Hospital Engineering

The Journal of the Institute of Hospital Engineering

Vol. 24 August 1970

Incorporating 'The Hospital Engineer'

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The Journal of The Institute of Hospital Engineering

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In May Hospital Engineering *published the report of the Regional Engineers Association on the second Green Paper. Now it is the turn of the National Association of Hospital Group Engineers. Readers may find it interesting to compare the two reports.*

FUTURE STRUCTURE OF THE NATIONAL HEALTH SERVICE

1 Introduction

The National Association of Hospital Group Engineers represents group engineers throughout England, Scotland and Wales, and has branches in all regional hospital board areas. The Association is an in-service body with the following aims:

(*a*) to promote, foster and develop the management and general advancement of the engineering services within the hospitals of the National Health Service;

(*b*) to provide a means by which the views of group engineers on matters relating to hospital engineering can be made known to the Secretary of State and other official bodies.

Group Engineers are directly and solely responsible to their respective hospital management committees for the management, efficient operation and maintenance of engineering services in hospitals in the National Health Service at an annual cost of £80m. In addition, some group engineers have responsibility for building works.

The Association submitted comments on the first Green Paper and welcomes the opportunity to contribute further to the discussion on the future of the Service. The intention to discuss the details of the proposed reorganisation with all staff organisations is noted, and the Association would welcome the opportunity to participate in this way.

The report which follows this introductory section is presented in three parts: in Section 2 direct comment is made referring in bold type to paragraph numbers in the Green Paper, Section 3 contains general observations on the needs of the Service of the future, and Section 4 outlines a possible organisation for a works department at area health authority level.

2 Comments on Second Green Paper

2.1 'The principles of the new Health Service—Chapter 1'

The Association welcomes and supports the main objective of the Second Green Paper to integrate the Health Services in one administrative structure.

1 (ii) The Association is not entirely in agreement that 'hospitals outside the main centres of population have been upgraded within the limits set by antiquated buildings'. Much more could be done to improve the environment of older buildings if resources were made available. Recent observations made by the Comptroller and Auditor General draw attention to the impoverished resources applied to maintenance of buildings and engineering plant.

2.2 'The case for unification—Chapter 2'

8-17 The Association fully supports the abolition of the tripartite structure and its replacement by one homogeneous organisation for all aspects of health. In this way better use of the total resources available will be achieved.

2.3 'Area health authorities—Chapter 3'

2.3.1 Administration by local government; The establishment of area health authorities

18-21 The Association supports the view that the Service should not be run by the local authorities.

22-23 The need for close collaboration and co-ordination between local-authority services and health services is of the utmost importance, but, in determining boundaries of the respective area health authorities, prime consideration should be given to the natural catchment areas for health purposes.

2.3.2 Membership

26 The Association supports the expressed view that 'the local professions must shoulder their share of responsibility for the management of the health service in their area which they so largely provide'. The Association recommends the extension of the principle of professional representation on the area health authority to disciplines other than medical.

2.4 'Collaboration with local government—Chapter 4'

2.4.1 Exchange of services

42-45 Except in the fields of medical and nursing staffs it is difficult to visualise in practice a great deal of interchange of services between local authorities and health authorities. Administrative and financial barriers have to be crossed which could inhibit such actions.

2.5 'Local participation—Chapter 5'

2.5.1 District committees

54 The Association endorses the proposals to set up district committees as a basis of local participation. It is noted that the district committee will be served by officers of the area health authority. In this way 'area' and 'district' policies will be discussed with full appreciation of all relevant factors.

2.5.2 Voluntary organisations and voluntary work

55-59 The Association endorses the need to encourage voluntary work particularly in relation to long-stay and mental patients. Much public criticism has been expressed in these areas of patient care. A greater degree of voluntary work would open up this difficult area to public awareness.

2.6 'The administration of area health authorities—Chapter 6'

2.6.1 The role of the central Department

61 The Association generally supports the proposed role of the central Department, provided that adequate delegation of powers to the area health authority is given to carry out effectively the management of local services.

2.6.2 Internal organisation

70-71 The Association is concerned that the rapidly increasing engineering content of hospitals is properly understood and recognised in the new administrative structure. For this reason, the Association strongly recommends the appointment of an Area Engineer as one of the chief officers of the area health authority. His role would be to act as the authority's principal adviser on all engineering matters and provide a technical link with the central Department.

The Association recommends the uniform establishment of single works departments embracing all aspects of maintenance work as is the current practice in many groups. If the flexibility of staff in all trades now being encouraged by the Department and the development of productivity schemes are to achieve optimum results, it is of paramount importance that the management of building and engineering work is a single function. This was the basis of this Association's evidence to the Woodbine Parish Committee, but the absence of this Committee's report at this point inhibits further discussion.

No functional relationship is seen to exist between supplies on one hand and building and engineering on the other which would justify the setting-up of a single department for all three functions.

A suggested pattern for works-department management at area health authority level is contained in Section 4.

2.6.3 Finance

79 The Association generally supports the new role of the central Department and the proposed method of apportioning budgets for area health authorities being determined primarily by the population served.

2.7 'Regional health councils and central government—Chapter 7'

2.7.1 Regional health councils

93 While the need for regional health councils to advise on the wider aspects of planning is supported, this would, as now proposed, lack the technical advice of architects and engineers. It is important that the present practice in regional boards of project term planning be retained in order that the effectiveness of proposed projects is related to cost and technical feasibility. It is therefore recommended that medical planning should be carried out in conjunction with capital-works planning.

2.7.2 The central Department

90 The need for a constant interchange of staff at all levels within all disciplines in the service is of the utmost importance for the benefit of the service as a whole. There will be considerable difficulties to this within the framework of the proposed organisation. Without making all employees in the service civil servants or withdrawing the central Department from the Civil Service and creating one uniform pattern of staffing, as in a nationalised industry, the conditions of employment would not be compatible.

91 It is recognised that regional boards have made a major contribution to the development of hospital planning and design, but the proposed new role of the central Department offers a wider opportunity for the standardisation of building and engineering design to take full account of revenue implications.

94 The development of the National Health Service Hospital Advisory Service is welcomed. It will considerably improve communications throughout the service and promote better management.

2.8 'Staffing the service—Chapter 8'

100 The Association supports the proposal to set up a national staff commission to consider all aspects of redeployment of staff arising from the reorganisation of the service, and places its services at the disposal of the proposed commission.

101 One of the most important considerations following the publication of the White Paper will be to clarify all staff aspects of reorgnisation in order that key staff are not lost to the service during a period of uncertainty. For this reason it is recommended that, as soon as the major principles governing the new organisation are defined, the process of reorganisation and redeployment takes place as quickly as possible.

3 General observations

The objective of the proposed reorganisation is to give an overall benefit to the community through a unified National Health Service. There are many organisational structures which would serve this purpose. Some functions of organisation will involve compromise to suit the major considerations of patient needs and medical requirements. Subject to these criteria the proposals contained in the Green Paper provide a sound planning basis for reorganisation.

In the creation of the new administrative structure attention should be given to improving the conditions of service of health-service staff. This is the most valuable and expensive asset that the new organisation will inherit, and the opportunity should be taken to bring the rewards of the staff more into line with other public bodies, not only in financial terms but in other respects such as staff health, personnel management, leave, recreational facilities, training and career development.

Medical science offers almost unlimited opportunities for treatment in the future. This in turn may cause frustration to potential patients through the constraints of limited skilled staff and finance. This will be an ever-present problem, and care will always be needed to balance the needs of today against the possibilities of the future.

The National Health Service is a labour-intensive organisation, and will therefore continue to make increasing financial demands on the Exchequer The introduction of productivity schemes and the application of automation may produce savings, but the savings are likely to be more than offset by rising demands on the service. This financial demand would not be appreciably lessened by any proposal to introduce privately financed health schemes as part of the service, and this aspect would not generally find support within the service as a whole. It is therefore of vital importance that the service receives political support from all areas of public life.

The continued participation of lay persons in the management of the service is essential to the interests of the locality which the area health service serves. However, the correct balance must be found between committee management and the delegation of management to professional officers.

4 Area health authority works organisation

4.1 General

Although the area health-authority organisation must primarily be determined by patient and medical criteria, many advantages can be foreseen for a works department covering a much larger unit than the present hospital management committees.

The rapidly increasing complexity of engineering and building services in the new developments, and the hospital engineer's increasing involvement with equipment directly related to patient care, demands the supporting services of many engineering specialists to cater for the expansion in engineering technology in hospitals.

The area concept offers a more economically viable organisation in which to introduce a modern engineering management structure than hitherto possible at hospital management committee group level.

