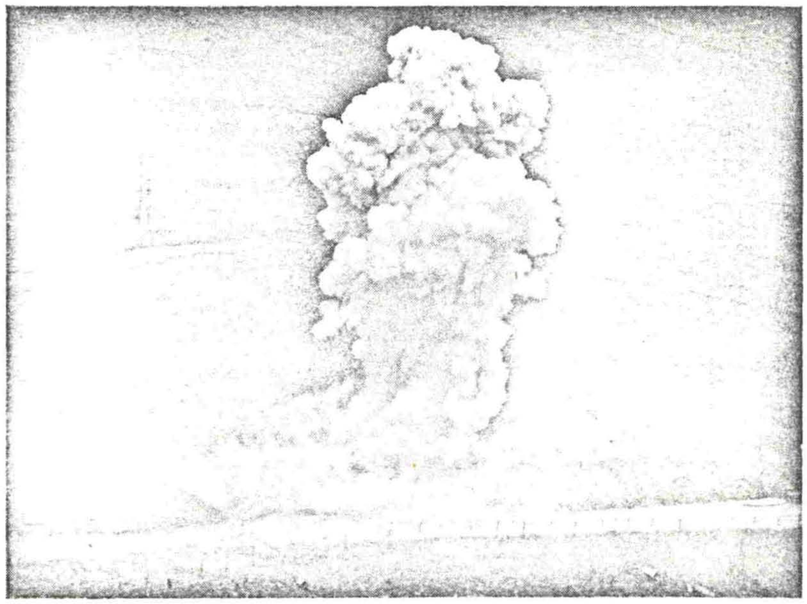
Cladding by Explosive

I.C.I. Kelomet Process in Operation in Scotland



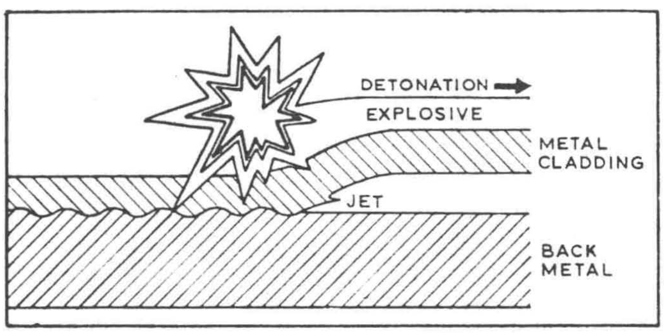
Joining of the plates by the detonation of an explosive charge.

A REVOLUTIONARY new bonding technique, patented by Du Pont in the U.S.A., is offered to industry by the Nobel Division of Imperial Chemical Industries, Ltd. Using explosive power to give a bond of guaranteed continuity and shear strength between the two slabs or plates of different materials, the process has been given the name Kelomet by I.C.I. The resulting product may be used in this form or may be subsequently rolled down to a lesser thickness. By means of this new process the corrosion-resistance or other special properties of an expensive material may be combined with the strength and economy of an inexpensive one, with a resultant lowering of the cost of plant without sacrifice of any technical qualities.

Cladding Technique

In carrying out the Kelomet technique, the cladding metal, which may vary from $\frac{1}{16}$ in. to $\frac{3}{16}$–$\frac{3}{4}$ in., depending on the material, is placed at a controlled distance from the thicker backing metal. Then a uniform layer of explosive is spread across the cladding plate and detonated. The explosion progressively bonds the cladding plate to the backing metal, forming a metallic jet at the point of impact. The effect of this jet is to remove the contaminated surface of both metals.

The nature of this operation necessitates carrying it out in an area where the noise and associated effects of the explosion will not constitute a disturbance of the amenities, and the company have been fortunate enough to secure, by arrangement with the Forestry Commission, a site 'near' to Kirkconnel in South Ayrshire. This houses a building in which final preparation of the metal plates is carried out, a magazine in which explosive is stored, blended and weighed for each operation, and a site where the explosions can be carried out in safety.



