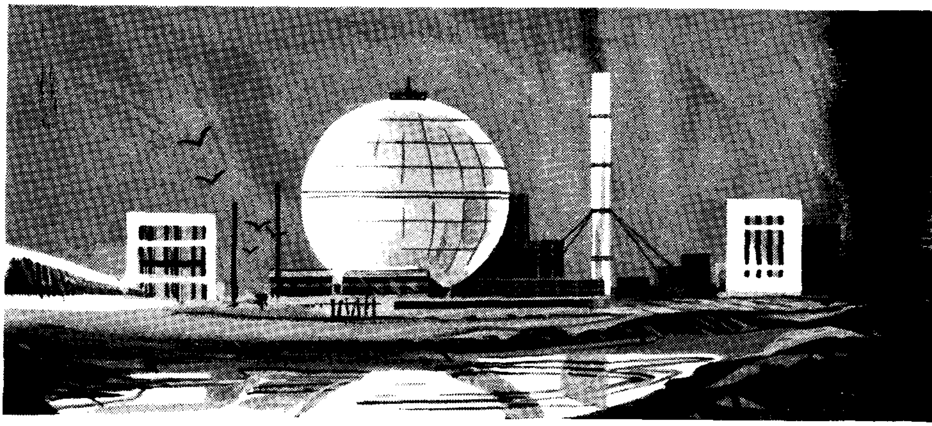
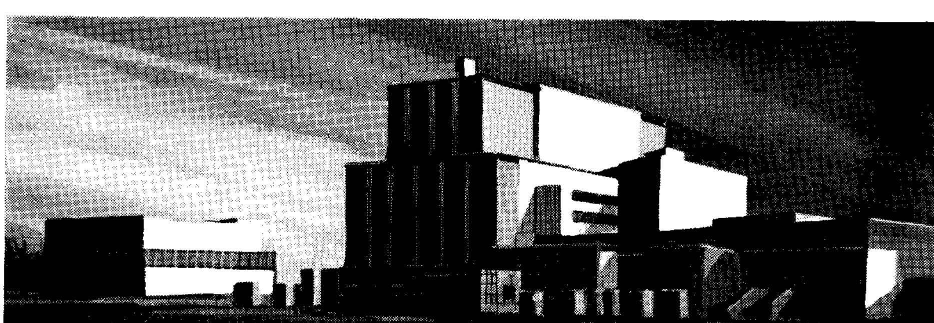
ATOM

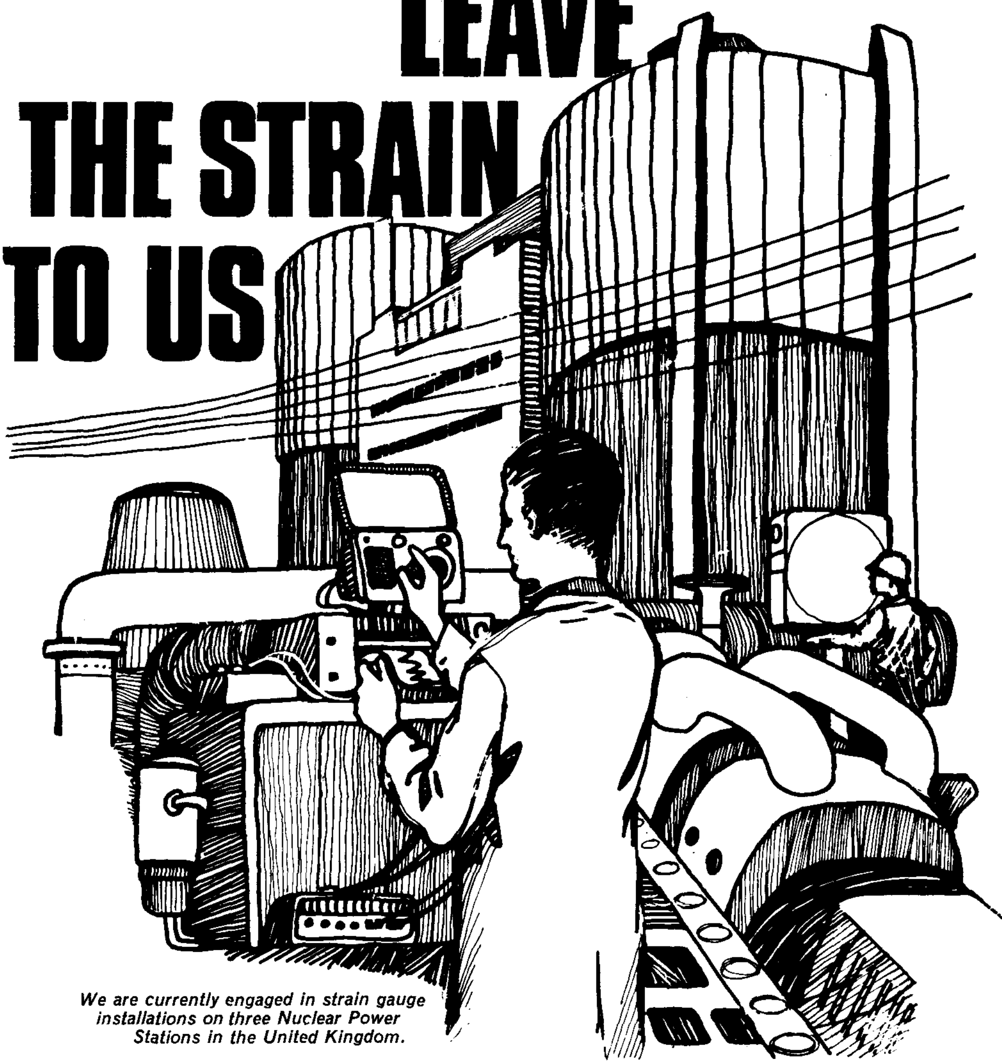
Number 158 / **December 1969**

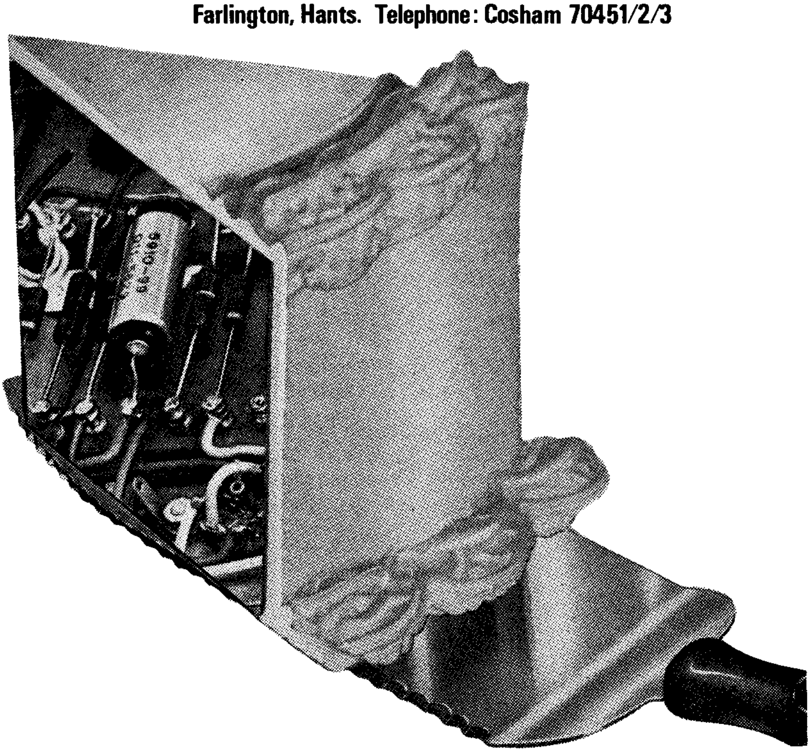
MONTHLY INFORMATION BULLETIN OF

THE UNITED KINGDOM ATOMIC ENERGY AUTHORITY









ATOM

MONTHLY INFORMATION BULLETIN
OF THE UNITED KINGDOM
ATOMIC ENERGY AUTHORITY

NUMBER 158
December 1969

Contents

ATOM

monthly bulletin of the UKAEA is distributed to the staff of the Authority, to similar organisations overseas, to industrial firms concerned with the exploitation of nuclear energy, to the Press and to others to whom a record of information of the work of the Authority may be useful.

Enquiries concerning the contents and circulation of the bulletin should be addressed to

Public Relations Branch
UKAEA
11 Charles II Street
London sw1
Telephone 01-930 6262

New power stations

Approval by the Government of the C.E.G.B.'s proposals for two further nuclear power stations—Heysham and Sizewell B—was announced on 29th October, 1969.

The C.E.G.B. subsequently stated: " Heysham will be the first station to be ordered. The Board will immediately seek competitive tenders for a two-reactor station of 1,320 MW capacity with the intention of placing the construction contract next spring and commissioning the first reactor on full power in the summer of 1975 ".

The timing of the release of construction contracts for Sizewell B would depend on the Government's consideration of the C.E.G.B.'s capital investment programme in the light of next spring's reappraisal of electricity growth prospects.

" Both Heysham and Sizewell B will have advanced gas-cooled reactors. Three stations of this type are already under construction for the C.E.G.B. which together with a similar station being built for the South of Scotland Electricity Board represent 5,160 MW of AGR capacity.

" Since adopting the AGR system in 1965, the Generating Board's confidence in its technical and economic merits has been confirmed as developments have proceeded. New design and construction features leading to falling costs have marked the development of the AGR which will play a growing role in the C.E.G.B.'s nuclear programme."