There is a need to cover more extensively than at present the following specialist services which could be

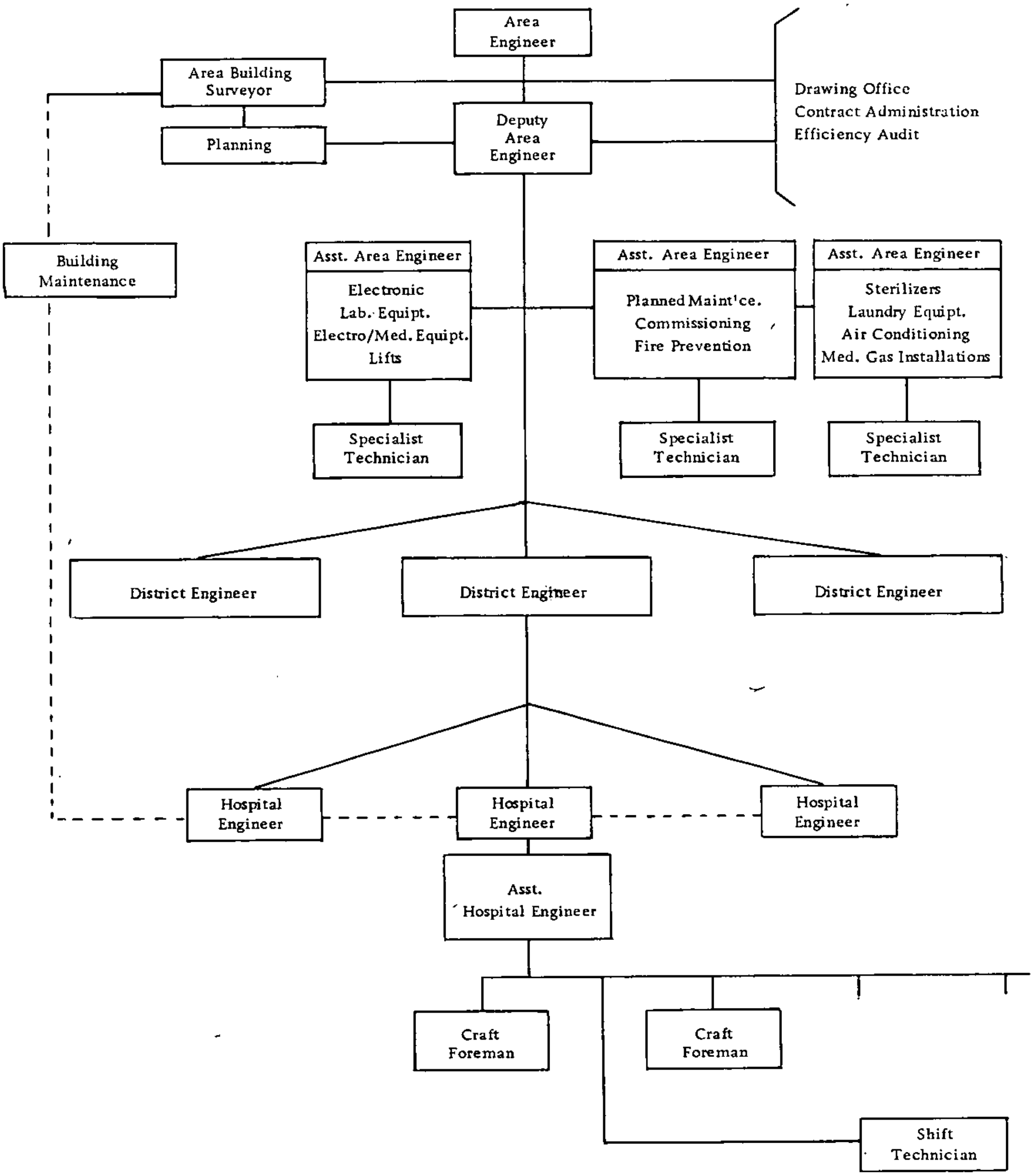


Fig. 1 Chart of suggested organisation for an Area Health Authority Works Department

efficiently deployed as an area service:

- medical electronics
- electromedical apparatus—maintenance of domiciliary dialysis, breathing machines etc.
- high-voltage electricity supplies
- sterilisers
- laboratory equipment
- lifts
- transport (joint arrangement for maintenance with local authority possible)
- laundry
- X ray
- medical-gas installations
- fire prevention and safety
- planned maintenance
- area engineering stores
- commissioning of new developments.

The engineering organisation of an area health authority can best operate through a combination of functional and line-management structure.

If it is accepted that building and engineering operate as a combined works department, it is envisaged that building would form another line of functional management operating through the hospital engineer, who would co-ordinate all maintenance functions at hospital level. A suggested organisational structure is shown in Fig. 1.

4.2 Recruitment, training and career structure

The area health authority structure will call for qualities in the chief officer in engineering at area level not previously sought within the Health Service. The area engineer will carry greater responsibilities than the present group engineer and, in contrast with the regional engineer posts, will require direct experience in the operation and maintenance of engineering services and equipment. He will need experience in the management and direct supervision of operational and maintenance staff at professional, technical and manual levels. His training, both academic and practical, must be such as to give him knowledge of a very wide range of engineering practice, mechanical, electrical and electronic, and he must also be trained in management techniques and in methods of administrative and financial control.

Many of the most capable of existing group engineers possess these qualities but are not chartered. Nevertheless, engineers of chartered status are seen as the needs of the service, and a formula will need to be found to cover the initial reorganisation. Training courses should be held at the Hospital Engineering Centre, Falfield, to prepare suitable engineers for area appointments.

It follows from the above that a route must be found to chartered status for young entrants in the Health Service who are making a career in engineering. The requirements of the chartered engineering institutions now preclude the attainment of membership of the professional institutions by part-time study; so it will be necessary to offer student apprenticeships in engineering in the service. Properly formulated sandwich courses at universities should provide the opportunity for student apprentices to take a degree in engineering as the first step towards membership of one of the chartered institutions. In the long term, a flow of candidates, trained and qualified within the Health Service, will be formed for the filling of vacancies in both the area health authority and the central Department. Potential engineers entering the service will then have the real prospects of a satisfying career.

At all levels the in-post training of area engineering staff should include short periods, for appreciation purposes, in the Department of Health & Social Security central and regional offices. The Department's staff should also undergo short-term secondment to area health authorities.

As the area organisations develop, the hospital engineer will have the benefit of closer technical support and training, but there will be a need for formal training in management, administration and forward-planning techniques. Eventually, engineers at this level will be potential chartered engineers, and will have completed their formal academic courses. After a qualifying period of service in the grade they should be candidates for area assistant engineer posts and chartered status.

The service needs to recruit engineering staff at three levels: craft apprentice, technical apprentice and student apprentice. While these are basic training levels, it is important that channels are provided to change from one to another. The technical apprentice, through day release facilities for HNC courses and through training at the Hospital Engineering Centre, will be able to qualify for posts up to area assistant engineer by specialising, during his part-time studies, in the branch of hospital engineering most suited to his talents. The in-post training of both types of apprentice should include periods in hospitals, with the area specialist teams, and with the area engineer and his deputy.

The Association fully supports the Department's recent opening of the Engineering Training Centre at Falfield, Gloucester, and foresee that this centre will play a major role in training engineers for the Health Service of the future.

Efforts towards the achievement of the composite craftsman in the service should be intensified, and encouragement given to undertake City & Guilds craft and technician courses and courses at the Hospital Engineering Centre.

4.3 Finance

It is important to establish a realistic budget for the maintenance functions of an area health authority, and it is also important, therefore, that the area engineer takes an active participation in senior management decisions affecting financial matters at area health authority meetings.

For the larger of the area health authorities the likely budget for the engineering operation and maintenance services will be of the order of £1m., with a further £200 000 being spent on building maintenance. It is essential, therefore, that the area engineer is accountable for this expenditure and budgetry control. This should include the continuous monitoring of areas of expenditure by means of efficiency audit of boiler-house production and all fuel and services consumption, complete job costing, and cost evaluation of direct labour, contract labour and maintenance-service contracts.

27th ANNUAL CONFERENCE

Medical Equipment Engineering

A. C. Sutherland, B.Sc.(Eng.), C.Eng., M.I.E.E.

If we look at the field of health care in the UK, in particular the hospital service, with which most of us are involved to some degree, there are three important features which are obvious if we examine the trends over the last ten years and try to extrapolate these over the next ten years. These three features can be summarised as follows:

more is known
more is done
more people are needed to do it.

First, more is known. More is known in technology: man now has at his fingertips techniques which were unheard of 50 years ago; some even 20 years ago. In materials and in electrical, electronic, mechanical and hydraulic techniques great advances have been made. In data acquisition and processing it is possible to handle large amounts of information quickly and accurately. Technology is developing so rapidly that it is sometimes frightening to look up the dates of first appearance of things which we now take for granted.

More is known too in medicine, in understanding the processes at work in the human body and the effect of environmental factors on these. In physiology and biochemistry particularly, knowledge is increasing continuously and rapidly.

When these two areas of increased knowledge are brought together, it sometimes becomes possible to recognise, treat, alleviate and possibly cure diseases which previously have been mysteries. This is one factor affecting our second obvious trend; namely, more is done. Year by year our health-care system is able to treat a wider range of conditions in an ever increasing population. The population in general also expects the health system to deal with more of its ailments, disabilities and problems which may previously have been accepted and tolerated.

If more is done, more is spent. Between 1963 and 1969 expenditure on the hospital service in England and Wales went up by 61% to £1559 m. Even when the fact that the pound decreased in value over the same period by about 20% is taken into account, this still represents a huge increase. Gerald Leach, author of 'The Biocrats', comments that, when the entire health service was formed in 1948, it was planned to cost £170 m, and because of improved health care it would cost about the same in 1968. But if more is done, more must be spent, and the more that is being done often involves the most expensive techniques.

Mr. Sutherland is the Product General Manager of G. & E. Bradley Ltd., Neasden Lane, London NW10

Between 1963 and 1968, the number of staffed beds in the hospital service went down by 1·5%. The total staff involved in the service went up by 14·5%, but we still hear that recruiting of hospital technicians and nursing staff is becoming impossible. Doctors are joining the brain drain, and talk about a staffing crisis can be heard everywhere. More staff are needed and staff are hard to recruit.

