Research, Ottawa, and welded at Carleton University. It was significantly more efficient than any previous microwave filter. A filter of this type not only reduces the transmitter power needed for satellites but also reduced a proposed satellite package from 23 to eight pounds.

● Steel and zirconium products are often manufactured from large bars, called ingots, if the bars are cast, and billets, if they are formed. Defects in these bars are usually machined off with lathes, cutting torches or grinding machines. This involves a loss of material which for zirconium is estimated at $300,000 per year in Canada alone. In the low-carbon steel industry, the cost of removing defects, that is the cost of labor and supplies but not the yield loss, approximates 50 million dollars per year in Canada and a whopping billion dollars per year on a world scale.

When the Carleton group used electron beams to remelt the defective volume, pores and cracks remelted and froze without defects. The result was a better surface than obtained using conventional methods — with no yield loss. An improved over-all product was obtained at only a fraction of the cost.

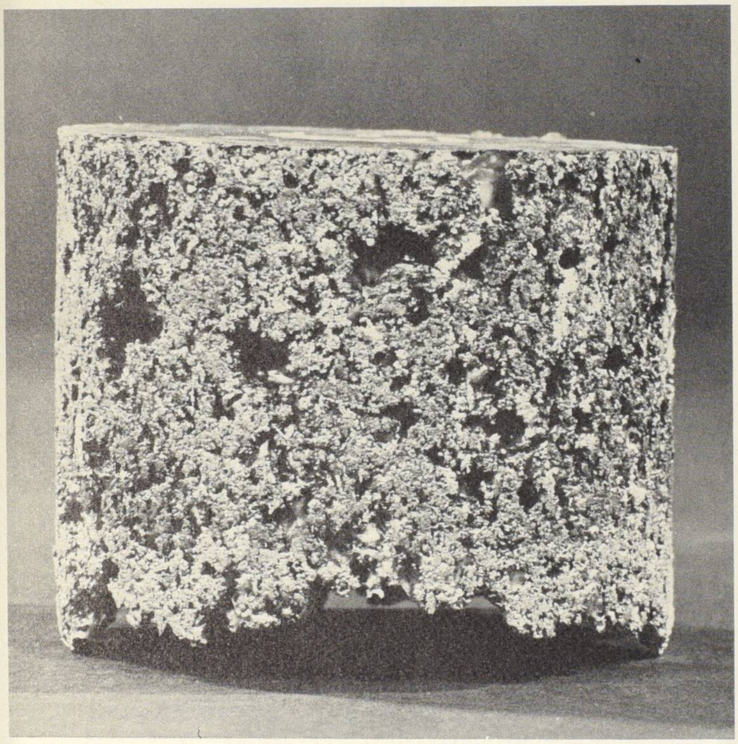
● During EBW studies, methods were developed and perfected for welding "gassy" low-carbon steels with high initial oxygen content. Unless precautions are taken, the gas causes bubbles or pores which weaken the weld. Deoxidizers used with these gassy steels and welds using electron beams proved highly satisfactory.

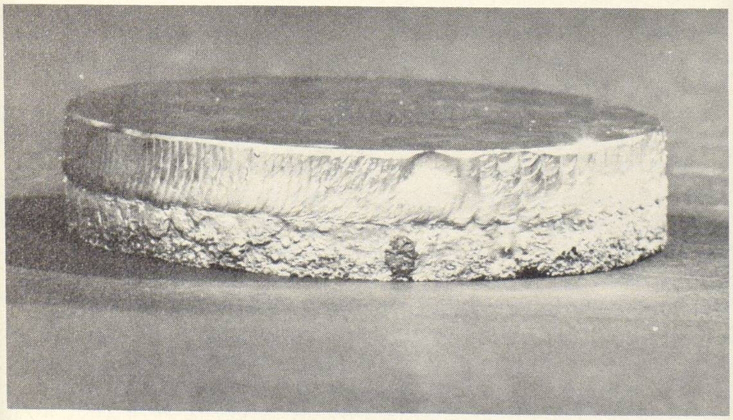
● Heat exchangers contain hundreds of tubes (usually stainless steel) passing through plates up to 15 inches thick. A good, pressure-tight weld between tube and sheet is an absolute must and literally millions of such welds are needed in a nuclear reactor. The Carleton University research team designed an electron beam welder for tube-to-tube sheet welding that would reduce the time per weld from 15 minutes to less than 15 seconds. In addition, the electron beam presents advantages for the quality of the weld. It is narrow and deep-penetrating, and "slides" down between tube and sheet for a deep weld.

● Another important advantage of the electron beam welder for this and numerous other projects is that it is an electronic device which means the welding process can be automated. In fact EBW really shines when there are many repetitions of the same process to be carried out. Once the magnetic fields for focussing and deflecting the beam are modified and made to alternate as desired (and this can be done by machine), the rest can be automated and largely controlled by computer.

"In order to continue our work in developing and perfecting applications of EBW, we intend to improve the design of the equipment," says Dr. Goldak. "We could build better electron beam guns and systems right here in our laboratory. At present, the tungsten cathodes must be replaced from time to time. The design and material used in this cathode could be improved for longer life. The optical system for focussing high-power beams could profit from more research as could the procedure for automatic welding with a scanning beam.

"The electron beam now serves to cure paints, engrave photographic plates, make artificial leather, drill, cut, machine, refine and melt. Electron beam technology has become commercially important only during the last 15 years and its future looks extremely promising. As for electron beam welding, it will keep pace with the needs of developing technology. It will provide higher quality welding, consistently, reproducibly, with the added advantage of low labor costs." □





Ingots before (above) and after conditioning with electron beam.
● *Lingots avant (en haut) et après traitement avec le faisceau d'électrons.*