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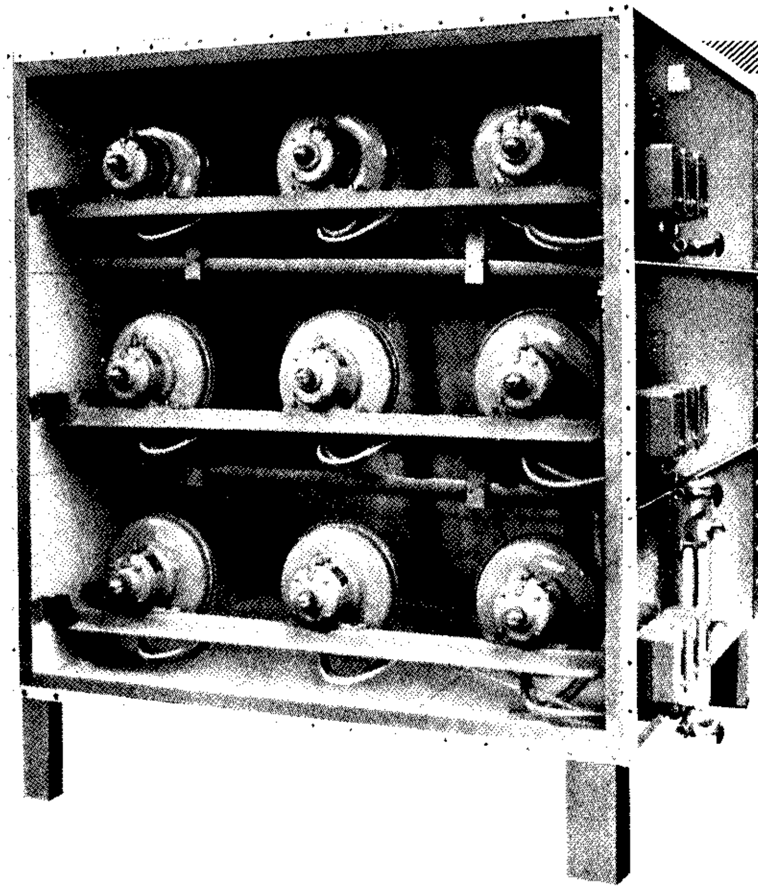

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A Cheaper Hospital?

By R. A. EMSLIE, C.Eng., M.I.E.E., M.A.P.L.E.
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THE expansion and modernisation of the hospital service under the direction of the Department of Health and Social Security involves vast expenditure which needs to be tightly controlled to ensure the best possible facilities for the capital involved. In view of the continuing rising costs due to economic situations, it is of particular importance to provide an efficient medical unit, both in view of the initial capital cost and the continuing running costs of the unit.

Hospital projects are subject to rigorous financial control in the preliminary sketch design stage, and again in the rationalised design stage, when the Final Cost Limit is expected to be the overall cost of the project. At completion stage, however, the final account is often in excess of the budget sum which had been set aside for the project.

Apart from the changing economic situation, these cost increases are often due not only to changes in the original brief but also to site conflictions which had not previously been envisaged or thoroughly investigated during the design stage. The costs of the latter are not always taken into account at the briefing stage of the project, and the following considerations examine some of the possible reasons for increased costs over original tender sums, and also put forward considerations which may lead to overall cost reductions.

The Building Notes and Technical Memoranda published by the Ministry Department of Health set out recommendations in respect of provisions to be made for engineering services. The services requirements particular to any individual hospital project are finally agreed by the design team, comprising the Architect, the appropriate medical Authorities and the Engineering Services Designers, following which the design positions of all outlets in each room are usually rationalised and sometimes co-ordinated in drawings produced by the Architect. It is often discovered during construction, sometimes at a stage when individual rooms are thought to be completed, that there are conflictions of outlets with furniture and/or medical equipment. These conflictions often result in considerable effort to move at least one of the pieces of equipment which, apart from costing more money, requires a previously finished room to be redecorated. To overcome this problem, drawings should be available to all interests involved to enable physical co-ordination of services outlets with furniture and/or medical equipment to take place within each department and room area during construction. It is also an important task to co-ordinate the services runs to these services outlets.