What part, if any, can the engineer as a professional play in alleviating these gloomy prospects? Engineers can and must make a major contribution to every problem area which faces the health system.

First, take the whole question of cost, increased work load and difficulty in recruiting more staff. The answer to this must lie in a considerable improvement in operating efficiency, using every technological trick in the book. I do not mean a piecemeal and halfhearted introduction of a few items of mechanical-handling equipment and electronic gadgetry, but a realisation that we are dealing with a major industry heading for trouble. The hospital service is long overdue for a complete rethink of its aims, objectives, priorities, administrative systems and structure, and engineers and engineering must be involved at the very highest level in planning, specifying, designing and operating these changes. The basic importance of the patient and the community must be borne in mind throughout. This relates not only to buildings and their equipment and operation but also and perhaps especially to equipment directly involved with the patient.

Very often a new technique for diagnosis or therapy originates in a research laboratory, where the technique is conceived and its feasibility demonstrated. The effect of this origin is unfortunate in an age which glamorises research and tends to ignore both the implications of the research results and the enormous amount of work necessary to turn these results to practical account. The next stage of the process, in my opinion, should be a period of evaluation and development in which the total implication of the new idea is worked out and the cost, efficiency and environmental factors are related to the engineered equipment. This, I submit, can only be done within the total concept of a health-care system. In general it cannot or should not be left to the research laboratory, the research worker or clinician with the initial idea, or the industrial unit manufacturing and selling the equipment, to recognise the implications of implementing a new treatment or diagnostic method.

This is particularly true when there is such a problem in allocating priorities on expenditure in different parts of the hospital service and in deciding how limited facilities can be best utilised. Once potential feasibility has been demonstrated, this is the time to make sure that the needs of the team responsible for operating the equipment and keeping it working are met in the engineered design. I think that the most satisfactory way of dealing with the post-research phase of any equipment which may have widespread use in community health care and treatment would be to put it in the charge of an engineering development unit administered jointly by the Ministry of Technology and the Department of Health. This unit would have the responsibility of advising on the total economic, functional and commercial future of any new equipment in the context of a total health-care budget and policy which (hopefully) would be clearly defined. It would also have the responsibility of assessing overseas market potential in collaboration with the Board of Trade.

This National Medical Equipment Centre (for want of a better title) could liaise directly with the manufacturing and trading industries, and I feel that industry would prefer to do this rather than plough through the present morass of medical preference, economic feasibility and national policy.

A number of organisations are already applying engineering knowledge to medical-equipment problems. Among these is the Bath Institute of Medical Engineering which is very much concerned with the question of turning equipment or technique ideas into manufacturable realities. Although absolutely correct in its aims and approach, unless it is fully in the context of a national policy and an economic structure, it is not likely to realise its full potential.

Another association involved with medical equipment and techniques is the Midland Medical Engineering Group which has been operating successfully for several years in achieving a link between medical and industrial research teams in the Midlands. A number of large industrial organisations are involved in this, and it results in a very worthwhile interchange of ideas and information between the worlds of engineering and medicine at the research and development level.

Attempts are being made to harness the efforts of Government research establishments to meet the medical-equipment development needs of the country. Notable here is a programme of work at Aldermaston in which a number of worthwhile projects are included. But even the most wholehearted supporter of this policy would not deny that so far little effect has been made on the overall problem, because it is being attacked on the wrong basis.

The whole principle of structure, organisation and operation of the hospital service must be re-evaluated before any national approach to the relation of equipment technology to medicine can succeed.

The days are past when we can depend for the health care of our community on the individuality of each doctor, however eminent, competent and well intentioned he may be. The clash of medical opinion can always stimulate new advances in knowledge and ability, but if we find that the medical prestige and autonomy tail is wagging the community-health dog we have every reason to be worried.

Engineers are brought up to have foremost in their minds the interplay between the concepts of technology, efficiency and cost to achieve a particular purpose. This is precisely the attitude of mind which must be brought to bear in the reorganisation of the health and hospital service. The status of the engineer in community health care is of tremendous importance, and no opportunity to make this known should be neglected.

* Market News *

For further details, simply encircle the relevant numbers on the reply-paid postcard

Mains-failure alarms

Londex Ltd. has introduced two new units designed to give instant warning of a failure in the mains supply. Should the supply fail a red lamp is lit and a miniature hooter sounds. A useful feature is an internal change-over relay which is normally energised by the main supply. The contacts may therefore be used to operate a remote alarm from a standby supply. Two models are in production: type MFA employs two PP1 dry batteries, giving 12 h continuous alarm, and type MFA/R uses a cadmium–nickel battery which is maintained fully charged by the mains giving $1\frac{1}{4}$ h continuous alarm.

Londex Ltd., PO Box 79, 207 Anerley Road, London SE20 **HE 50**

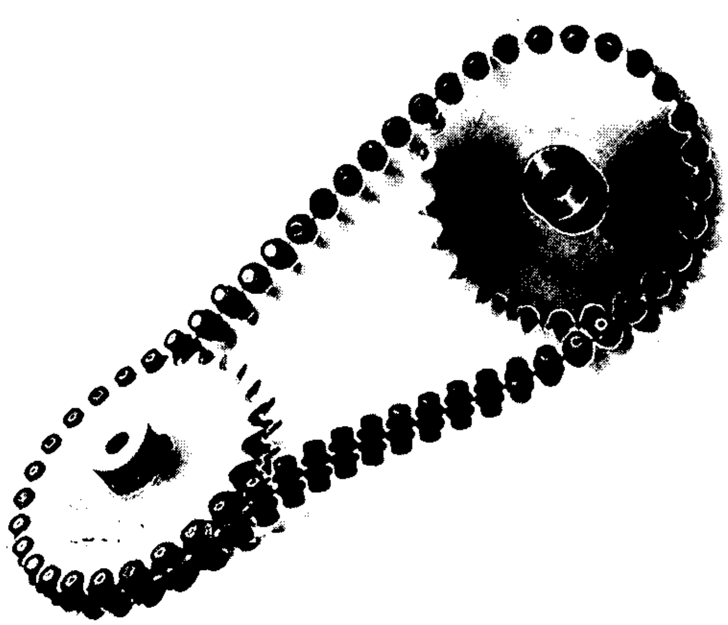
Heat-transfer units

Allen Ygnis Boilers Ltd. is now manufacturing a range of heat-transfer fluid units which employ organic or inorganic heat-transfer media in liquid or vapour phase to provide constant heating to high temperatures at low pressure. Suitable for either oil or gas firing, the units are fully automatic complete packaged plants, requiring only connection to fuel and electricity services etc. They can be supplied for open- or closed-circuit operation, and can be used singly or in combination. Leading advantages include extremely compact size, high efficiency and rapid heating to operating temperature. The range at present includes outputs covering from 300 kBtu/h to 8 MBtu/h, and will shortly be extended to 20 MBtu/h. Each unit consists essentially of a vertical cylindrical heater, circulating and oil-feed pump, storage and expansion tanks and control panel mounted on a common chasis. A notable feature is the simplicity of con-

struction; the two tube coils and the coil bottom forming an adequate heating surface. The top portion of the heater housing the burner can be easily removed for cleaning and routine maintenance. The burner fires vertically downwards and exhaust gases are redirected upwards between the coils to an exhaust-gas exit fitted with an explosion door. Strainers and check valves are fitted on either side of the main circulating pumps to eliminate the need to drain the system during cleaning or servicing.
Allen Ygnis Boilers Ltd., Princes End, Tipton, Staffs. **HE 51**

Chain-drive system

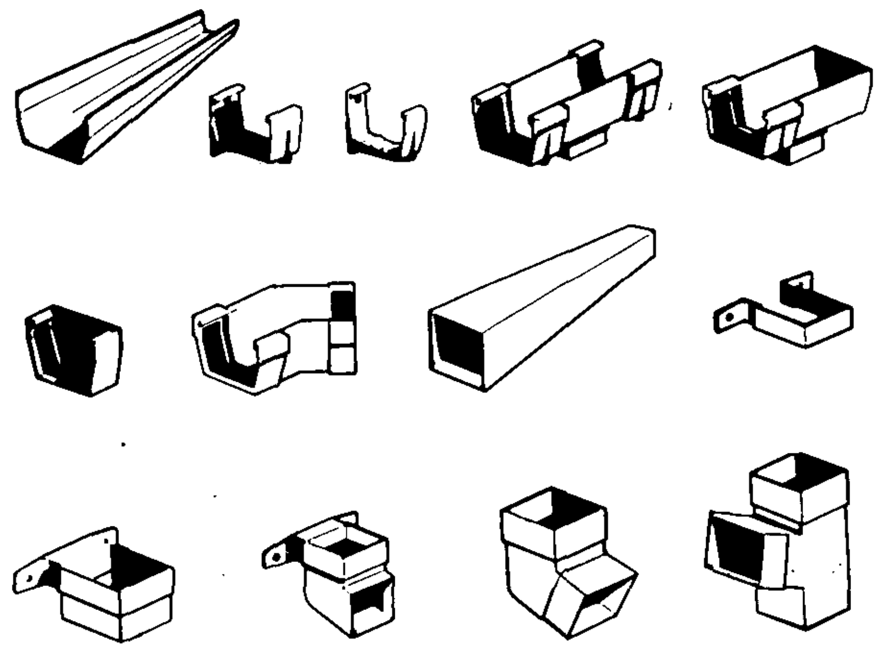
A completely new chain-drive system called 'Pow–R–Tow' is being introduced by Reliance. This American-invented system overcomes many of the limitations of standard roller chains and allows for a whole new series of applications. Sprocket axes do not have to be parallel. Even at 90° the cable operates with true pitch velocity—as true as a spur-gear system—and should prove of great value in precision drives. Three versions are available: a cable belt, a 3D cable belt and a cable chain. They are ideal where the specification calls for resistance to corrosion, lightweight silent drive, no lubrication and extreme flexibility.
Reliance Gear Co. Ltd., St. Helen's Gate, Almondbury, Huddersfield, Yorks. **HE 52**



