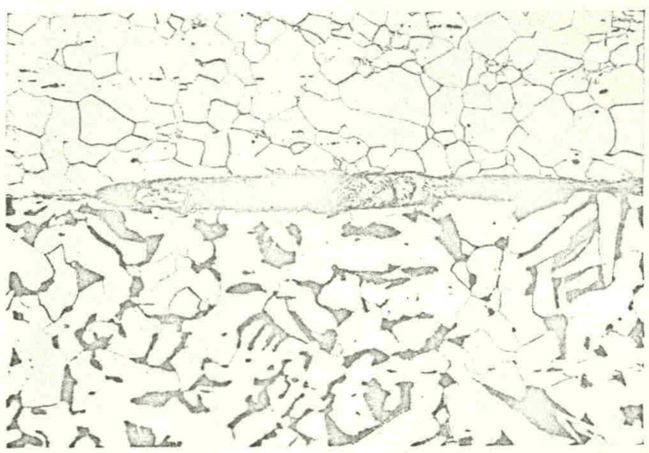
18 Flat-plate cladding. (*Philipchuk.*[1])



19 Micrograph of a steel weld made by using a knurled base plate. × 45.



20 Separating the flyer plate from the parent plate by small particles.



21 Micrograph of a steel weld made by supporting the flyer plate on metal particles. × 150.

The process thus continues in a zip-fastener manner. Bahrani *et al.* have suggested a mechanism of wave generation which appears to most readily agree with general metallographic observations of explosive welds. Figure 17 shows the basic steps as suggested by them. However, it would appear that this mechanism defies analysis at the present time. Hunt considers that the waves can be explained by Helmholtz instability. The main difficulty in providing a satisfactory explanation is that the properties of the metals at the interface during this process cannot be measured or even estimated.

II. Explosive cladding

The inclined-angle set-up shown in Fig. 2 is strictly needed only if a high-detonating-velocity explosive is being used, to bring the collision-point velocity down to an acceptable value. However, the use of such an explosive gives rise to problems of spalling and surface damage. There is, in addition, the problem of supporting a large flyer plate with the minimum of constraint to prevent excessive deformation of the plate under its own weight, thus changing the value of the initial angle of obliquity. If, however, the flyer plate is fairly thick it can be adequately supported at the edges. The problem remains that the clearance between the flyer and parent plate in this arrangement does not remain constant, and at the large-clearance end of the plate it is probable that the flyer-plate velocity at impact is below the maximum or terminal velocity that is reached at smaller clearances. This becomes more serious the larger the plate. However, the technique can be used satisfactorily for areas of a few square feet.

There are considerable advantages in using a lower-detonation-velocity explosive and a parallel or only slightly inclined plate technique, but there is still the problem of how to support the flyer plate at a fixed clearance above the parent plate without providing excessive constraint. The plates might be arranged in the vertical position, but this gives rise to practical problems in placing a uniform explosive charge in juxtaposition with the flyer plate.

Philipchuk[1] suggested supporting the flyer plate on a knurled or grooved parent plate, as shown in Fig. 18, but Shribman *et al.*[39] showed that this produced a weld with voids and excessive melting (see Fig. 19). As a consequence, this would seem to be an unacceptable method for high-quality welds.

Cowan *et al.*[40] proposed that the necessary clearance between the flyer and parent plate could be achieved by placing metallic particles of a suitable size between the two plates, as in Fig. 20. This certainly provides an adequate weld but, as shown by Crossland and Bahrani[4] or Shribman *et al.*,[39] the jet is apparently trapped behind the particle and a void is formed in front (see Fig. 21). Also, with fairly thin flyer plates the impression of the particles is visible on the top surface.

Otto[14] suggested that welding could be achieved with plates in contact using a high-detonation-velocity explosive, but attempts by Crossland and Bahrani[4] to repeat this work with *Metabel* sheet explosive proved abortive. However, using