Computational Physics Conference Proceedings

The Computational Physics Group of the Institute of Physics and the Physical Society announce the publication by the U.K.A.E.A. Culham Laboratory of the Proceedings of the Computational Physics Conference, 1969. The work is in two volumes and the price for both parts is £4.

Volume 1 (xvi + 190 pages) consists of nine invited papers. Volume 2 (iv + 346 pages) consists of 53 original research papers in most fields of physics including those covered by the invited papers.

The Proceedings are available from H.M.S.O., 49 High Holborn, London, W.C.1, or any bookseller.

Group Technology

by D. Bennett, C.Eng., M.I.Mech.E., Senior Project Engineer, The Group Technology Centre, U.K.A.E.A., Blacknest, Brimpton, near Reading.

It has long been accepted by production engineers that the most economic methods of manufacturing engineering products occur when mass or flow line production of components can be established. Rationalisation of the product has occurred and manufacturing facilities have been tailored to produce a clearly defined range of components against an established demand.

Unfortunately most engineering organisations never attain this ideal and are faced by the nature of their products and the fluctuation in market demand to consider the manufacture of component parts in small batches. Invariably in this situation an "economic batch quantity" approach to component manufacture is adopted in an attempt to reduce machine setting costs per component. This in its turn produces large stocks of finished components awaiting orders, and when coupled with the manufacture of these components in a functionally laid out workshop, a large capital investment in work in progress.

Group Technology is a technique which allows the production of components required in small batches to achieve similar economic advantages to those associated with continuous flow line production. The approach is to analyse a company's total product and to identify within this product families of components which are related by a similarity in shape and/or the type of production facilities required to manufacture them.

To carry out this analysis it is essential that each component part can be examined in an unambiguous manner, the shape and manufacturing requirements clearly identified and related to other components within the total product. The use of functional descriptions of component parts is not normally satisfactory for this purpose as parts having similar or identical shape features can carry widely varying descriptions. A simple illustration of this is shown in Fig. I where the parts are described in different functional terms but obviously their shape envelope is almost identical.

The key to the situation is to use a classification and coding system which identifies the shape and manufacturing requirements of the components by the allocation of a specific digit to each significant feature. By this means, a mass of information is subdivided into smaller related units which can then be examined more easily.

The way in which a classification system works can be illustrated by the way in which each house in the country is identified for the purposes of delivering mail. The procedure this follows is shown. **U.K.: England: Ireland:** COUNTY: TOWN: Street: *House no.* The total area of a country has thus been sub-divided in such a way that the unique identity of each house is established.

A similar approach can be made to the identification of component types where a basic division is made separating rotational (ie, components normally rotated during their machining) from non-rotational components and then identifying their shape features. Thus – **TOTAL COMPONENTS IN COMPANIES PRODUCTS: Rotational: Non Rotational:** OUTSIDE SHAPE: Inside Shape: Material. This simple method of classification is of little value in a practical sense as the information contained within it is relatively small. However, a number of more sophisticated systems do exist which identify all the features that would be required to be analysed for Group Technology purposes. The general information content that a classification system suitable for Group Technology applications should carry can be listed as follows:—

1. Geometric definition of external and internal shape.
2. Additional features such as holes, slots, splines, etc.
3. Material type and where practical the initial material form, ie. bar forgings, castings, etc.
4. Size envelope.

This information can be supplemented by other features such as accuracy and

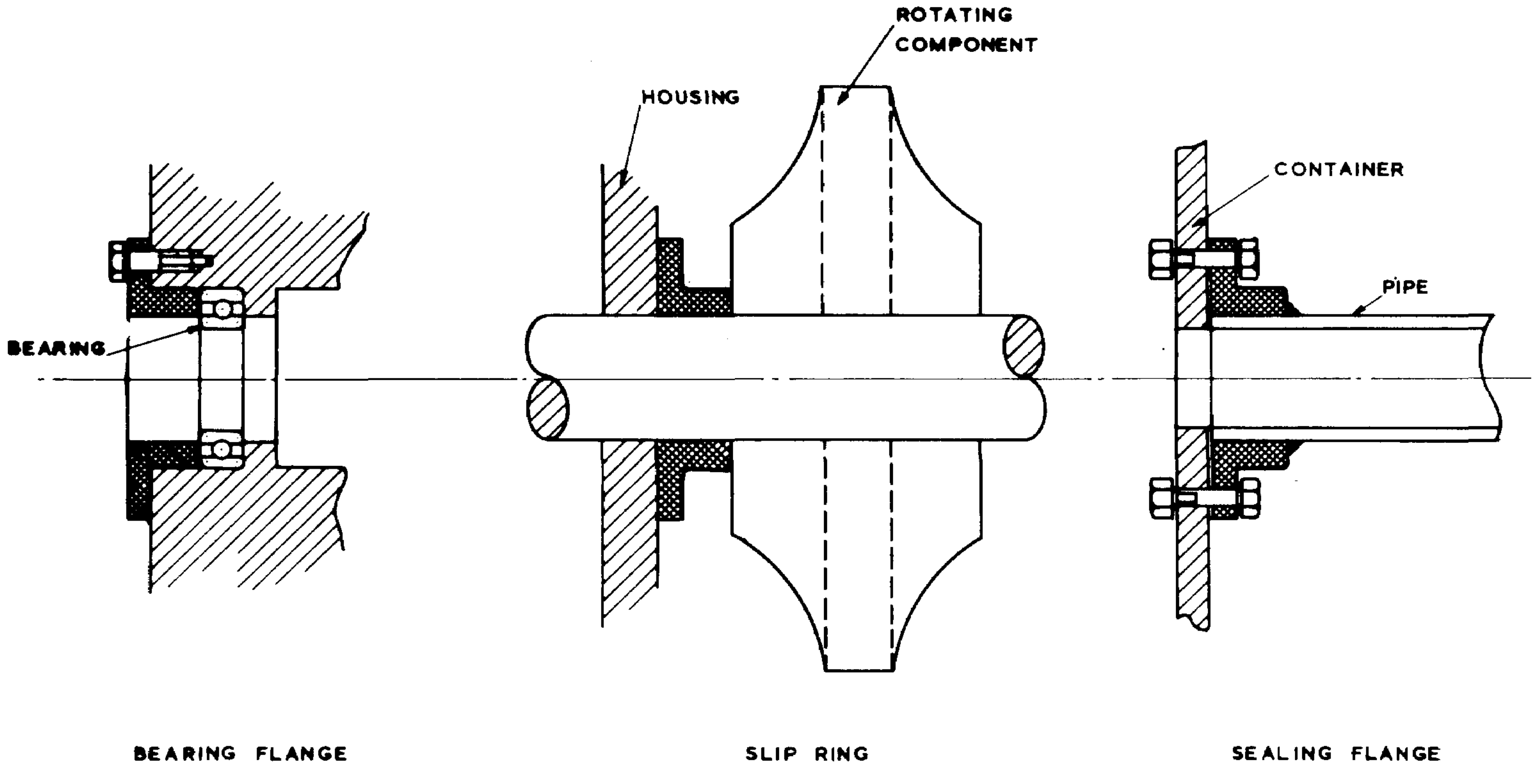


Figure. 1. *Components identical in shape but differing in function*

weight where the products type requires them.

It is important to recognise that a very long code number indeed would be required to classify in precise detail all the information related to each component feature. The preferred approach is to use the simplest classification system possible, which contains the necessary levels of information and use this as a key to the precise detail information already existing on the drawings and production planning documents. The code structure should ideally contain a high level of digital significance as this will greatly simplify the sorting procedures used to gather together families of similar components. With complete digital significance all that will be required is a listing of the coded components in numerical sequence which will automatically assemble components with similar major features adjacent to each other.

Having identified families of components by these means the next stage is to associate with these families the quantities of each component required over a given period, the allowed machining and setting up times, and the actual manufacturing process. By simple calculation of manufacturing times and quantities required an assessment of machine group load content of a component family can be established. Should this not be sufficient to economically load a group of machines, the parameters of the family can be logically extended in either shape, size, or material until a satisfactory load has been established.

At this stage the opportunity should be taken to examine the technological processes used to manufacture the components as this could well be changed when considering the production of what is now effectively a very large batch of components with a high level of similarity.

The final stage in the process is the examination of each component within the family to define its tooling requirement. Once this has been done a group of dissimilar machines can be brought together which will be capable of manufacturing the complete component family. To gain maximum benefits all the technical requirements of the machine group in terms of information, tools and services should be associated with it. When this has been done the total manufacturing time cycle of the components will be very clearly defined.

The immediate effects of manufacturing on this machine group will be a radical reduction in total component manufacturing time as components will enter the group as raw material and emerge as finished parts. Machine setting times will be drastically reduced as machines will now be " adjusted " round a basic setting rather than being reset completely for each new component. Work in progress will be reduced as the lower machine setting times will allow actual component production to reflect much more closely the state of the company order book. Also the queuing time associated with inter operational machine loading in the functional lay-out workshop will have been eliminated, and this in turn will reduce the work in progress still further.

The finished stock holding of a company is often a reflection of lack of confidence in the production departments achieving their manufacturing objectives. As the machine group has been tailored to a precise manufacturing requirement, this uncertainty no longer exists and a positive approach can be made to the reduction of finished stock holding with a consequent release of capital.

To create this situation a large bank of data will have been established to identify the families of components and their manufacturing processes. This data can be used for a number of other purposes, the inter-relationships of some of which are shown in Fig. 2.

Consideration of the planning function indicates the ability to create standard planning procedures related by component similarity. The documentation of process planning then becomes greatly simplified particularly where it has been possible to establish large and homogeneous component families. An examination of allowed manufacturing and machine setting times of closely related components can easily be carried out and, from the results of this, standard work/time schedules based on real or synthetic times produced.