Squareline drainage system

Following its introduction on a test-marketing basis, the 'SquareLine' rainwater system is now available throughout the UK. Comprising a 102 mm box-section gutter system, it is manufactured from light grey u.p.v.c. which complies with BS 3506. Gutter jointing is by resilient neoprene sealing pads which are injection moulded and bonded to the union clips which connect the lengths of guttering. This pad provides a snug-fitting cushioned area for the pressure-sealing action of the snap-fit gutter and ensures a leakproof joint. Down pipe is available in lengths up to 5·48 m, which reduces the number of connectors required. The number of gutter-support brackets is also reduced by providing for running and stop-end outlets to be screwed directly to the fascia. The 57 mm square section allows changes of direction to be made onsite using only one offset bend. The entire system is made up of only 13 components.

Osma Plastics Ltd., Hayes, Middx. **HE 53**

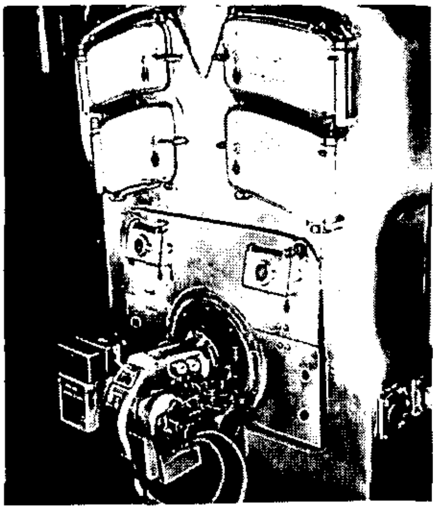


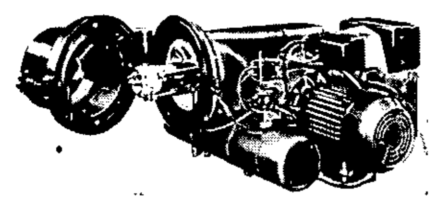
Emergency spotlight

An automatic light that comes into operation for illuminating switch boards, fuse boards, corridors and signs when the mains lighting fails has been designed by Electronic Alarms Ltd. Powered by Deac rechargeable batteries, the self-contained spotlight can be mounted in any position. It incorporates a sealed vacuum-coated reflector, prefocus bulb and chrome-plated bracket. The two models can provide a minimum of 1·5 h and 6 h emergency lighting. Installation requires only connection to an unswitched 240 V supply. The prices are from £8 10s.
Electronic Alarms Ltd., Staines, Middx. **HE 54**

Conversion oil burner

A new fully automatic oil burner of compact design is now available from Nu-Way. The Series A, comprising a range of eight models, will replace the existing SB range. Series A burners are suitable for the conversion of existing cast-iron sectional boilers to oil firing. Designed for flange mounting, the new burner is a

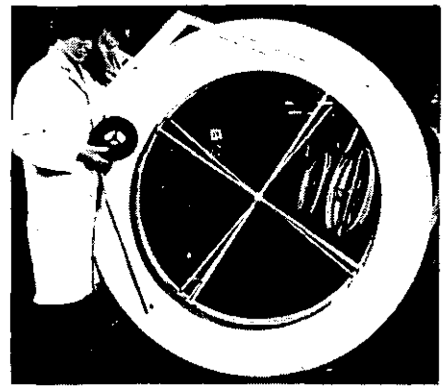




completely packaged fully automatic piece of equipment requiring only connection to oil and electricity services. A control system is mounted and prewired to the burner; this may be for a hot-water or steam boiler as required. An all-metal combustion head incorporates a diffuser air-handling system to produce a clean, concentrated high-temperature flame, and the amount of refractory material has been reduced considerably.
Nu-Way Heating Plants Ltd., Droitwich, Worcs. **HE 55**

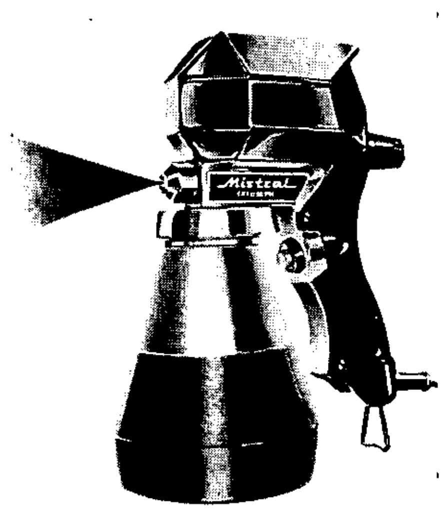
Iris dampers

The range of Airmaster iris dampers for use in air-distribution systems has recently been considerably increased, and standard sizes up to 48 in neck diameter are now available. The range of operating pressures has also been considerably extended, and a recent installation has been satisfactorily completed to operate at 42 in w.g. Higher pressures could be handled. The damper can be operated by key, by handle or by remote manual or automatic control, from fully open to fully closed, but whatever area is open is always in the centre, thus maintaining the efficiency of a distribution system at all levels of air supply. The photograph shows a 48 in bore damper with the operating handle at the top; the operator is holding a 4 in damper in his hand.
Fairitt Engineering (Sales) Ltd., 24 Worple Road, Wimbledon, London SW19 **HE 56**



Paint-spray gun

A new electrically-operated spray gun will handle almost every type of paint and varnish, and many other materials, including washes, primers, polishes, stains, disinfectants, insecticides and anticorrosion fluids. The 'Mistral' is completely self-contained and is operated simply by plugging into an electric socket. No airline is required. The high-pressure operation eliminates mist; the material is sprayed directly in a microfine atomisation which with paint produces a mirror-smooth finish. There are three different models and a full range of accessories including various nozzles, and prices are from £15 15s.
Gray–Campling Ltd., Magnalux Works, 7 Norwich Road, Bournemouth, Hants. **HE 57**



NEW LITERATURE

'Grundy'
16-page booklet describing the interests of Grundy (Teddington) Ltd. in brewing- and catering-equipment manufacture. *Grundy (Teddington) Ltd., Somerset Road, Teddington, Middx.* **HE58**

Ball valves
Wall chart, 24×16 in., tabling the available valves in the Truflo range. Metric and Imperial sizes are given. *Wilmot Breeden (Truflo) Ltd., Westwood Road, Birmingham 6* **HE59**

Aluminium forgings and castings
Two brochures giving information for the design engineer on the properties of aluminium and on the forging and casting processes. *Alcan Castings and Forgings Ltd, Middlemore Road, Birmingham 21.* **HE60**

EMI Guide
Useful 28-page buyers' guide describing the products and services of the 20 organisations comprising the electronic and industrial operations of EMI. Includes fire-protection, c.c.t.v. and data-recording systems. *EMI Ltd., Blythe Road, Hayes, Middx.* **HE61**

Photomicroscope
Detailed 32-page brochure with full-colour illustrations describing the Photomicroscope II fully automatic camera microscope. *Degenhardt & Co. Ltd., Carl Zeiss House, 31-36 Foley Street, London W1P 8AP* **HE62**

Coolers
Leaflet describing the range of coolers producing chilled water at 3000-150 000 Btu/h. *F. & R. Engineering Ltd., Wellington, Som.* **HE63**

Gear oil
Illustrated booklet on gear lubrication covering fundamental principles, lubricant properties, film thickness and surface finish, gear failure, gear-tooth examination and the lubrication of sealed gearboxes. *Burmah–Castrol Industrial Ltd., Marylebone Road, London NW1* **HE64**

Powrmatic manual
Service and maintenance manual giving complete instructions for the installation and servicing of Powrmatic oil- and gas-fired warm-air heating equipment. Instructions for routine servicing and complete overhaul are given, with full information on the control units and oil pumps. A fault-finding chart is also included, and instructions for converting the gas-fired heaters from town to natural gas. *Powrmatic Ltd., Winterhay Lane, Ilminster, Som.* **HE65**

Humidifier
Detailed leaflet giving specifications of the Carter spinning-disc humidifier with information on the device's applications, advantages and principles of operation. *Carter Thermal Engineering Ltd., Redhill Road, Hay Mills, Birmingham 25* **HE66**

Metric units
Leaflet setting out the more common metric units and their correct symbols. *Information Divn., Dept. 4, Metrication Board, 22 Kingsway, London WC2* **HE67**

SOME ASPECTS OF MEDICAL ELECTRONICS

W. H. Wakely, F.S.X ray T., A.M.I. Hosp. E.

When medical electronics is mentioned I suppose the first thing that comes to mind is patient monitoring. In recent years, monitoring equipment has become very sophisticated, and, as a result, a very high degree of skill is required from the nursing staff using this equipment. On numerous occasions I have been called to investigate an alleged fault only to find that the trouble lies with the operator. Unfortunately there is no real training given to staff, and consequently they do not fully appreciate how the equipment works or how it must be connected to the patient to obtain optimum results. This criticism is not confined to the really sophisticated equipments; in fact most difficulty is experienced with basic e.c.g. equipment. E.C.G. recordists are often completely untrained in the accepted sense of the word; they are normally given only about two hours of instruction on fixing the electrodes and switching through the various lead positions. The basic principles of cardiography are not explained, and the records produced leave a great deal to be desired. Possibly the worst situation is where an equipment is available for use by a number of doctors and nursing staff. Each considers himself the expert and is convinced that the others all use the equipment wrongly. If this kind of situation is investigated it is generally found that none of the group has received any training

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at all and the equipment failure rate will be predictably high.

