

given in 1968-69 prices, and the 1969-70 figures in 1969-70 prices. The percentage increases calculated do not then give a true impression of the growth of the research council expenditures. Unfortunately, there is no simple rule of thumb which can be used to convert increases in money terms into increases in real terms, but the Department of Education and Science has provided the list of growth rates for the research councils, shown in the table, together with the expenditure figures taken from the Vote on Account.

These figures, although they show that the research councils will be doing substantially better in financial terms, also indicate that increases in costs have eaten away much of the advantage. The ARC, in particular, must be feeling very sorry for itself.

#### SHIPBUILDING

### Turbine Trouble Diagnosed

SIR ARNOLD LINDLEY, called in by the Minister of Technology to investigate defective turbines in the Queen Elizabeth 2, has turned up nothing unexpected. His report, delivered last week, confirms that the turbine blades failed in fatigue, caused by resonant vibration in the tangential mode. The blades in rows 8, 9, 10 and 11 were set vibrating at their resonant frequency by the steam issuing from the preceding steam nozzles, and the condition was made more serious by the nature of the blade mountings. A secondary cause of vibration may have been torsional vibration of the rotor, caused by lack of truth in the main coupling from the rotor to the reduction gears, but Sir Arnold is convinced that steam excitation was the principal cause. To remedy the deficiencies, Sir Arnold says that the blades in rows 7 to 12 should be changed to "rhubarb" section, which gives better strength at the junction between blade and root, and that the first 1.1 inches of each of these blades should be thickened, again to increase root strength. Midway along each blade, lacing or binding wires should be provided to damp out the principal mode of vibration. Finally, in the rows of blades from 2 to 6, the method of mounting should be modified to remove stress concentrators; this can be done by removing fillets at the junction of the blade with the root.

Happily, Sir Arnold's report has been accepted by all involved, including Cunard, who had previously made angry noises about appointing their own independent expert. "We are very greatly encouraged by this report", said Sir Basil Smallpiece, chairman of Cunard, adding that, of course, there would still be a need for full sea trials and subsequent stripping of the turbines to make sure all was well. Sir Basil revealed, with some reluctance, that the delay had cost Cunard "£2.5 million in gross revenue", but John Brown Engineering would not be drawn on the cost of the repairs. Sir Arnold's schedule provides for the turbines to be reassembled and in the ship by March 21, and for a proving voyage early in April. If all goes well, the ship should be handed over by the second half of April. To judge by the alacrity with which the port turbine has been returned to Southampton, Sir Arnold's report does no more than put the seal of approval on steps already taken by John Brown Engineering.

Mr Anthony Wedgwood-Benn, clearly relishing the

role of peacemaker, hinted that his department would be taking up Sir Arnold Lindley's recommendation that "more work should be done in turbine development and instrumentation", although all agreed that in matters like these it was impossible to be right every time. To have tested the turbines fully before they were installed, Sir Arnold said, would call for boilers "as big as Battersea Power Station", at a cost nobody was willing to bear.

In effect, Sir Arnold's report clears all those who are still around to care. Blame is attributed only to Pametrada, the now defunct organization which designed the turbines in the first place. The failure of the blades, said Sir Arnold, "is no reflexion whatever on the quality of workmanship or of material used in any part of the construction of the HP turbines". It is, perhaps, a reflexion on John Brown Engineering's enthusiasm for monitoring the design work contracted out to Pametrada. Even if it was impossible to anticipate exactly the resonant frequency of the blades, it would surely have been possible to avoid stress raisers in the junction between blade and root. In this sense, the whole episode is a lesson in the dangers of divorcing design from construction. Mr Benn, who is an advocate of contract research, particularly if it helps to employ Government establishments, should not have missed the point. But he almost certainly has.

#### ENGINEERING

### Ronan Point Discussed

THERE were more than mere murmurings of discontent at a meeting organized by the Institution of Structural Engineers at City University last week. The engineers were discussing the report of the investigation into Ronan Point, the twenty-two storey block of flats in Canning Town, London, a section of which collapsed dramatically last May. The meeting, attended by Mr Hugh Griffiths, the chairman of the tribunal which conducted the investigation, and Sir Alfred Pugsley, a fellow member of the tribunal and a past-president of the institution, was called to discuss the long term implications of the report, rather than the precise circumstances of the collapse at Ronan Point which is the subject of legal proceedings. The principal complaint was that the actions taken after the tribunal had reported were motivated by "panic" and "hysteria". Some blocks, one speaker complained, were standing empty awaiting rules from the Ministry of Housing which might never be made, and some local authorities were finding it difficult to accept blocks as "satisfactory" because the word had not been defined. When the new rules were published, all the people who had just set up home in the flats might have to move out for alterations to be made.

While it was generally agreed that codes of practice were useful guidelines for the designer and that they needed to be brought up to date, it was argued that they were not substitutes for professional experience and skill. Some of the engineers who spoke feared "codes of mandatory practice" which would restrict initiative. It was made only too obvious how little is known about structures and the forces acting on them. Mr Gordon Rose, a member of the institution, suggested that there should be a two-tier system with