If the product demands it one of the parameters for a machine group could be a special level of accuracy. In this case it becomes possible to institute individual machine group costing and so create a

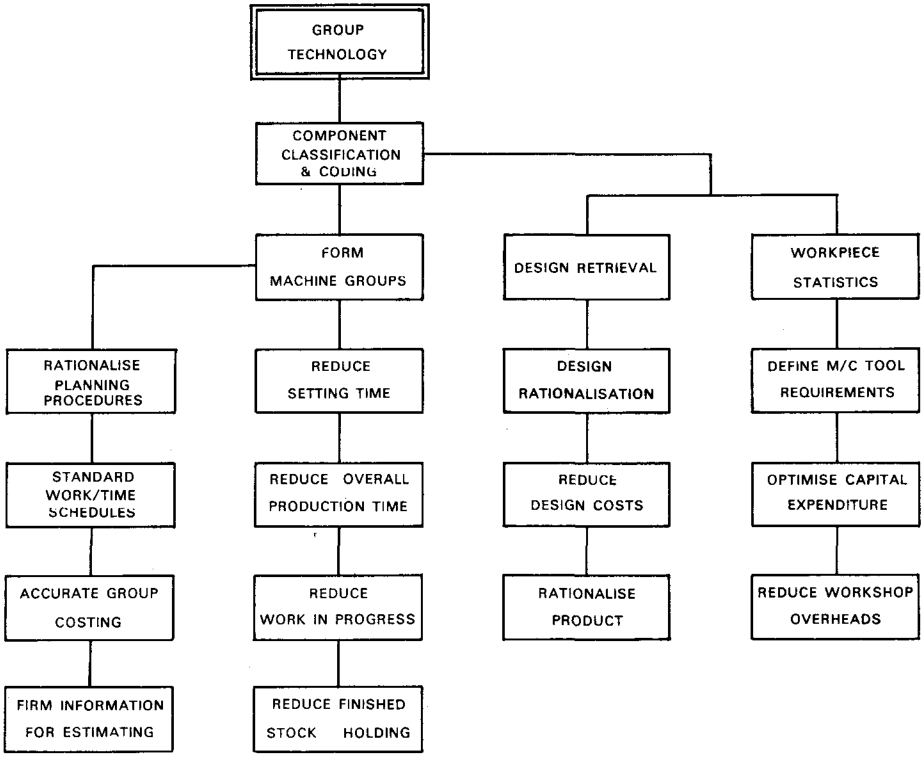


Figure 2

situation where the overheads collected by the component truly reflects the capital costs of the machines required to produce it.

By establishing a classification-based retrieval facility containing all this data a powerful tool is available for estimating production time and costs for any new product. All that is needed is to code the component parts of the new product and having so identified them search the classified data files for information on currently manufactured components with similar code numbers.

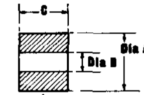
In the design office a retrieval facility can be established by creating a duplicate set of reduced size or microfilmed drawings filed in code number order. The designer or draughtsman considering a new component design can, after coding a rough sketch, quickly search the retrieval facility to identify any similar components already in existence which may suit his purpose. This same retrieval facility also creates a very firm foundation on which to base a programme of standardisation, value analysis, or any other technique which requires the examination of components related by specific features.

The relationships between component shape and manufacturing requirements used to establish the machine groups can also be used to define very closely the type and size of machine tools required to produce them. With this information, any future machine tool purchase programme can be based upon the clearly identified needs of the components to be produced. Analyses of present workshops machine capacity invariably reveal a total imbalance between the size of components produced and the size of machine tools available to produce them. The machine tools are much too large in size and must therefore have been more expensive than was necessary. Keeping in mind that the machine tool population of Great Britain is estimated at about 1,000,000 the potential savings available to industry by instituting a machine tool purchase programme based on true workpiece statistics is enormous.

An example of the use of this interrelated information is shown in Fig. 3. Here a number of very simple component

MANUFACTURE BY GROUP TECHNOLOGY

COMPONENT FAMILIES



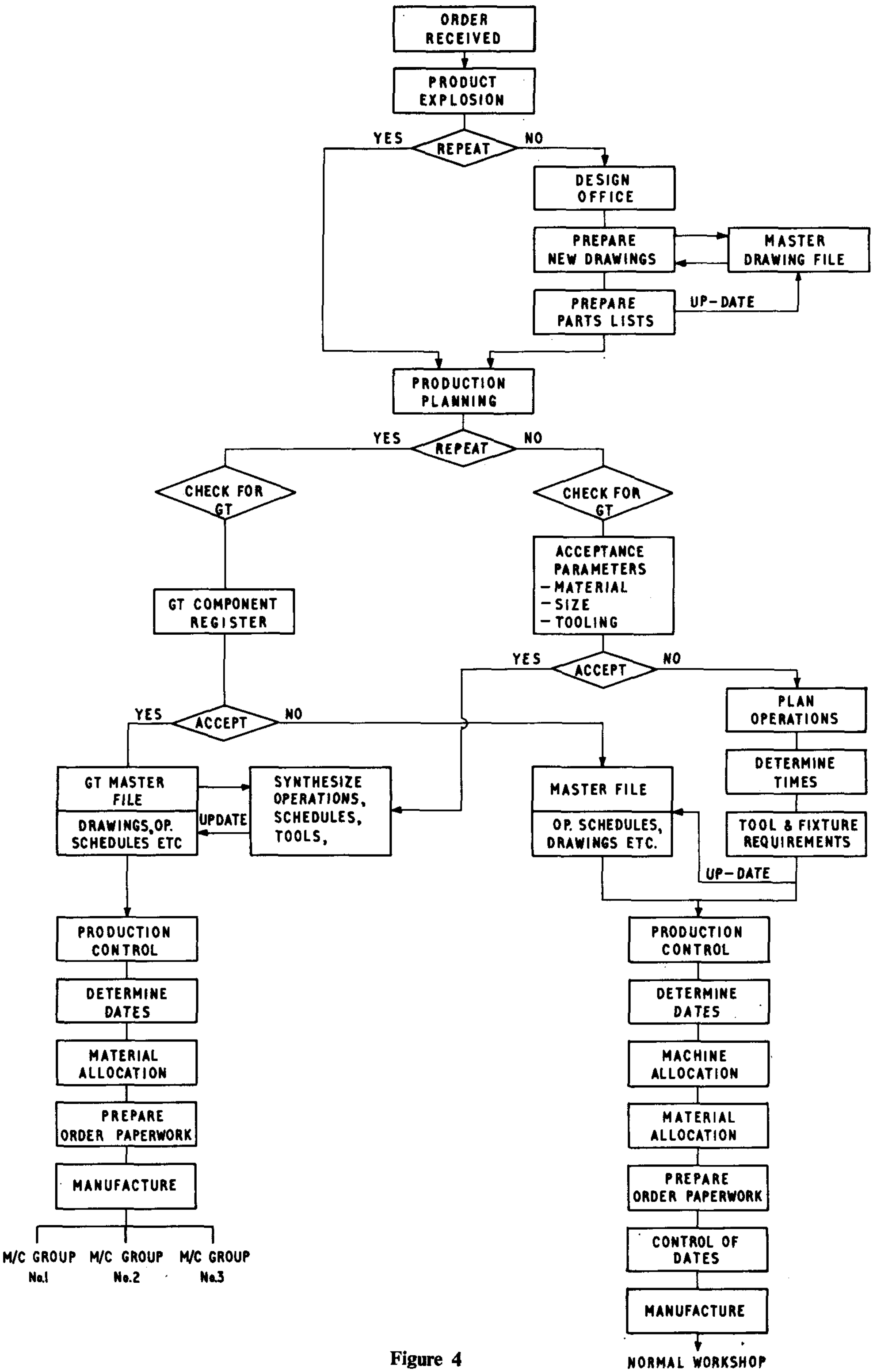
CLASSIFICATION — DESIGN — ANNUAL USAGE — PRODUCTION (PLANNING; MANUFACTURE TOOLING ANALYSIS)

Geometric Classification	Dimensions	Supplementary Information (Material Form & Accuracy)	Drawing No.	Dimensions: Dia A	Dimensions: Dia B	Dimensions: C	Title		Annual Usage
00100	00	210	20274	.228 .225	.125	.020	WASHER		70
00100	00	210	20343	.301	.189	.028	WASHER		31
00100	00	210	21150	.318 .313	.250 .251	.032 .030	WASHER		50
00100	00	210	21094	.333 .330	.250 .251	.032 .030	WASHER		107
00100	00	210	2508	.406	.191	.125	EJECTOR SPRING WASHER		7
..	..	210	20198	.406	.257	.020	SPECIAL WASHER		1
..	..	213	20414	.485 .480	.3755 .3765	.187 .182	SLEEVE		15
..	..	210	10006	.500	.218	.125	WASHER		1
..	..	210	2494	.500	.257	.125	WASHER - EJECTOR SPRING		36
..	..	215	20391	.570	.5020 .5025	.187 .182	THRUST SLEEVE		1
..	..	210	20219	.546	.250	.046	SPECIAL WASHER		1
..	..	210	20218	.546	.390	.031	SPECIAL WASHER		1
..	..	210	21015	.562	.390	.036	WASHER		1
..	..	210	031-38064	.620 .615	.218	.156	WASHER		60
..	..	410	20837	.625	.390	.048	WASHER		2
..	..	410	2493	.625	.390	.125	WASHER		17
..	..	210	031-29502	.687	.251 .252	.245 .240	ROLLER		6
..	..	210	2187	.705 .700	.257	.093	WASHER-CUP PACKING RETAINER		162
..	..	410	280	.750	.250	.125	TOP WASHER		9
..	..	213	21121	.750	.250 .251	.249 .244	ROLLER		6
..	..	510	20056	.750	.3125 .3132	.300	ROLLER-COLLET VALVE		8
..	..	210	2580	.750	.390	.250	SPACING WASHER	IDENTICAL COMPONENTS	87
..	..	210	20987	.750	.390	.250	WASHER		1
..	..	210	031-38171	.750	.531	.062	SHIM		1
..	..	210	20822	.750	.546	.048	WASHER		1