It is my personal opinion that as engineers we should do as much as possible to encourage the training of medical staff in the correct use of equipment purchased for them. No one would consider buying a new car to give to someone who had not had any driving lessons; yet this is the kind of thing that happens with medical equipment, and much of this equipment is more expensive than the average car.

As a purely personal opinion I think that societies like the EPTA should be encouraged so that they could ultimately have the same recognition as the Society of Radiographers. This would help to raise the standards of recordists, ensure that the best use was made of the equipment and reduce maintenance costs.

In recent months, the subject of patient safety has received much sensational publicity in the US. Early in 1969, several newspaper articles appeared stating that at least 1200 patients in the US were killed every year as a result of electric shocks from equipment connected to the patient. Although it is hard to substantiate the figure, the fact that it has appeared in print leads people to believe it to be true. There does not appear to be any real data on the subject, as hospitals do not appear to keep very good records on patients killed by electric shock. In general there is a great deal of misunderstanding on the subject of patient safety, and I hope to be able to show how hazards can occur.

It is important to know the effects of different currents at 50 Hz when applied to the body surface. Although it varies from person to person, the threshold of perception is about 1 mA: at this level a faint tingling can be felt. At about 5 mA many sensory nerves are stimulated, pain is felt and the subject jumps away from the source of stimulation. Above 5 mA motor nerves are stimulated and the affected muscles contract. Around 16 mA the subject has no control over his muscles and is unable to release his grip on the conductor. At about 50 mA great pain is felt, and there is danger of mechanical injury due to the contraction of the skeletal muscles. Fainting and exhaustion may be experienced, but the heart and respiratory functions continue. At about 100 mA ventricular fibrillation may occur, the heart cannot pump blood, and the subject will die unless the fibrillation is corrected within minutes. At around 6 A the heart goes into sustained muscular contraction (as did the muscles at 16 mA), but usually reverts to its normal rhythm when current ceases. This principle is employed in defibrillators. Continuous currents of the order of 6 A cause temporary respiratory paralysis and may cause serious burns. Above 6 A great damage is caused owing to the heating effect of the current.

As a result, 5 mA has come to be accepted as the maximum current that should be allowed to pass through a human being from external contact.

Although 5 mA has been accepted as the maximum safe current passing through intact body surfaces, most people can feel currents much smaller. The average person can sense 1 mA and small children and some sensitive adults can sense currents of 100 μA. The threshold of perception for most people requires that they contact two surfaces separated by a potential difference of 10–50V.

For this reason, in the USA, all electrical appliances are tested to ensure a maximum of 5 mA leakage current. As an example consider an electric toaster: this is connected to the supply by means of a 2-core cable, and the case of the toaster is earthed through a resistor which simulates a barefoot adult standing on damp earth. The toaster would pass the test if no more than 5 mA passed to earth.

All appliances including electromedical equipment undergo this test, and it is quite adequate for apparatus found in the home and in industry. Until quite recently it was also adequate for medical equipment, but the situation in hospitals has changed radically over the last 10 years, and it is now common practice to provide a patient in a coronary-care unit with a pacing catheter making good electrical contact with the heart. In the past three or four years, concern has been felt about the inherent hazards to patients with direct electrical connections to the heart. In experiments conducted with dogs with a connection made to the exposed heart and with the body well earthed, it was found that, in a significant percentage of the dogs, ventricular fibrillation could be induced by currents as low as 35 μA. Other investigators put the threshold as low as 20 μA, and cases have been observed where ventricular fibrillation was caused by currents of 10 μA. As tests are unlikely to be conducted on human subjects, safe currents have to be calculated from animal experimental data. This is complicated by the fact that catheters are often passed into patients who are already very sick. There is a general feeling that their fibrillation threshold is reduced by their already compromised heart function. It expected that 10 μA will become the accepted standard. Since the minimum impedance between two patient electrodes can be as low as 500 Ω, it is recommended that any non-therapeutic potentials which a patient may contact should be less than 5 mV.

Let us consider some of the situations that can arise in practice. A patient lies in bed with earthed monitoring equipment attached. By the bedside is a lamp connected to the supply by a twin lead. The lamp appears to be in good order, but it has a leakage current of 1 mA. If the patient switches on the lamp, 1 mA passes through his arm and body, a proportion going through the heart. If the earthed electrode was attached to the heart, immediate ventricular fibrillation would be caused.

In the next case the patient lies in a bed which has electric motors to adjust his position. The earth wire has become broken, but this has not been noticed since it does not affect the working of the bed. The bedframe is, however, at some potential with respect to earth owing to the capacitive coupling between the motor windings and the frame. The patient is earthed through an e.c.g. monitor and has a pacemaker catheter inserted into his heart. The pacemaker is battery operated and not tied to any a.c. outlet; so the patient is safe at present. If a doctor were to adjust the pacemaker wiring while leaning against the bedframe, he would supply a path from the bed to the heart and onto the earthed monitor. As much as 100 mA could flow through the patient's heart causing ventricular fibrillation. This is entirely due to the easily neglected considerable stray capacitance between motor and frame which allows a small amount of alternating current to pass to the bedframe; if the earth wire is intact, this leakage current passes harmlessly to earth, but if it is broken, there is no return path. Typically, this stray capacitance may be as much as 2500 pF. At 50 Hz this amounts to an impedance of about 1 MΩ, and the patient impedance is about 500 Ω. When the doctor contacts the catheter terminals and the bed, he provides a resistive path of about 100 kΩ. From these rough figures it can be seen that the current through the patient is of the order of 100 μA and definitely hazardous to the patient.

This hazard was caused by a defective earth wire which would not have been apparent unless earth-continuity checks had been made. If the nurse had touched bed and earth simultaneously, 100 μA would have flowed through her, but, as previously mentioned, this is below the threshold of perception of most people. The only indication of a fault might have been excessive interference on the e.c.g. trace, and the nurse's natural reaction would be to suspect bad electrode contact. If she cleaned and reapplied the electrodes, the interference would still be present, and, unless the interference was particularly severe, she would probably accept the situation, or possibly call in the technician to check the monitor. Often if something does go wrong there is no way in which the medical staff can recognise the problem.

There is unfortunately another kind of hazard which is even harder to detect: the low-voltage hazard. Consider first a patient with a catheter connected internally to the heart. If the impedance of the catheter and patient is 500 Ω, it requires only 2·5 mV to force 5 μA through the heart. In another example the patient is again earthed by an e.c.g. monitor. His blood pressure is being monitored by a saline-filled catheter inserted through a vein into the patient's heart. The saline column is also effectively earthed to its monitor. The patient is in an old hospital where the intensive-care unit has been converted from a general ward requiring the installation of additional outlets. When these were installed, the wiring was taken back to the main distribution board. The e.c.g. monitor is connected to the old wiring and the pressure monitor to the new, but so far all is well.

A cleaner plugs a vacuum cleaner into one of the sockets in the ward. The vacuum cleaner has a leakage current of 1 A owing to dust and damp in the motor, and the leakage current flows through the earth wire back to the distribution board.

Now our patient is connected between two earths having a potential difference of 80 mV. As the patient resistance is likely to be as low as 500 Ω, well over 10 μA would flow—with fatal results. So this patient could die without anyone touching him or any of his equipment.

Now that we have considered the problem, let us look at the characteristics of some types of e.c.g. monitors. Normally a differential amplifier is used, and the reference electrode, naturally, is connected direct to the chassis of the equipment. The system achieves high common-mode rejection and has the advantage of simplicity, but it also has the disadvantage of directly earthing the patient.

Better is the right-leg-drive circuit—a circuit which samples the 50 Hz common-mode signal and feeds back an out-of-phase voltage to cancel it. This gives a considerable improvement in quality of the trace as far as 50 Hz interference is concerned. Additionally, the system provides improved isolation of the patient from the chassis of the equipment. The patient–chassis impedance is of the order of 30 kΩ.

The third type of patient input circuitry is the floating input. It is felt that if the input circuit can be sufficiently isolated from earth, connecting the cardiograph will not additionally hazard the patient. Typically, two isolation transformers are used: one provides power to the floating amplifier at 100 kHz and the other passes the e.c.g. signal through to the earthed monitor containing the display and alarm circuitry. There is no resistive connection between the input circuit and chassis, and the small capacitance existing gives an impedance better than 25 MΩ.

Although modern equipment can do much to protect the patient, to offer him maximum protection, great care must be exercised in the installation and maintenance of all equipment within his reach. 3-core mains leads should be used exclusively, and all electrical equipment within 20 ft of the patient should be fed from a single bank of socket outlets which have their earth terminals strapped together. There should be no other outlets near the patient. Any conductive surface of nonelectrical devices within 20 ft of the patient should be connected to the common earth.