Diagrammatic representation of the process in action.

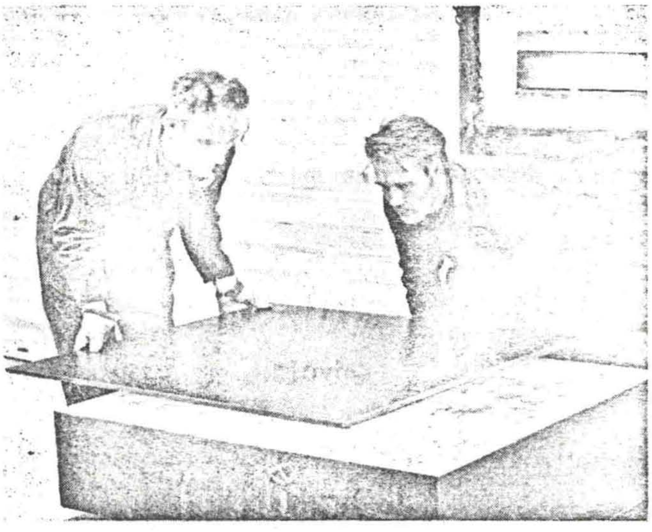
Unlike hot-roll cladding, which can produce only a limited range of combinations of materials, the Kelomet process can be used to bond a wide range of metals to one or both sides of carbon, low-alloy or stainless steels, or non-ferrous metals. The wide range of cladding metals, which may be different on the two sides of the plate or slab, includes austenitic stainless steel, ferritic stainless steel, aluminium, copper, brass, aluminium bronze, cupro-nickel, nickel, nickel silver, Monel, Inconel, Incoloy, tantalum and titanium (grades T115, 130 and 260).

Size Limits

As mentioned above, the thickness of cladding metal which can be used varies according to the material. For stainless steels the minimum thickness is $\frac{1}{16}$ in. and the maximum $\frac{3}{4}$ in. The same figures hold for copper and copper alloys and nickel and nickel alloys. The minimum thickness for the titanium alloys is $\frac{1}{16}$ in. but the maximum varies from $\frac{3}{8}$ in. for T115 to $\frac{3}{16}$ in. for T130 and 260. The backing material should be at least twice as thick as the cladding, and should not normally be less than $\frac{1}{2}$ in., but there is no upper limit on thickness.

The upper limit on the size of plate which can be clad is ultimately governed by the capacity of the cladding site, but in practice the actual limitation is more often the size of cladding metal available. In some cases two plates can be pre-welded together to form a larger single plate for the purpose. For shell plates the following figures provide a guide:

Clad Thickness	*Maximum Area*
$\frac{1}{4}$ in.	100 sq. ft.
$\frac{1}{2}$ in.	65 sq. ft.
$\frac{3}{4}$ in.	40 sq. ft.



Before cladding, the metals to be bonded are abraded to remove contamination and to achieve an acceptably smooth surface, they are then carefully examined for size and flatness.

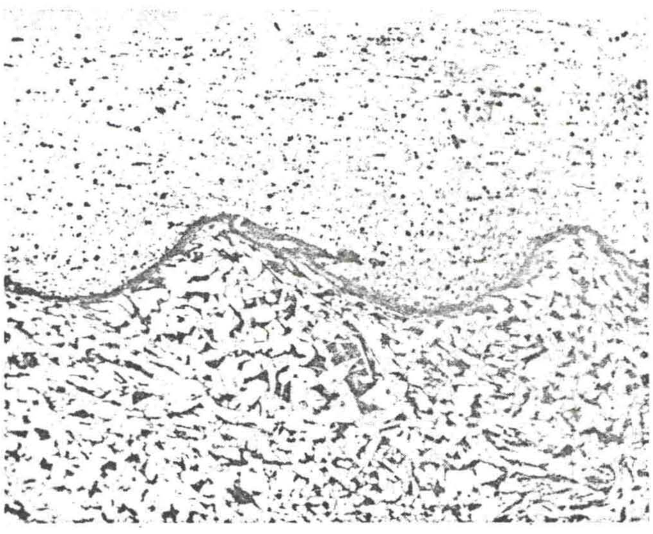
For tube plates the figures are:

Clad Thickness	*Maximum Diameter*
$\frac{1}{4}$ in.	96 in.
$\frac{1}{2}$ in.	84 in.
$\frac{3}{4}$ in.	66 in.