DIMENSIONS IN INCHES
TOLERANCE ± 005 UNLESS STATED

Drawing No.	Time in Mins: Setting	Time in Mins: M/Cing	External Form	External Form	External Form: 45° Chamfer	External Form: Radii	Part Off	Internal Form: Drill	Internal Form: Reamer	Internal Form: 45° Chamfer	Internal Form: Radii
20274	75	3	√	√			√	1/8			
20343	30	3	√	√			√	No. 12 (.189)			
21150	30	5	√	√			√		1/4		
21094	30	4	√	√			√		1/4		
2508	30	5	√	√			√	No. 11 (.191)			
20198	30	5	√	√			√	F (.257)			
20414	45	10	√	√			√		3/8		
10006	30	5		√	1/32		√	7/32		3/64	
2494	30	2		√			√	F (.257)			
20391	60	3	√	√			√		1/2		
20219	30	5	√	√			√	1/4			
20218	30	5	√	√			√	25/64			
21015	30	5	√	√			√	25/64			
031-38064	30	5	√	√				7/32		5/64	
20837	30	4		√			√	25/64			
2493	45	3		√			√	25/64			
031-29502	30	15	√	√			√		1/4		
2187	60	5	√	√		5/64	√	F (.257)			
280	30	6		√			√	1/4			
21121	30	12		√			√		1/4		
20056	45	10		√			√		5/16		
2580	30	3		√			√	25/64			
20987	30	5		√			√	25/64			
031-38171	30	5		√			√	17/32			
20822	30	5		√			√	35/64			

Figure 3



ORDER RECEIVED
PRODUCT EXPLOSION
YES
REPEAT
NO
DESIGN OFFICE
PREPARE NEW DRAWINGS
MASTER DRAWING FILE
PREPARE PARTS LISTS
UP-DATE
PRODUCTION PLANNING
YES
REPEAT
NO
CHECK FOR GT
CHECK FOR GT
GT COMPONENT REGISTER
ACCEPTANCE PARAMETERS
- MATERIAL
- SIZE
- TOOLING
YES
ACCEPT
NO
PLAN OPERATIONS
YES
ACCEPT
NO
GT MASTER FILE
DRAWINGS, OP. SCHEDULES ETC
UPDATE
SYNTHESIZE OPERATIONS, SCHEDULES, TOOLS,
MASTER FILE
OP. SCHEDULES, DRAWINGS ETC.
DETERMINE TIMES
TOOL & FIXTURE REQUIREMENTS
UP-DATE
PRODUCTION CONTROL
DETERMINE DATES
MATERIAL ALLOCATION
PREPARE ORDER PAPERWORK
MANUFACTURE
M/C GROUP No.1
M/C GROUP No.2
M/C GROUP No.3
PRODUCTION CONTROL
DETERMINE DATES
MACHINE ALLOCATION
MATERIAL ALLOCATION
PREPARE ORDER PAPERWORK
CONTROL OF DATES
MANUFACTURE
NORMAL WORKSHOP

Figure 4

parts are brought together by the use of a classification system. The random nature of the original drawing numbers and component description shows that they could not have been used to identify the component relationships. An interesting point is that two completely identical components have been designed and that in the previous year 87 had been manufactured to one drawing number and 1 to the other. Similarly an examination of the allowed setting times show a variation of $2\frac{1}{2}$x, and the allowed machining times a variation of $7\frac{1}{2}$x. This is not an indictment on the particular company for inefficiency in the production planning office but an indication that before classifying their product they had no means of identifying even simple components related by shape.

In establishing groups of machine tools capable of producing a defined family of components the production process has been more clearly defined in terms of capacity and location than is ever possible in a functional workshop. Because of this the ability to control the production process becomes greatly simplified, and with a suitably developed system the instructions to a machine group for a specified production period need be no more than a list of component identification numbers with the quantities required off each. So long as the raw material arrives at the right time and the work load is within the machine group's capacity all the remaining information and equipment to produce them will be available within the machine group.

However, it must be accepted that a disciplined approach to the control of the machine groups must be established. Each new order must be exploded into its component parts, each of these coded, and examined against the existing machine groups' parameters. Decisions must be made as to the acceptability of a new component within an existing group and if necessary the group parameters and tooling extended to accept it. The lay-out of a model system to suit these requirements is shown in Fig. 4.

The effects of applying Group Technology in a company can be very significant. Total component manufacturing times are invariably reduced by a factor of 4 or 5, machine setting times are also reduced on average by about 70%. However, the major benefits occur as the full effects of the technique is extended into the management structure of the organisation. The following results reflect some of the effects in Serck-Audco Ltd., Newport, who apply Group Technology principals across the total management structure of the organisation.

Finished Stock — Reduced by 44% = £550,000

Average Manufacturing Time — Down from 12 weeks to 4 weeks

Value of Despatches/Employee — Up from £2,220 to £3,105

Average Income/Employee — Up 35%

A full description of the company's application is described in *Production Planning & Control* (H.M.S.O.).

Group Technology is a technique which can have a far reaching effect on manufacturing economics in industries requiring component parts in small batches. Each application will be completely individual to a particular company and must be developed within the company by personnel fully conversant with the product and the skills available within the production environment.

In the limit the success of Group Technology within a company and the benefits gained will totally reflect the vision and tenacity of the senior management responsible for its implementation for without these qualities innovation is not possible.

Harwell computer services

A range of new services for industry is now available from Harwell in multi-access computer system technology; systems analysis and design (software); using computer methods to solve optimisation and scheduling problems.

From January 1970 the main computer complex alone will consist of a large IBM 360 Model 75 multiplexed to over 200 typewriter terminals via satellite computers and multiplexers

The experience of designing, operating and improving the system and of using sophisticated computer methods to solve problems effectively and cheaply provides the expertise on which the services are based.

Enquiries about these services should be made to Mr. T. D. Phillips, The Computer Manager, AERE, Harwell, Didcot, Berks. (Tel.: Abingdon 4141 ext. 3227)

U.K.A.E.A. SCIENTIFIC AND TECHNICAL NEWS SERVICE

U.K. and U.S.S.R. collaborate on fusion

The results of a successful example of international scientific collaboration are announced in an article in the centenary edition of *Nature*, published on 31st October, 1969. British and Russian scientists are co-operating on a ZETA-like nuclear fusion experiment known as TOKAMAK at the Kurchatov Institute in Moscow, and the article describes the results of precise measurements of temperature made by a small team from the U.K.A.E.A's Culham Laboratory using an advanced technique perfected at Culham.

These results show that the gas within the device is well confined at temperatures reaching 10 million degrees for times exceeding 1/20 second with a density about 1/10 of that required for a nuclear fusion reactor. The experiment confirms that conditions in TOKAMAK approach most closely those required for a fusion reactor, in which energy would be obtained in a controlled fashion from the fusion of hydrogen atoms to give a new source of power for the world.

Since 1958 there has been a full exchange of information between all countries working in this field and progress has been measured on an international scale. Hitherto these exchanges have been both by visits and reports; scientists have also been exchanged between some of the U.S.S.R. and U.K. laboratories. The present collaboration, which started in March this year, is the first investigation in which teams of Soviet and British scientists have worked together on an experimental research project in the nuclear energy field. A continuing programme of collaboration with the U.S.S.R. is now anticipated on fusion research.

The aim of this research is to establish the possibility of producing power from the controlled fusion of the atomic nuclei of light elements such as hydrogen. The method envisaged for achieving fusion power is to confine an extremely hot gas of hydrogen isotopes so that energy is released by thermonuclear reactions between the atomic nuclei. The crux of the problem is to find means of isolating the gas at the required density and temperature (about 100 million degrees centigrade) from the walls of its containing vessel for long enough for a net gain in energy from the nuclear reactions to be released. The only way envisaged for confining this high temperature gas (known as a plasma) is by the use of magnetic fields. It is the shape of the magnetic field which distinguishes the type of fusion systems currently being studied in fusion laboratories throughout the world and TOKAMAK is one such system.

If controlled fusion can be achieved a new and widely available fuel could supplement or replace fossil fuels and uranium as a source of power.