Separate earth wires should be used, as conduit connections may corrode and develop resistance. Regular earth-continuity checks should be made on all equipment, and no conductive surface within 20 ft of the patient should have a potential greater than 5 mV with respect to earth when all the equipment is working. Continuing with this basic theme, I should like you to consider the hazards present in the operating theatre. Much electrical and electronic equipment is used in the theatre today, and in my experience the potential dangers are not appreciated. For example, surgeons sometimes use diathermy equipment and hold forceps carrying r.f. at high voltage in the gloved hand. They rely on the insulation provided by the glove, and if there was a small nick in the glove, the result could be disastrous. An even more dangerous situation may arise when a surgeon applies his eye to a metal-sheathed endoscope while diathermy is being used. On occasions electronic stimulators are used in conjunction with other equipment. It is not generally appreciated that some stimulators can produce small voltages between the output terminals, but high voltages with respect to earth. Consequently, if a patient is earthed through another piece of equipment or through the table, a severe shock may be produced. Wherever possible battery-operated stimulators should be used to reduce this possible hazard. Where mains-operated equipment is used, it is essential that a common earth is used and that no large potential differences exist between the outputs of different equipments.

I would suggest that surgeons should be encouraged to invite engineers into the theatre to watch procedures and give advice on basic electrical safety. This, of course, requires considerable diplomacy, but it would be of ultimate benefit to the patient, surgeon and engineer.

In order to complete the picture presented by the correspondence between the British Fire Services Association and the Department of Health & Social Security published in the July issue of *Hospital Engineering*, we here reproduce HM (69) 62 at the request of the DHSS. The circulation of this document has been restricted to the hospital service.

Fire precautions in hospitals

To: Regional Hospital Boards
Hospital Management Committees
Boards of Governors

Summary This memorandum reinforces previous general guidance on fire precautions. It requires all hospital authorities to conduct an immediate review of existing arrangements; to notify to the Department, or to the Welsh Office as appropriate, within 48 hours of their occurrence all fires causing injury, death or significant damage; and to report on progress of its implementation.

General

1 All hospital authorities are reminded of the dangers of fires in hospitals and of their duty to ensure that stringent fire precautions are taken and observed at all times.

2 Following a fire in a mental-illness hospital in the early part of 1968 when 24 patients lost their lives, hospital authorities, in letters dated 19th April 1968 and, to Welsh hospital authorities, 23rd April 1968, were told of some of the main amendments to be made in a revision of Hospital Technical Memorandum 16 (which describes in general terms good practice in hospital fire precautions) and were asked to examine their fire precautions and to see that staff properly understood the action they should take. Advance copies of the revised Hospital Technical Memorandum have been issued to Boards and Committees and it is now available at Her Majesty's Stationery Office.

3 The danger of fire must be brought home to all: the varied activities in hospitals make them especially vulnerable. The presence of laboratories, stores, kitchens, laundries, electrical equipment, gas apparatus and many specialised services adds to the fire risk. And there is risk from the careless, or even malicious, action of the many people not on the staff of hospitals who use hospital premises.

4 The consequences of fires in hospitals can be much more serious than in many other types of building since numbers of helpless people are exposed to risk and can only be moved with danger and difficulty. Apart from risk to life, damage from fire can put the hospital or part of it out of action with serious effect on services.

5 In recent years there has been an increase in fires in hospitals in England and Wales. Many have been minor, but some have been serious fires. The cost of repairing damage has increased and for 1968 will amount to about £600 000. Repairing damage uses substantial resources which could well be employed elsewhere.

6 Each hospital authority should regularly survey the fire precautions for each building for which it is responsible. It should seek the advice that is available from the local fire authority in fire prevention, fire precautions, equipment and instruction and invite it to carry out inspections at convenient intervals.

7 Action should be taken to ensure that:

(*a*) all members of the staff, full-time and part-time, and any voluntary workers, know what to do if a fire occurs

(*b*) there is regular instruction of staff, including part-time staff and others on permanent shifts particularly at night (information about instruction of staff is given in paragraphs 174 to 181 of the revised Hospital Technical Memorandum 16 which are reproduced as an Appendix to this memorandum)

(*c*) the dangers of fire are brought home to all those who use hospital premises, including the employees of firms who may be working there

(*d*) efficient fire-fighting equipment is available and is regularly inspected to ensure that it is in proper working order

(*e*) restrictions on smoking which are imposed for whatever areas are appropriate are enforced.

8 The Subcommittee of the Hospital Management Committee or Board of Governors dealing with the maintenance of buildings should have as one of its responsibilities fire prevention and the overseeing of fire precautions.

9 When considering their programmes of minor works, Boards should consider the possibility of including schemes contributing to the prevention of fire hazards: the elimination of these hazards should always be borne in mind in the construction of new buildings (see Hospital Design Note 2 'Protection against fire', HMSO).

Review of existing fire precautions and responsibilities of staff

10 On receipt of this memorandum all hospital authorities should without delay review all fire-precaution arrangements to ensure that they are efficient and up to date. The responsibilities of all officers connected with fire precautions should be clearly defined.

11 Where such an arrangement does not already exist a group officer should be given overall responsibility for ensuring, in co-operation with others concerned, that the Committee's policy on fire precautions is implemented throughout the group. An important feature of this officer's responsibilities will be to ensure that a comprehensive programme of instruction is carried out and for this he should seek the full co-operation of the heads of all departments and of the Chief Officer of the fire brigade for the area.

12 There should be in every hospital a senior officer with defined responsibility for carrying out Group fire-prevention policy; if the Group offices are situated in the hospital this person may conveniently be the officer mentioned in paragraph 11 above who carries Group responsibilities. In addition hospital authorities are reminded of paragraph 4 of Hospital Technical Memorandum 16:

To supervise the day-to-day maintenance of fire precautions and to co-ordinate and direct the action of staff in a fire emergency, a member of the staff at each hospital should be nominated as fire officer. It is important that this person should have both the competence and the authority to enable him to carry out his duties effectively. One or more deputies should also be nominated to ensure that a responsible member of the staff is available when the fire officer is absent.

If there is no Fire Safety Officer (see paragraph 13 below) the nominated fire officer should be responsible for making arrangements for the regular examination of fire-fighting equipment etc.

13 Where it is considered necessary in a psychiatric hospital or in a group of hospital premises with more than 1000 beds the hospital authority should appoint a Fire Safety Officer to carry out the duties defined in the handbook of the Ancillary Staffs Whitley Council. These broadly cover inspection of appliances, maintenance of necessary logs, regular inspection of premises and some aspects of training. The Fire Safety Officer cannot be expected to accept full responsibility in his hospital or group of hospitals for fire-safety procedures and the appointment of such an officer does not remove the need to nominate the senior staff referred to in paragraphs 11 and 12 above.

Reporting and investigation of fire

14 All fires which result in loss of life or injury or disturbance to patients or damage (excluding minor damage only) to hospital property must be reported promptly to the Department (for the attention of Hospital Building Division) or to the Welsh Office (for the attention of HS3) to enable questions arising from public concern to be answered and permit technical analysis by which guidance on fire prevention can be improved. Hospital authorities were asked in letters dated 29th December 1966 and, to Welsh hospital authorities, 3rd January 1967, to forward such information immediately, but this procedure has not always been followed. The importance of this notification which should be made within 48 hours of the fire is emphasised. Hospital Management Committees should notify the Regional Hospital Board at the same time.

15 The responsible group officer should examine the circumstances of all fires reported under these arrangements, co-ordinating all reports received in order to establish the facts and consider what measures, if any, are necessary to prevent future occurrences, and the results should be placed before the Hospital Management Committee or Board of Governors. A copy of the report from the fire brigade together with the result of any investigation should be forwarded (via the Regional Hospital Board in the case of a Hospital Management Committee) to the Department (Hospital Building Division) or to the Welsh Office (HS3) as appropriate, together with a statement of action taken on it by the hospital authority. If in the view of the hospital authority the circumstances warrant it, a similar investigation and report should be made in respect of any other fire which would not initially be notified under the arrangements in paragraph 14 above. If it appears that blame may be attributable to any hospital personnel, the normal disciplinary procedure should be followed. Where malicious action is suspected, the police should be informed and any subsequent investigation by the hospital authority should await the result of police enquiries. Any losses should be accounted for in the normal manner.

16 The Department and the Welsh Office are especially concerned to be informed of any instance where a fire (even though trivial in its consequences) has presented features of special technical interest and details of any such incident should be notified; it may be necessary subsequently to require a more detailed report from the hospital authority. Evaluation of such incidents produces information which could be used to prevent similar fires elsewhere.

Building under construction

17 Hospital authorities are reminded that the fire risks underwritten by the Government extend to hospital buildings under construction and to fires arising from building and engineering operations in connection with hospital buildings. Boards should take appropriate measures to see that contractors with their workmen observe adequate fire precautions.

Capital expenditure

18 Any capital expenditure necessary to carry out work in connection with fire precautions resulting from the review mentioned above will need to be met from within the overall capital allocations notified to Regional Hospital Boards and normally from the sums allocated to Boards of Governors for 'other schemes'.