Properties of Clad Plate

Clad shell plates are supplied flattened and cut to size, and guaranteed in bond strength and continuity of bond. The minimum shear strength of the bond varies, according to the cladding metal. from 15.000 lb./sq. in. for copper and copper alloys to 30,000 lb./sq. in. for stainless steel and nickel alloys. Clad shell plates are flattened to commercial tolerances before despatch, but tube plates are flattened according to the following tolerances:

Thickness	*Tolerances for Diameters up to*	
	72 in.	96 in.
Up to 2 in.	$\frac{1}{8}$	$\frac{3}{16}$
2–4 in.	$\frac{1}{8}$	$\frac{1}{4}$
4–8 in.	$\frac{1}{8}$	$\frac{3}{8}$



Micrograph showing the nature of the bond between copper and mild steel. ×70

Ultrasonic testing is carried out on all plates after cladding, and a continuity of bond of 95% is guaranteed, with not more than 9 sq. in. in any non-bond* or 4 sq. in. in the case of stainless, nickel or nickel alloy clads. For tube plates the continuity guarantee is 98%, with no individual non-bond greater than 1 sq. in.

The mechanical properties of cladding and backing metals are not materially affected by the cladding process, although titanium-clad plates are stress-relief annealed before despatch to restore ductility. Other combinations do not normally need heat treatment. I.C.I. can make available to users recommended procedures for heat treatment after welding or forming, where this is necessary. Particular care is necessary with reactive metal clads, where excessive heating can cause loss of quality.

Applications

The unique properties of Kelomet plate can be put to use in transition joints, which eliminate the problems associated with joining metals either different or impossible to weld. Standard combinations are aluminium/steel and copper/aluminium. Tailor-made blocks or strips are supplied ready for welding in place. The resulting connections have high strength and resistance to impact, and very high and consistent electrical conductivity.

Applications of this type of joint include anode and cathode connections for aluminium, chlorine and other electrolytic reduction processes, where electrical reliability is of the greatest importance. Other applications can be found in shipbuilding, where the use of a transition strip between an aluminium superstructure and the steel hull gives a continuous crevice-free joint of high strength and reduced corrosion rate.

The cladding technique is being used for the production of Colclad plates, in which the basic steel is clad with stainless, and may replace the earlier method of production of this material. Many of the applications of the process are obvious, but I.C.I. Nobel Division is making rapid developments in the use of Kelomet: almost daily they are investigating new techniques to satisfy new requirements from interested parties. To those engaged in the specification, design or fabrication of equipment for the chemical, petro-chemical, food or allied industries, the product may be worthy of consideration.

* Non-bond is defined as complete loss of back reflection in the ultrasonic test.

First Russian Order for Birwelco

Its first order from Russia has been obtained by GKN Birwelco (Uskside), Ltd. The order is for one of the largest output capacity bar heating furnaces made in the world, and for two smaller but otherwise similar furnaces. Total value of the order is over £250,000.

The large SFR 90 furnace is a fully automated electric induction heater, feeding a Hatebur AMP 70 press with heated bars at up to 8½ tons/hr. Only two other furnaces of this capacity exist, one in Japan, one in Italy, and both were made by Birwelco. The two smaller furnaces are both SFR 29 electric induction bar heaters, with output capacity of 3 tons/hr.

Russia's biggest ball bearing factory, G.N.P.Z., near Moscow, is taking the big SFR 90 and one of the smaller furnaces. The other SFR 29 is for the Zyl car factory.