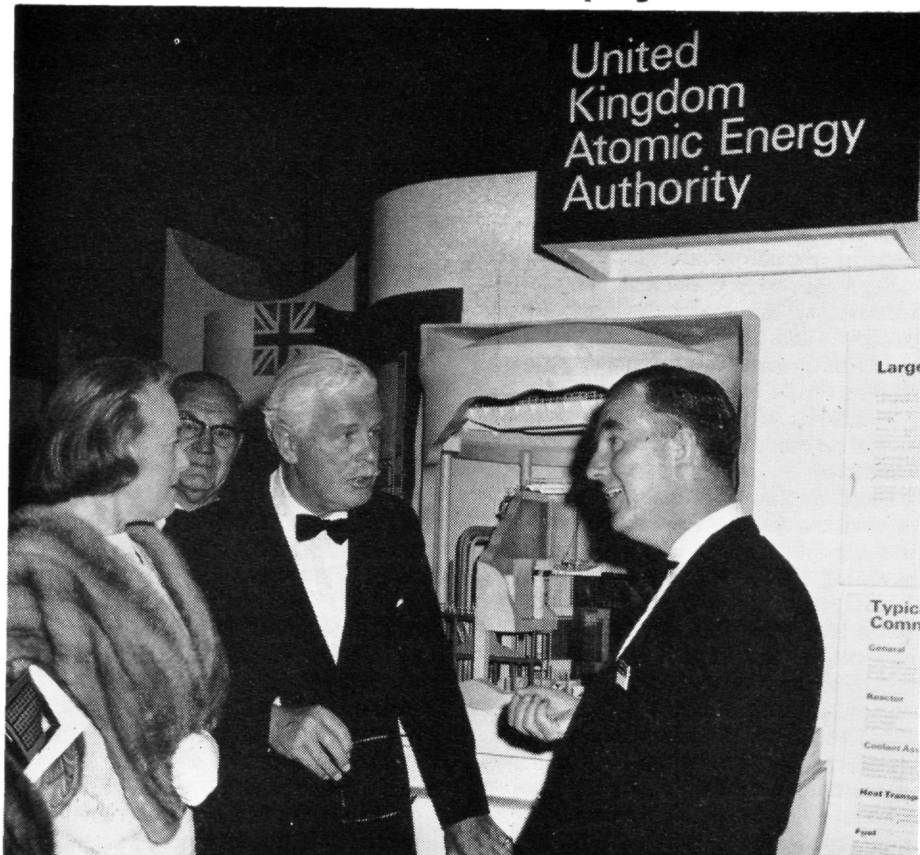
Background notes

The Culham scientific team engaged in these experiments comprises: Dr. N. J. Peacock (Leader), Mr. M. J. Forrest and Mr. P. D. Wilcock. The team spent several months in Moscow, where they were joined by Dr. D. C. Robinson, who is spending a full year at the Kurchatov Institute.

The accurate measurements of temperature and densities of the hot gas within TOKAMAK, on which interpretation of this Russian experiment has depended, have been carried out by the British team using a technique developed by them for a number of Culham experiments. This technique depends on lasers which give out powerful pulsed beams of monochromatic light. The plasma is irradiated with the laser light and the spectrum of the laser photons scattered by the plasma is recorded. A specially designed spectrometer, with associated electronics, analyses this scattered light; from its spectral distribution and intensity the electron temperature and density at any point in the plasma volume can be readily obtained, more accurately than by any other known method. This intricate apparatus, assembled at Culham and weighing five tons, was flown to Moscow on 16th March this year.

TOKAMAK is the generic name for a series of toroidal pinch devices at the Kurchatov Institute. TOKAMAK 3 is the largest (2 metres major diameter and 20 cm. minor diameter) plasma confinement device in which a toroidal discharge,

Visitors to A.E.A. Melbourne display



On the Authority's stand at the Expo Electric exhibition in Melbourne, Australia, in October, Dr. G. R. Bainbridge (right), Assessments Manager in the Technical Operations Directorate of the Authority's Reactor Group, discusses the steam-generating heavy water reactor with Sir Rohan Delacombe, Governor of Victoria. A model of the reactor is behind them.

On the left is Lady Delacombe and in the background Dr. W. H. Connolly, Chairman and General Manager of the State Electricity Commission of Victoria.

carrying about 100 kA, is stabilized by a very strong longitudinal magnetic field. The discharge current both heats and confines the plasma.

The proposals for collaboration were initiated in discussions between Dr. R. S. Pease, Director of Culham Laboratory, and Academician Artsimovich, who is in charge of this work at the Kurchatov Institute.

30th October, 1969

The A.E.A. in Sydney

The U.K.A.E.A. had a small stand in the British exhibition at the International Trade Fair in Sydney, 16th-25th October, which showed that Britain has produced more electricity from nuclear power than the rest of the world combined.

The stand featured the Steam Generating Heavy Water Reactor, Britain's newest power station system, which has been operating successfully for nearly two years now at Winfrith (near Bourne mouth) in Dorset. Larger versions of this system have been designed with outputs of 450 to 600 megawatts.

A design team of engineers from Australia was attached for about a year recently to the U.K.A.E.A.'s reactor design headquarters at Risley in Lancashire to investigate the possible use of S.G.H.W.R's in Australia.

There were models of the S.G.H.W.R. and fast reactor systems on the stand

and a display of fuel elements. Britain is one of the world's largest manufacturers of nuclear reactor fuel, which the U.K.A.E.A. sell all over the world.

Inspection and quality techniques displayed

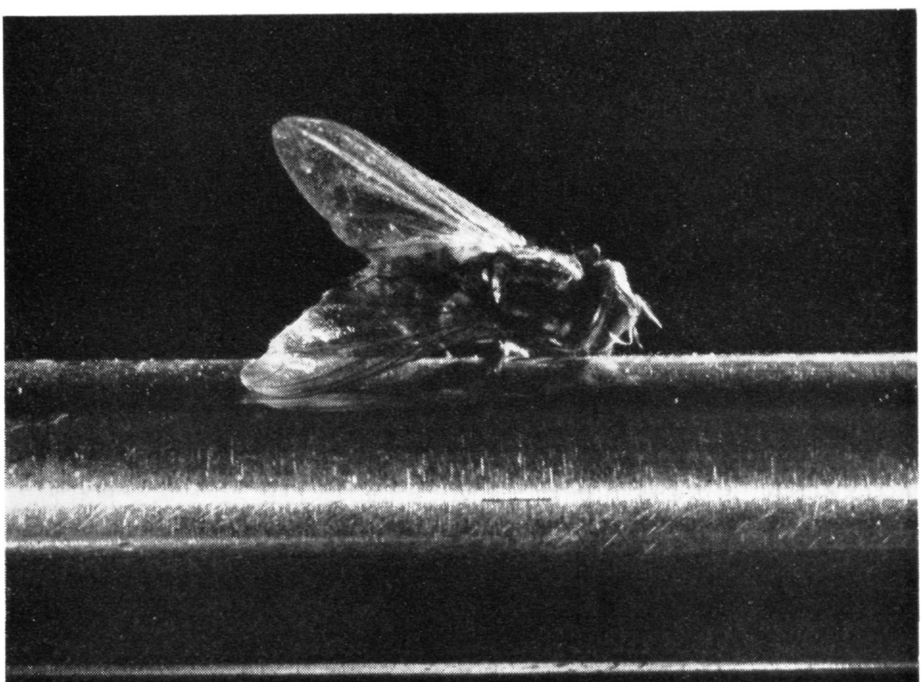
The UKAEA participated in Inspex '69, the 3rd Exhibition and Conference on Inspection and Quality Control in the Engineering and Allied Industries, at the Royal Horticultural Society's Halls, London, S.W.1., 10th-13th November, with a display of advanced techniques in inspection, metrology, nondestructive testing and analytical services, all of which are available to industry.

Two of the Authority's establishments, A.E.R.E. Harwell, and RFL Springfields, were represented on the stand.

A.E.R.E., Harwell: Over more than 20 years Harwell has built up an unrivalled range of resources and expertise covering most quality control fields and these are now available for use, in confidence, by industrial companies who need information, advice or assistance.

The range of expertise and facilities available to industry from Harwell was illustrated on the stand by work of the Nondestructive Testing Centre, the Mechanical Standards Laboratory (together with the Winfrith Mechanical Standards Laboratory), the Analytical Research and Development Unit and the Physico-Chemical Measurements Unit.

These displays described the services provided by the units and showed equipment which has been developed. The Analytical R & D Unit, for instance, showed an electrohydraulic crusher for small samples and an X-ray milliprobe analyser, and also featured activation analysis techniques. The NDT Centre showed a Delayed Ultrasonic Pulse Echo Thickness Gauge for measuring the thickness of components while they are being machined; a precision on thickness of 0.0001″ (2.5 microns) can be achieved for materials such as mild steel. This is obtained by measuring the flight time of a pulse of ultrasound to 1 nanosecond



At Inspex '69, the Reactor Fuel Element Laboratories, Springfields, described a simple spark machine method to produce defects in pieces of tubing. The defects are of known size and shape and are used to calibrate ultrasonic testing equipment. The size of one of these defects is shown in the photograph—the dark line in the band of light immediately beneath the house-fly (included to show scale).

using electronic circuits originally developed for nuclear physics time-of-flight experiments.

RFL Springfields: The inspection techniques needed in developing nuclear fuel elements are usually in advance of those required in most industrial operations. These techniques can now be made available to industry and range from non-destructive testing of 1mm diameter balls to the alignment of a 1,600 ton extrusion press.

The exhibits covered the inspection of small bore internal weld profiles, simple statistical metrology, the manufacture and inspection of NDT calibration standards, and circumference and circumferential strain measurement.

This last exhibit showed a transducer attached to a radial grating which rotates on an air bearing; this system measures the radius of a tube and the angle of rotation. Computer calculation for cumulative arc values gives the circumference of the tube. For the measurement of plastic strain, a 0.5 mm grid pattern is etched on the specimen. By measuring the lengths between the grid lines before and after a test, strain value can be determined.

A.E.A. Reports available

THE titles below are a selection from the November, 1969, "U.K.A.E.A. list of publications available to the public". This list is obtainable free from the Librarian, A.E.R.E., Harwell, Didcot, Berkshire. It includes titles of all reports on sale, translations into English, books, periodical articles, patent specifications and reports which have appeared in the published literature. It also lists the Depository Libraries in the U.K. and the countries with official atomic energy projects which receive copies of U.K.A.E.A. unclassified reports.

AEEW-M 912
Proportional Counters for Measuring Plutonium-239 'In Vivo'. The Choice of Counting Gas and the use of Pulse Shape Discrimination Techniques. By R. A. Pike and D. Ramsden. August, 1969. 9pp. H.M.S.O. 2s. 6d.