Implementation

19 Regional Hospital Boards and the Welsh Hospital Board (co-ordinating the reports of Hospital Management Committees) and Boards of Governors are asked to report within three months of the receipt of this memorandum on the progress made by all hospital groups in the nomination of officers with responsibilities for fire-prevention policy and for fire precautions and practices. Reports should be sent to the Department (Hospital Building Division) or to the Welsh Office (HS3) as appropriate. In addition Regional Hospital Boards and the Welsh Hospital Board are asked to see that the responsibilities of Hospital Management Committees in regard to fire precautions are adequately discharged, making such checks on the state of fire precautions as they consider appropriate.

Appendix: Extract from Hospital Technical Memorandum 16

Staff instruction

It is of little use providing the protection of separate fire compartments, alternative means of escape and other fire precautions if, at the time of an emergency, these arrangements are not fully understood by all concerned; for continuous fire safety regular training of hospital personnel is absolutely essential.

Since only a proportion of the staff on duty can be made available for instruction at any one time, and having regard to constant changes of staff, instruction needs to be given at sufficiently frequent intervals to ensure that all personnel are familiar with the action which they should take on discovering a fire and on hearing the fire-alarm signal. To this end, a responsible officer should be nominated for arranging for instruction to be given to staff, and he should receive the support and co-operation of all departments in the carrying out of his duties.

By arrangement with the fire authority, the services of the fire brigade should be utilised where possible in giving instruction to staff and, in particular, for instructing on the use of fire-extinguishing equipment.

At least twice a year practice fire drills should be carried out simulating conditions in which one or more of the escape routes is obstructed by smoke. During these drills the fire alarm should be operated by a member of the staff who is told of the supposed outbreak and, thereafter, the fire routine should be rehearsed as fully as circumstances allow.

The principles of fire and evacuation procedures should also be taught at nurses' training schools but must afterwards be related to the arrangements actually in force at each hospital.

Raising alarm

All staff should be given details of how to operate the fire-alarm system and know the locations of manual fire-alarm points, internal fire telephones, fire-alarm indicator panels, and the correct method of calling the fire brigade.

Telephone operators

The exact procedure to be followed by telephone operators will, of course, depend on the fire warning and alarm system installed in the hospital, but it is important that all operators, including any relief operators, should receive precise instructions on the action to be taken and, in particular, the action they should take on being notified of a fire by telephone or any other means. In hospitals where the switchboard is not continuously manned it will be essential to ensure that the calling of the fire brigade is the first responsibility of a competent person who, together with deputies, has been nominated for this duty.

Engineering staff

Members of the engineering staff should receive instructions on the location and use of the main controls for the electrical, oil, water and gas installations, including those of any medical gases, and should be familiar with the distribution of these installations.

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* Among the Branches *

LANCASHIRE BRANCH

On the 16th May the branch visited the CIS building in Manchester and were conducted on a tour of inspection of the engineering services and plant installation by Mr. T. Ridings, CWS Chief Engineer. Mr. McCann of Drayton Controls Ltd. gave a short talk on the computer control. The project comprises a large building which will be occupied entirely by the CIS with a staff of over 2500, and a smaller building for the CWS executive staff which includes a new conference hall and new dining facilities.

The CIS building is a 25-floor steel-framed office tower, with an adjacent 28-floor service tower and 5-floor podium block both constructed in reinforced concrete. The office tower and podium are clad in curtain walling using about 250 000 ft^2 of glass weighing 300 ton. The solid walls of the service tower are clad in mosaic. The service tower is 400 ft high, and the total floor area of the whole building is 550 000 ft^2.

The boiler house is in the subbasement, 50 ft below ground level, and houses four 10MBtu/h Danks high-pressure hot-water corner-tube boilers. The boilers are oil fired with 3500 s oil, with Hamworthy rotary-cup burners. Oil storage capacity is 54 000 gal, sufficient for 2–3 weeks.

The whole of the building is fully air conditioned, which maintains 70°F in winter with outside temperature 32°F, and 75°F in summer with outside temperature 85°F. A humidity of 50% is maintained at all times. The main air plants are in the plant room on the podium roof, and the plants serving the upper floors of the office tower are at the top of the service tower.

The office tower has two groups of four high-speed Otis passenger lifts, each to carry 23 persons at 800 ft/min. The low-rise group serves up to the 14th floor, and the high-rise group serves from the 14th floor to the top. These lifts are capable of clearing the building of all occupants in around 20 min. The podium block is served by 10 reversible Otis escalators operating at 120 ft/min. A goods lift serves the full height of the building with a capacity of 3500 lb at 500 ft/min, and is designed as an emergency firemen's lift. An automatic document conveyer is provided for distributing files etc. from floor to floor, and to and from the document-storage areas in the basement.

A fully equipped kitchen and cafeteria in the basement is designed to serve 2500 dinners over a period of two hours.

The fire-fighting installation includes a rising water main to the top of the tower, with fire hydrants and hose reels at each floor complete with automatic pump equipment operated by electrical fire detectors. Operation of the fire detectors sounds an alarm and automatically alerts Manchester fire brigade.

The electrical substation housing three 1250 kVA transformers and l.v. and h.v. switchgear is in the lower basement at boiler-house level, and is fed by two separate 6·6 kVA service networks. All floor areas are provided with a pattern of electrical underfloor ducting buried in the floor screed.

MID-SCOTLAND BRANCH

Meeting at the Aberdeen Royal Infirmary on the 2nd May, the Branch held a worthwhile tour of the laundry and c.s.s.d. departments before proceeding to a business meeting. The decision was made to try to obtain permission to hold meetings during the working day, as it was felt that this would encourage members to attend more regularly than at present with Saturday or evening meetings. The Branch would then be in a better position to attract speakers and papers for publication.

SOUTH-WEST BRANCH

Two speakers from Static Switching Ltd. visited the Branch meeting on the 20th May. Mr. Griffiths, Sales Manager, and Mr. Bloxwich, his technical assistant, gave an interesting talk on equipment based on the thyristor switch. This includes not only simple call lights and buzzers, but also more sophisticated selectors, nurse-station indicators and audio tones for emergency use. One of the great advantages of the thyristor switch is its small size coupled with easy servicing. In general, an entire assembly of thyristor, trigger circuit, multivibrators and amplifiers is constructed on a very small printed-circuit board which is used as a plug-in module. Should a fault occur the whole board is simply replaced and the faulty one thrown away. The speakers also introduced the new 'Identikit' system for bed-head panels, which enables the buyer to select from a variety of standard features when specifying such panels.

NEW FACES

Mr. F. J. Beard, Graduate Member, has been appointed Hospital Engineer, Kings College Hospital.

A number of changes have taken place at the West Suffolk General and St. Mary's Hospitals. **Mr. L. F. Townsend,** Hospital Engineer, has been seconded to the East Anglian RHB to be Site Engineer II at the Bury St. Edmonds Best-Buy Hospital. The assistant Engineer, **Mr. L. Murton,** has retired after 24 years of service, and his place is taken by **Mr. F. Fenton,** who was Engineering Craftsman II.

Particular congratulations to **Mr. J. H. O'Neill,** appointed Deputy Group Engineer to the Harefield and Northwood Group HMC, and to **Mr. F. E. Scott,** who leaves the post of Hospital Engineer at Queen Mary's Hospital, Sidcup, to become Deputy Group Engineer, West Suffolk HMC.

Clippings

What is believed to be the largest single laundry processing machine of any type in the world was recently opened by Initial Services Ltd. to process the 45 yd cabinet towels installed in its automatic towel cabinets. Soiled towels are fed continuously into one end of the machine and are passed through washing, rinsing and drying operations, finally emerging clean and rolled ready for installation. The processing capacity of the fully automatic machine is 500 towels per hour, or 20 000 cabinet towels per 40 h week—nearly 400 miles of towel! The machine is 130 ft long and contains 60 electric motors of various sizes. Instrumentation includes chart recording of concentrations of washing materials at each stage, rinsing efficiency and running time and speed.

Britain's first computerised patient-data retrieval system to establish a link between doctors' surgeries and a large central computer, will shortly be going into service. The scheme, designed jointly by Essex University Department of Computer Science and Guy's Hospital, under the direction of Dr. Keith Bowden, will give the many doctors at two large group practices and medical centres in Thamesmead and Harlow instant real-time access to patients' medical histories stored in the University's Honeywell 516 computer. The terminals will allow doctors to call up all existing data on any of their patients and display it on a screen during a consultation. In the course of an examination, the doctor will be able to update the information in the computer simply by typing in new symptoms, treatments or prescriptions on the terminal's keyboard, and also by selecting items from medical checklists. Each surgery will also be equipped with a teletype, which will be used by the receptionist for appointments and prescriptions.

Research workers at the UK National Institute for Medical Research have been using a Honeywell 516 computer to analyse records carefully kept over several years of the susceptibility of the inhabitants of the temote south-Atlantic islands of Tristan da Cunha ro the common-cold virus. The research programme, begun when Tristan's 200 inhabitants returned home after their enforced evacuation owing to severe volcanic eruptions, was aimed at studying the reoccurrence of common-cold epidemics.

Maintained by the islands' medical officer, records covered the appearance of cold viruses and their rapid spread through the population and the duration of colds among individuals. Detailing every cold symptom on the island from 1964 to 1968, these records had first to be transcribed into a form acceptable to the computer. Analysis showed that there was a common pattern in the progress of the epidemics, and that each was apparently related with ship arrivals—within days the first symptoms tended to appear, suggesting that ships often bring more than the islanders bargain for!

The computer analysis yielded most new material when the researchers built a mathematic model of an epidemic. When run on the same basic data, the model produced markedly different results which were inexplicable until the model was extended to take into account two epidemics spreading simultaneously. The model results then matched those of the real epidemics very closely, suggesting that the basic assumptions made on the way in which an epidemic spreads are very close to the truth—a factor that may help in understanding, and perhaps even combating, more complex epidemics in more densely populated areas.

Part 6

Electrical-installation testing

by A. Egley

4 Instruments

4.1 Moving coil

This is the basis of the Avometer and many other high-grade universal instruments. The basic instrument is a d.c. moving-coil milliammeter, which requires a rectifier for use on a.c. Its main advantages are high accuracy, good sensitivity and high torque and linear scale on d.c. voltage and current. It can have very good damping, and is not affected by stray magnetic fields. However, it is expensive and can only be used for a.c. measurement with a bridge rectifier. As it depends upon the rectifier characteristics an a.c. scale is not linear.

When used as an a.c. voltmeter, a high-value series resistance is used to mask the nonlinearity. For a.c. the instrument cannot be used with a shunt; a c.t. must be used to extend the range. It is accurate over a wide frequency range, but although it actually reads mean values, the scale is usually calibrated for r.m.s. values. Because of this, the waveform errors may be considerable when harmonics are present.

4.2 Moving iron

This is the basis of the instrument used in commercial a.c. and d.c. measurements when high accuracy is not required. There are two types: attracted-disc and repulsion.

Their advantages include being usable for both a.c. and d.c., and that they are cheap and robust. The disadvantages are that they are less sensitive and have a nonlinear scale. Errors can arise owing to heating, stray magnetic fields, frequency variation, hysteresis and nonlinear waveforms.

This instrument is normally used for switchboard work, but forms the basis of the clip-on ammeter now in general use. For conversion to a multirange instrument it is provided with an open-core current transformer with tappings on the secondary side. The primary is one turn of conductor which passes through the opening of the hinged core.

4.3 Dynamometer

This type of instrument is used for wattmeters and voltmeters. It has two sets of coils set at an angle to each other, and thus indicates the product of voltage and current. It can be calibrated in kW, kVA or kVAr. Inertia of the moving parts ensures that average values are indicated, and since this is the power in the circuit no correction is necessary.

4.4 Galvanometer

The earth-loop tester made by Evershed & Vignoles is basically a ballistic galvanometer. It is a very expensive instrument and is used where accurate readings are required. It is seldom justified on other than laboratory and specialised testing procedures.

4.5 Amprobe

The amprobe is a combined ammeter, clip-on ammeter and voltmeter. Maximum use is made of the basic moving-iron instrument for the current readings by using a current transformer. Voltage readings are obtained by direct connection between the points at which voltage measurement is required, and series resistances are included in the switching mechanism to give appropriate values. To read resistance, a small high-grade cell is used as an energy source, and then the instrument operates by measuring the voltage drop across the resistance (or the current through the resistance). The scale is in ohms.

Incidentally, resistance scales are never linear because they actually measure the *reciprocal* of the current flow at a particular voltage. That is:

$$R = \frac{V}{I} = \text{constant} \times \frac{1}{I}$$

4.6 Phase-sequence meter

The phase-sequence meter is basically a very small 3-phase a.c. motor, and as such is sensitive to the phase sequence. If we reverse any two leads we reverse the direction of rotation of the disc. It is important to realise the limitations of this instrument. The fact that one has clipped onto red, yellow and blue, in that order, is not to be taken as an indication that the red lead is the red phase taken from the supply. It indicates the measured sequence, RYB or RBY, at that point only. Changing colour bands on the conductors does not change the sequence!

5 Acknowledgments

Thanks are due to the Sheffield Regional Hospital Board for permission to publish *Electrical-installation testing,* and also to Mrs. Barbara Miles, the Board's senior tracer, for her work on the drawings.

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APPOINTMENTS AND SITUATIONS VACANT

Lewisham Hospital

High Street, London SE13

HOSPITAL ENGINEER required in the largest wholly acute hospital in this region. Salary £1704–£1964 (an increase of approximately £260 per annum *is currently being negotiated) including* £90 London weighting allowance, plus £100 special-responsibility allowance. Accommodation may be available to successful candidate. Applicants must have completed apprenticeship in engineering, have good practical experience and hold an HNC or HND in mechanical or electrical engineering (or equivalent approved by the Department of Health).

Application form and job description available from the Group Secretary, Lewisham Hospital, London SE13. (01-690 4311, extension 111). Closing date 28th August 1970.

CENTRAL WIRRAL HOSPITALS

GROUP ENGINEER

The Group Engineer is due to retire and it is intended to appoint his successor at an early date to take up duties on 1st January 1971.

The post will be based at Clatterbridge Hospital, which is an expanding designated District General Hospital.

The principal duties include the supervision and development of the engineering services of the Central Wirral Group.

The successful applicant will possess at least HNC mechanical or electrical engineering with the appropriate endorsements and, preferably, will have wide experience of hospital-engineering services.

The current salary scale is £2,044–£2,409 (within the 48½–60 points range) and there is an additional responsibility allowance of £125 per annum.

Please write for application form and job description to Personnel Officer, Clatterbridge Hospital, Bebington, Wirral, Cheshire, L63 4JY.

Closing date for the return of application form is Friday, 28th August 1970.

SOUTH-WESTERN REGIONAL HOSPITAL BOARD

Hospital-Engineering Centre
Eastwood Park, Falfield
Gloucestershire

INSTRUCTIONAL STAFF

Instructors are required at this residential centre accommodating 60 trainees, situated between Bristol and Gloucester. The Centre will provide training for a wide range of engineering staff employed in the National Health Service in England, Wales and Scotland, including design engineers, maintenance engineers and craftsmen. Courses will normally last one or two weeks and eventually they will cover all the aspects of hospital engineering. It is planned gradually to install a wide range of hospital plant and equipment so that operation, control and fault diagnosis can be demonstrated and practised.

Candidates should be qualified to at least HNC standard and have practical hospital or similar experience. Experience in sterilisation, ventilation and air conditioning, laundry machinery, automatic controls or lifts and hoists will be an advantage.

Salary scale £1781–£2190 per annum. Commencing salary may be above the minimum for a candidate whose qualifications and experience are appropriate. Whitley Council conditions of service for the National Health Service will apply.

Some unfurnished houses and flats are available at modest rental, also single residential accommodation.

TECHNICIAN DEMONSTRATORS

Technician demonstrators are required at the above Centre to install and maintain plant and equipment and prepare it for demonstration. They will also be required to construct demonstration equipment under the direction of the instructional staff and to assist them with practical instruction.

An Ordinary National Certificate or City & Guilds Certificate of similar standard is desirable, together with practical hospital or similar experience.

Salary scale £832–£1452 per annum. Commencing salary may be above £1000 for a candidate whose age, qualifications and experience are appropriate.

Whitley Council conditions of service and accommodation as above.

Application forms, indicating post required, are obtainable from the Secretary *to the Board, 27 Tyndalls Park Road, Bristol BS8 1PJ, to whom* they should be returned as soon as possible

ROCHDALE AND DISTRICT HOSPITAL MANAGEMENT COMMITTEE

Applications are invited for the above post in the Rochdale Group of Hospitals.

The Group consists of six hospitals and two clinics with a total bed complement of 1086 beds.

The successful applicant will be required to deputise for the Group Engineer over the whole range of his duties.

Applicants should have completed an apprenticeship in mechanical or electrical engineering and hold one of the following qualifications:—

(i) Higher National Certificate or Higher National Diploma in Mechanical Engineering with endorsements in Industrial Organisation and Management, and Principles of Electricity or Electro Technology.

(ii) Higher National Certificate or Higher National Diploma in Electrical Engineering with endorsements in Industrial Organisation and Management and including (at S III or 2 level) Applied Heat and Applied Mechanics, provided that they have suitable experience in Mechanical Engineering.

(iii) City & Guilds Mechanical Engineering Technicians Full Technological Certificate (Part III) which must include Plant Maintenance and Works Service.

The salary scale is at present £1514–£1774 per annum, with a special responsibility allowance of £100 (increase pending).

Applications giving full details including age, qualifications, experience and two referees, should be sent to the Group Secretary, Group Offices, Birch Hill Hospital, Rochdale.

Closing date—31st August, 1970.

SOUTH-WEST MIDDLESEX HOSPITAL MANAGEMENT COMMITTEE

DEPUTY GROUP ENGINEER

required to deputise for the group engineer over the whole range of duties.

The group comprises 12 hospitals and a chest clinic. The present group pointage is '72½ or more'.

The deputy group engineer will receive 70% of the salary of the group engineer, which is £2616–£3087 p.a., and 70% of the group engineer's special-responsibility payments. £90 p.a. London weighting is payable in addition.

Further particulars and application forms obtainable from the Group Secretary, South-West Middlesex Hospital Management Committee, *West Middlesex Hospital, Isleworth,* Middx., to be returned by the 21st August 1970

ASSISTANT ENGINEER required for Ascot/Bracknell subgroup of hospitals. Post offers valuable experience in the operation and maintenance of all engineering services in expanding district general and psychiatric hospitals. Practical experience and approved qualifications required. Day release for higher qualifications considered. Housing may be available. Salary £1077–£1403 per annum (increase pending). Job description and application forms available from Secretary, Heatherwood Hospital, Ascot.

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