AEEW-R 641
Noise Spectra Measured on the Dragon Reactor Primary Heat Exchangers. By J. D. Cummins. September, 1969. 10pp. H.M.S.O. 6s.

AEEW-R 648
Measurement of Relative Conversion Ratio and Fast Fission Ratio in Low Enrichment Oxide Lattices. By G. A. Barnett, C. B. Besant, M. F. Murphy and W. H. Taylor. August, 1969. 30pp. H.M.S.O. 6s.

AERE-R 5792
The Measurement of Small Dimensional Changes by Neutron Radiography. Progress Report. By R. S. Matfield, G. Constantine and S. C. Alexander. July, 1969. 53pp. H.M.S.O. 12s.

AERE-R 5944 (Vol. 1)
The Interactions Between Dislocations and Point Defects. Proceedings of a Symposium Held at Harwell, July 4th-12th, 1968. Volume 1. Part 1. Theoretical Considerations. Part 2. Dislocation Pinning. Edited by B. L. Eyre. December, 1968. 285pp. H.M.S.O. 39s.

AERE-R 5944 (Vol. 2)
The Interactions Between Dislocations and Point Defects. Proceedings of a Symposium Held at Harwell, July 4th-12th, 1968. Volume 2. Part 3. Dislocation Climb. Edited by B. L. Eyre. March, 1969. 286pp. H.M.S.O. 44s.

AERE-R 5944 (Vol. 3)
The Interactions Between Point Defects and Dislocations. Proceedings of a Symposium Held at Harwell, July 4th-12th, 1968. Volume 3. Part 4. Mechanical Properties. Part 5. General Discussion. By B. L. Eyre. December, 1968. 258pp. H.M.S.O. 34s.

AERE-R 6011
A Primary Standard of Gas-Flow Measurement. By G. V. Evans, R. Spackman and J. C. D. Gardiner. September, 1969. 12pp. H.M.S.O. 3s.

AERE-R 6052
A Neutron Diffraction Study of Carbon Fibres. By R. N. Sinclair, A. Wedgwood, D. H. C. Harris and P. A. Egelstaff. June, 1969. 10pp. H.M.S.O. 3s. 6d.

AERE-R 6138
A High Intensity Isotope Separator Ion-Source. By J. H. Freeman. July, 1969. 7pp. H.M.S.O. 3s. 6d.

AERE-R 6163
An Improved Method for the Determination of Plutonium by Alpha Counting. By A. J. Wood and G. W. C. Milner. August, 1969. 13pp. H.M.S.O. 2s. 6d.

AERE-R 6165
The Destructive and Non-Destructive Analysis of Vanadium for Carbon by γ Activation. By J. S. Hislop and D. A. Wood. August, 1969. 16pp. H.M.S.O. 3s.

Oxidation problem

13th October, 1969

MR. JUDD asked the Minister of Power whether he will make a statement on the recent technical difficulties which have led to a reduction in power output at nuclear power stations in Great Britain.

Mr. Benn: Oxidation of certain minor steel components at a greater rate than anticipated has occurred at six of the Central Electricity Generating Boards seven operational Magnox type nuclear stations: Bradwell, Hinkley " A ", Trawsfynydd, Dungeness " A ", Sizewell and Oldbury. The rate of oxidation is influenced by the temperature of the coolant gas inside the reactor which has therefore been reduced slightly to slow down the rate of oxidation.

Production from these stations will be reduced by about 400 MW, approximately 1 per cent. of the C.E.G.B.'s maximum output capacity. With present plant margins the C.E.G.B. foresee no threat to supplies this winter. All the stations affected remain in continuous operation and are, I understand, still exceeding their design load factors of 75 per cent. I am satisfied that they can continue to operate safely at the reduced temperatures.

I have satisfied myself that with help from the U.K.A.E.A. and the nuclear consortia the Generating Board are investigating the full consequences of the problem and ways in which to restore the lost output. I have the Board's assurance that A.G.R. stations will not be affected as they operate in a much higher temperature range for which special steel components are being provided.

16th October, 1969

MR. KELLEY asked the Minister of Technology what is the estimated loss of revenue arising from the need to operate Magnox nuclear power stations at low capacity because of the corrosion of parts of the reactors recently discovered.

Mr. Harold Lever: As stated in the reply to the Member for Portsmouth, West (Mr. Judd) on 13th October, the six Magnox stations affected by oxidation are still in continuous operation at above their design load factor. As the Board are confident of maintaining supplies there should be no loss of revenue.

Fast breeder reactor

17th October, 1969

MR. G. ELFED DAVIES asked the Minister of Technology when, taking into account the delays to the prototype fast breeder reactor mentioned in paragraphs 159 and 160 of the Atomic Energy Authority's Annual Report for 1968-69, he now expects the first commercial-scale reactor of this kind to be in operation.

Mr. Harold Lever: The delay is due to difficulties encountered in welding the biological shield roof and is not connected with the fast reactor system. The prototype is expected to be completed at the end of 1972 and it is estimated that a commercial fast reactor could be ordered to come into operation towards the end of the 1970s.

Power costs

20th October, 1969

MR. KELLEY asked the Minister of Technology if he will withhold permission for the building of any more nuclear power stations until the first commercial scale advanced gas-cooled reactor station has operated long enough for the running costs to be proved.

Mr. Harold Lever: No. The Government have been satisfied that the A.G.R.s will generate base load electricity at lower cost than conventional stations. To withhold permission for the construction of further A.G.R.s would delay unacceptably the reduction of the cost of electricity and the further development of nuclear power.

Winfrith S.G.H.W.R.

20th October, 1969

MR. CLIFFORD WILLIAMS asked the Minister of Technology what was the total cost, including loss of revenue, of the delays to the Winfrith S.G.H.W. reactor reported in Paragraphs 151 and 152 of the 1968-69 Report of the United Kingdom Atomic Energy Authority.

Mr. Benn: The cost of rectifying the plant was about £6,000; the further cost arising from fuel failures is not easily assessed. The estimated revenue that might otherwise have been obtained is £200,000. A load factor of 45 per cent. for the first year of operation of this prototype reactor is considered to be a very satisfactory achievement.

The prototype S.G.H.W. reactor at

Winfrith was not constructed solely to generate electricity, but to afford an opportunity to solve any development problems that might be thrown up. Achieving a high standard of water purification was part of the development programme. The time lost as a result of malfunctioning of the purification plant enabled other desirable experimental and engineering work to be carried out.

Dragon reactor

22nd October, 1969

MR. CLIFFORD WILLIAMS asked the Minister of Technology what was the total cost including any loss of revenue, of the delays to the DRAGON reactor reported in Paragraph 150 of the 1968-69 Report of the United Kingdom Atomic Energy Authority.

Mr. Wedgwood Benn: The Atomic Energy Authority operate this experimental reactor on behalf of the O.E.C.D. DRAGON Project. The reactor is not used for the production of electricity and its irradiation space is not sold; there is, therefore, no revenue. I am informed by the management of the DRAGON Project that the necessary cost of replacement of a complete set of heat exchangers, to which reference is made in the A.E.A.'s Annual Report, was of the order of £60,000.

Atomic Energy Board

22nd October, 1969

MR. NEAVE asked the Minister of Technology when he proposes to set up the proposed Atomic Energy Board.

Mr. Benn: This will require legislation. Issues for which the proposed board will be responsible are now being covered by the Atomic Energy Authority's Reactor Policy Committee, and a Reactor Export Committee which has been established.

Ground rules

22nd October, 1969

MR. EADIE asked the Minister of Technology why Her Majesty's Government agreed to change the ground rules for estimating the costs of the nuclear power stations now being built, in view of the fact that no commercial station using the advanced gas-cooled reactor has yet operated.

Mr. Alan Williams: My hon. Friend will be aware from the Answer he received on 25th March, that it is the Central Electricity Generating Board who have primary responsibility for determining the ground rules, but the Government were aware that the change was under consideration.

Dungeness B

22nd October, 1969

MR. ASHTON asked the Minister of Technology when the Dungeness B Nuclear Power Station is now expected to be in operation; and what delay this represents by comparison with the original estimate.

Mr. Harold Lever: In 1972. The first unit is expected to be delayed by at least 18 months and the second by about a year.

Mr. Ashton asked the Minister of Technology what was the original estimate of the cost per unit of electricity sent out from the Dungeness B nuclear power station; and what is the present estimate on the basis of the same ground rules.

Mr. Harold Lever: The initial estimate (0.46d./kWh) was given in paragraph 68 of Cmnd. 2798. There is no up-to-date estimate on the original ground rules, but the C.E.G.B.'s latest estimate using their revised ground rules is 0·56d./kWh as stated in the reply given to my hon. Friend on 13th March, 1969.

Nuclear reactor exports

22nd October, 1969

MR. HORDERN asked the Minister of Technology what action is being taken by his Department to encourage exports of British nuclear reactor systems.

Mr. Benn: A Reactor Export Policy Committee on which my Department and others is represented has been set up with the U.K.A.E.A., the U.K.A.E.A. Production Group (later to become the Nuclear Fuel Company) and the two nuclear design and construction companies as members.

In this way the fullest assistance and support can be provided.

Coal replacement

22nd October, 1969

MR. G. ELFED DAVIES asked the Minister of Technology what loss of annual business to the coal industry is represented by the nuclear power stations now operating; and what are their excess costs by comparison with coal-fired stations in the coalfields built at about the same time.

Mr. Harold Lever: It is calculated that the output of nuclear power stations in 1968-69 was equivalent to 8 million tons of coal, but it would be misleading to assume that coal stations would necessarily have been built if there had been no nuclear stations. The earliest nuclear stations under the first nuclear programme were less economic than contemporary conventional stations but the later ones to come into operation have base-load costs similar to those of contemporary coal-fired stations in the same part of the country.

Chapelcross

22nd October, 1969

MR. EADIE asked the Minister of Technology what are the final figures for the cost of the breakdown of the reactor in the Chapelcross nuclear-powered station, including the loss of revenue.

Mr. Alan Williams: Remedial work on No. 2 reactor at Chapelcross has cost £400,000. The reactor recommenced electricity generation in mid-July this year, by which time the loss of electricity sales revenue was £2·3 million against which may be set savings in fuel costs which cannot yet be assessed. It is not yet operating at full power and the final loss of revenue will depend on its future performance.

Isotope-powered electrical generators

5th November, 1969

MR. LUBBOCK asked the Minister of Technology if he will give a general direction to the Atomic Energy Authority to discuss isotope-powered electrical generators with new potential licensees, now that the Authority's existing partners are terminating their agreement.

Mr. Alan Williams: A direction would not be necessary or appropriate. The exploitation of isotope-powered electrical generators is a matter within the day-to-day responsibility of the Atomic Energy Authority.

A.G.R. export prospects

10th November, 1969

MR. PATRICK MCNAIR-WILSON asked the Minister of Technology if he will give details of the number of inquiries which have been received for the supply of advanced gas-cooled reactors to other countries.

Mr. Alan Williams: At the present time, five countries have reasonably firm nuclear power projects, of a size for which the A.G.R. system would be suitable, and the nuclear design and construction companies are in touch. In addition, licences for the A.G.R. have been taken out by German and Japanese firms.

Nuclex data sheets

Copies of the following data sheets produced by the U.K.A.E.A. for the Nuclex '69 exhibition in Basle, Switzerland, 6th—11th October, are available from Public Relations Branch, U.K.A.E.A., 11, Charles II Street, London, S.W.1.

A.E.R.E. Harwell.

- A.E.R.E. research reactors in support of reactor projects.
- Automatic potentiometric titration apparatus.
- A radiometric scanner with polychromatic display.
- Industrial uses of gamma radiation.
- Power from radioisotopes.
- Compatible nuclear electronic equipment (CAMAC).

A.W.R.E. Aldermaston.

- Low energy heavy ion accelerator.

Reactor Engineering Laboratory, Risley.

- Flux distortion flowmeters for P.F.R.
- Saddle-coil EM flowmeter.
- Automatic plugging meters.
- Electromagnetic differential pressure gauge.
- Sodium level measurement in P.F.R.

Reactor Fuel Element Laboratories, Springfields.

- Out-of-pile loop tests for C.A.G.Rs.
- Out-of-pile loop tests for S.G.H.W.Rs

Reactor Development Laboratories, Windscale.

- A.G.R. heat transfer.
- The C.A.G.R. handling test rig.

Dounreay Experimental Reactor Establishment.

- Fast reactor development in the U.K.
- Sodium water reaction work at Dounreay.

Courses at Harwell

THE following courses are due to be held at the Post-Graduate Education Centre, A.E.R.E., Harwell, Didcot, Berks. Further information and enrolment forms can be obtained on application. The fees shown are exclusive of accommodation.

Two-Phase Heat Transfer
5th to 9th January, 1970 (at A.E.E. Winfrith)
1st to 5th June, 1970
Should be of particular value to engineers and scientists working in the field but may also appeal to those requiring an introduction to two-phase heat transfer.

The subject is approached in a fundamental way and although its application to nuclear reactors problems has some emphasis, the material presented is useful to those requiring a knowledge of the problems inherent in two-phase heat transfer and of current solutions, theories and developments. The lectures are given by experts in their subjects. Fee: £40.

Modern Physical Techniques in Materials Technology
12th to 16th January, 1970
19th to 23rd October, 1970
Arranged in conjunction with the Institute of Physics and the Physical Society and the Metals and Metallurgy Trust.

Presents an opportunity to scientists engaged in research and development to familiarise themselves with seventeen different modern physical techniques of vital importance in materials technology. Lectures are given by specialists actively engaged in these fields.

The basic principles of each technique are outlined, together with the scope and limitations, and the course presents an overall picture of the inter-relation of the techniques and of their applications in the physical sciences. Fee: £40.

Radioisotope Methods in Chemistry
26th January to 13th February, 1970
Intended for chemists employed in pure or applied research who need a basic introduction to radioisotope methods coupled with specialised information in particular chemical fields.

Students will be encouraged to suggest experiments which they wish to carry out in the third week. Fee: £120.

Advanced Radiological Protection
16th February to 13th March, 1970
For the experienced health physicist to extend his understanding of the underlying philosophy and scientific bases of his profession. Attention is also given to the managerial and professional responsibilities of the health physicist. The subjects covered include many of those dealt with in the Post-Graduate Radiological Protection Course but emphasise more advanced aspects and modern developments.

The topics include more advanced lectures on radiation physics, dosimetry and modern developments in radiation detection. The practical work comprises syndicate studies in place of laboratory work, to provide participants with an opportunity to conduct joint exercises with their professional colleagues from other establishments and countries and so obtain a very wide perspective of their profession. Fee: £160.

Seminar on Harwell's Multi-access Computing System
18th and 19th February, 1970
13th and 14th May, 1970
The objective is to describe and discuss the multi-access computing facilities developed at Harwell for use on the IBM system/360 computer. The system is designed to operate efficiently with conventional batch-processing. Participants are given the opportunity to use it. Lectures describe how it is implemented, giving particular emphasis on what is required for similar systems to be implemented on other computers. Fee: £16.

Pressurised Equipment
9th to 13th March, 1970
For designers of graduate level who are concerned with pressurised equipment in a research and development environment.

Covers the following broad aspects of the subject:

Design of vessels, seals, joints, flanges; other practical aspects of design; materials and the effects of special environments; recent work on fracture mechanics and high pressure engineering.

Lectures are given by specialists from Harwell and Risley, from Government and industrial research and design establishments and from a University. Fee: £40.

Process Instrumentation

9th to 20th March, 1970

28th September to 9th October, 1970

For those of graduate level working on the instrumentation of process plant, nuclear reactors and scientific apparatus or who have a direct interest in the subject. Most of the lectures are given by specialists from U.K.A.E.A. establishments.

Demonstrations illustrate some of the lectures and there are visits to process plants. The emphasis of each visit is on the problems of instrument installation and maintenance in service. Fee: £80.

Radiological Protection

16th to 20th March, 1970

8th to 12th June, 1970

9th to 13th November, 1970

Lectures, demonstrations and practical work designed to give some experience in the safe handling of radioisotopes. While it is assumed that students are normally graduates in science or engineering, or hold equivalent qualifications, such qualifications are not considered essential to attendance. This course is intended to be of use to "competent persons" since it contains information about safety precautions when using x-rays, industrial use of radioisotopes, instrumentation and the regulations applicable to the use of ionising radiations.

The practical work is to familiarise students with simple measurements and calculations associated with radiological protection. Fee: £40.

Science and Mathematics Teachers

6th to 10th April, 1970

These courses for science and mathematics teachers, which may also be of interest to teachers in Colleges and Departments of Education, are intended to give a background knowledge of current developments in some of the subjects investigated at Harwell.

For science teachers the course covers some applications of nuclear physics, and is introduced by lectures providing a short account of recent nuclear physics research and the experimental apparatus involved. Other lectures include: physics, engineering and uses of nuclear reactors, materials research, developments in analytical science, applications of electronics and radioisotopes, and controlled fusion research. For mathematics teachers the course comprises a series of lectures on practical mathematics at Harwell, with particular reference to the impact of computers on problems encountered in scientific research. Fee: £5.

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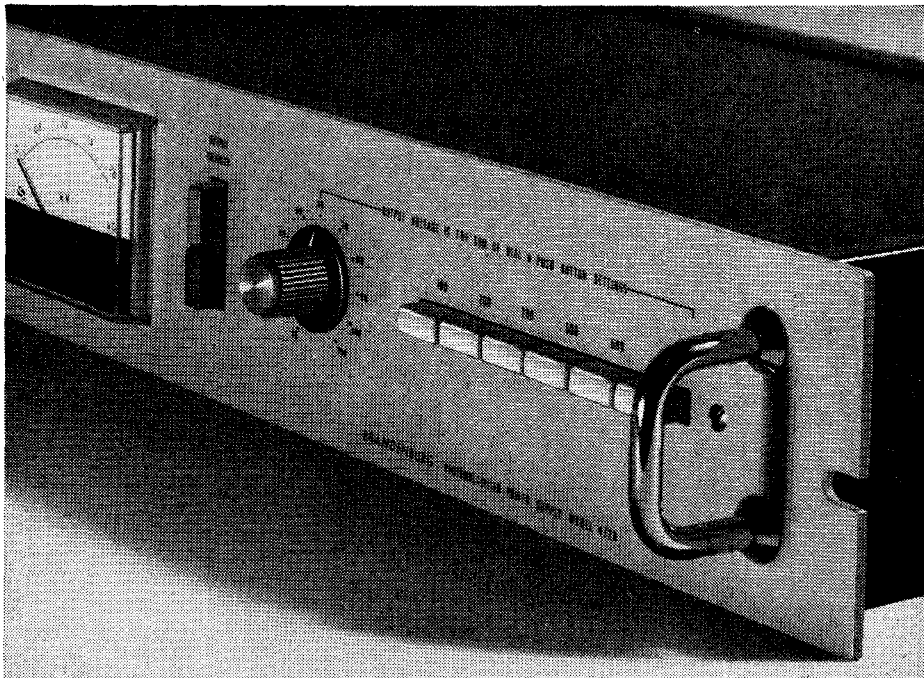
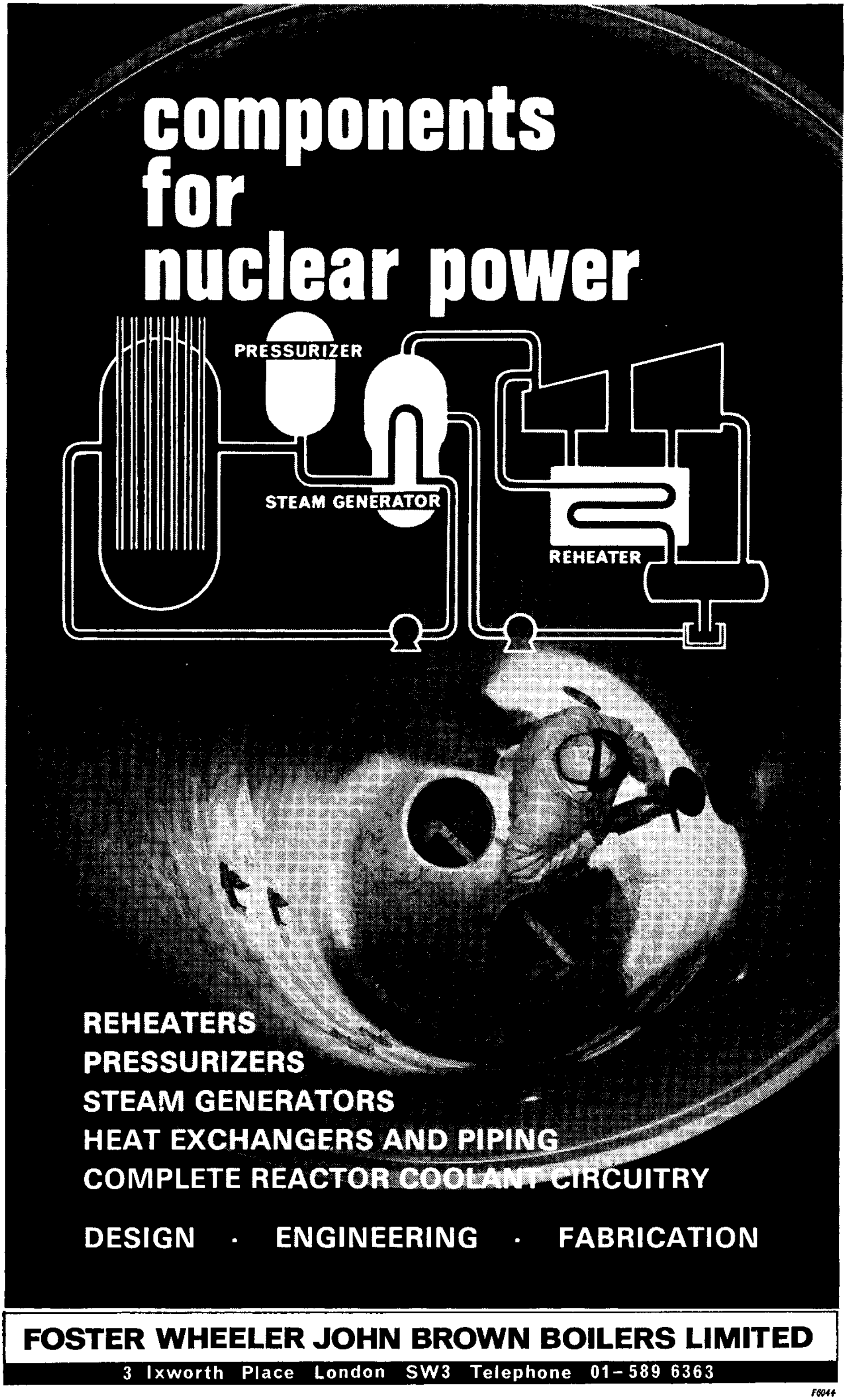
TITLES OF MAIN ARTICLES

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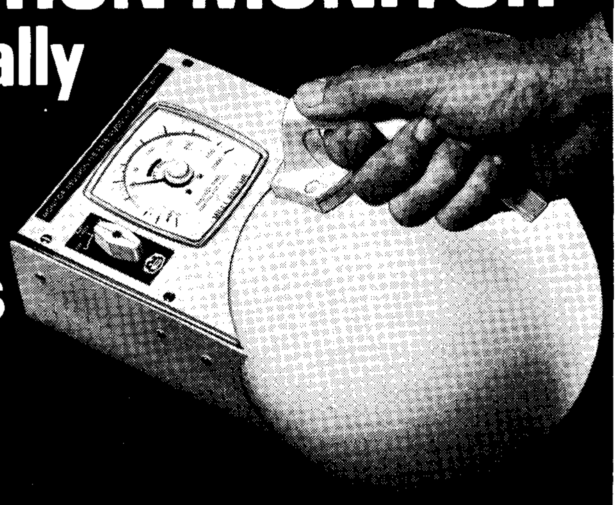

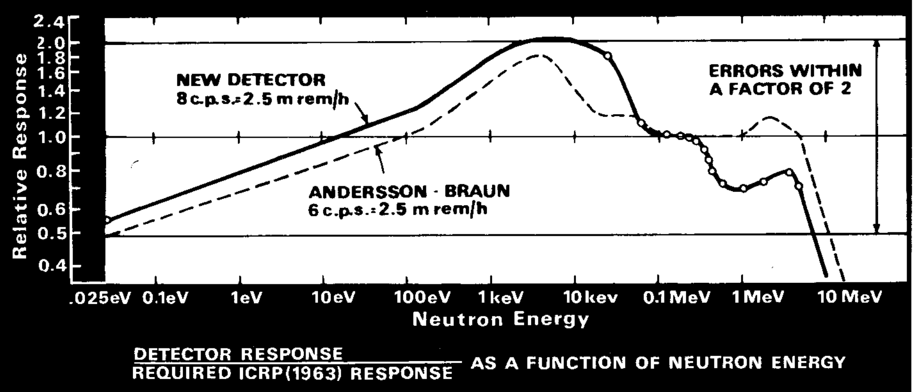
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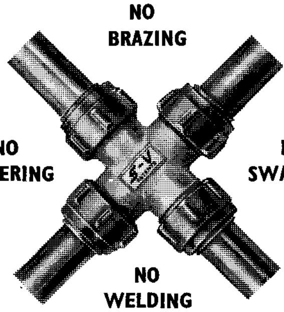

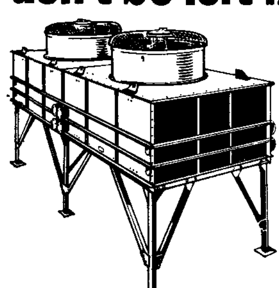

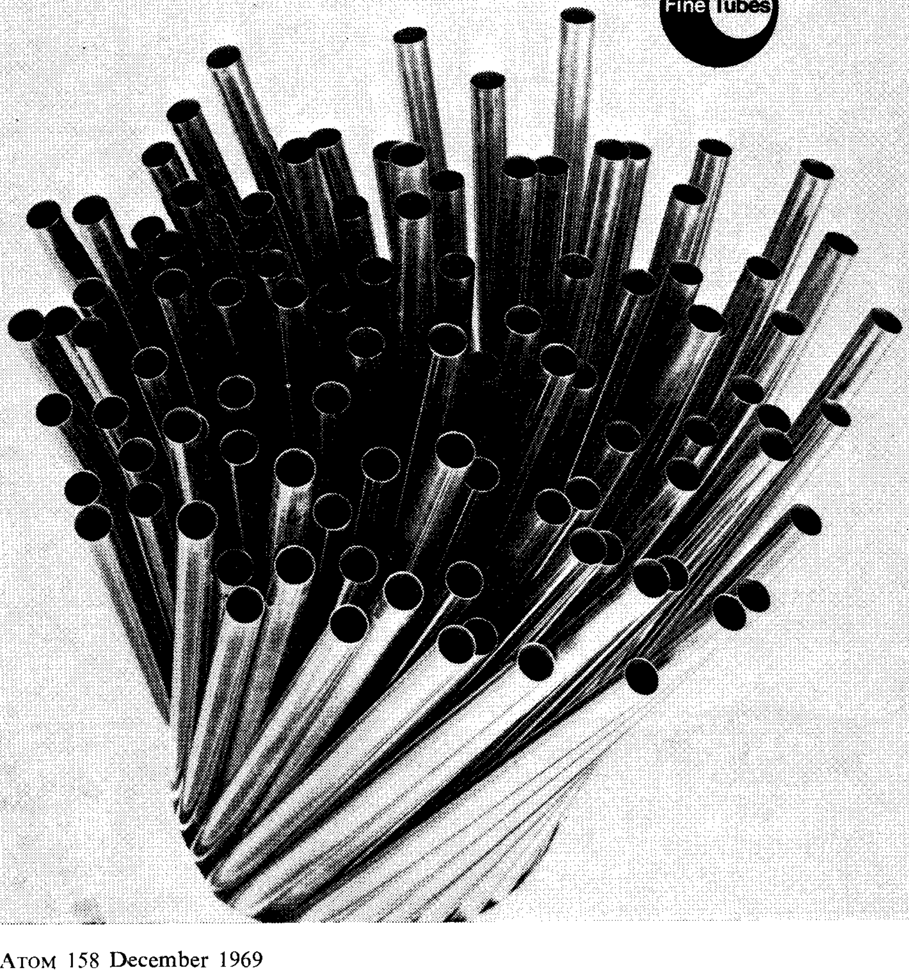

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