During the Architect's sketch plan stage, decisions have to be taken on the accommodation to be provided for services runs and equipment. These decisions are sometimes made at an early stage and are then irrevocable. The cost of the accommodation is not attributable to the engineering services sub-contract content but comes within the cost of the main building contract. Consideration of the purposes of this expenditure may show means of savings on the services installations, resulting in an overall saving on the whole contract.

Over the past few years various types of construction have been carried out in an attempt to ensure satisfactory provision for engineering services. These have included generous vertical ducts and false ceiling voids into which access is possible without entering the departmental areas concerned.

In some projects inadequate space has been provided for the engineering services, and this during con-construction has led to many complications, difficulties and increased costs on the services installations, quite often adding to the cost of the building contract. In a few projects, over generous space has been provided the cost of which could have been saved had early planning revealed this over generosity. An appraisal should be made to set the cost of services accommodation against the advantages to be gained in the ease of installation and future maintenance of engineering services.

Space provision for engineering services is dependent upon many factors, including the density of services and the plan ratio, and the height of the buildings concerned. A long narrow building affording natural ventilation does not require the volume of air handling equipment required of a deep plan building in which the majority of rooms, and certainly the numerous internal rooms, must be mechanically ventilated, necessitating space consuming air ducts.

In the overall planning stages the Architect needs to be aware of the requirements of the engineering services, including the space and clearance for the provision of fixings, and access in order that he may make the necessary allowance in his design, and for which adequate sums of money may be included in the tender figure. With this information he is then better able to make decision on the height of individual rooms, the type of ceilings to be employed and the type of access which will be required.

In considering the layout of engineering services the inherent flexibility of the various disciplines should be taken into account. A run of drainpipe depends upon the number of outlets and the gradient required, together with the positions of rodding eyes. Invariably, a run of drainpipe is not flexible but must usually follow the architectural layout of the sanitary appliances to which it is connected. Large elements of ventilation trunking are usually purpose made and are generally of such an area to render changes impracticable once their routes have been established. The number of piped services, i.e. C.W.S., H.W.S., Compressed Air, Medical Gas, etc. have a propensity to their being grouped together in a regular pattern, but the routing of which should enable the insertion of and future access to the valves, drain points, air bottles, etc. which are required. The stacking of these services usually precludes their being moved, particularly after lagging has been installed. Electrical services, including lighting, power, radio, call system and telephone services, etc. require space consuming trunking to which access is required at all times, but invariably where site conflictions occur it is the electrical work which can be altered at the least expense.

With room layout drawings and key plans prepared by the Architect as part of his working brief, the Engineering Services Designer can plan the integration of individual services outlets into a total scheme and, for each respective discipline, particular emphasis must be paid to the ancillary details. Co-ordination of wall mounted services can take place by reference to the room layout drawings, and these services concealed in wall chases, wall blocks, cavity walls, or encased in some enclosure provided by the Main Contractor. Much more planning, however, is required to enable adequate space provision to be made in ceilings and ceiling voids and, at tender stage, the Main Contractor should allow in his tender for the provision of all built-in supports, frames, fixings and access panels which may be required.

In the design processes of services the respective disciplines, i.e. drainage, mechanical services and electrical services, may well be co-ordinated in themselves with respect to the architectural and structural layout. It is, however, far more difficult to integrate all runs of all services without considerable total co-ordination being required, and these elements of design should be included in the design brief.

The preparation of co-ordination drawings would enable services to be installed without a multiplicity of complications. Where one service needs to be designed to be diverted around another, purpose made fittings can be detailed and specified. Without prior co-ordination an installed service may need to be taken down and moved to clear another, which costs extra money for disturbances, wastage, additional materials and delays. A purpose made fitting, designed to pass clear of another, may cost a very small sum if this had been included in the original tender, but to take down a length of run to fabricate on site the means of diverting one service around another would cost far more.

Full co-ordination of services during the design processes could determine the optimum amount of space required for services which would be reflected in the cost to provide this accommodation. These drawings would indicate to all the full extent of services without the necessity of waiting until these had been installed, when drawings before the final installation could be renewed and any modification considered.

For tendering purposes, full information should be given to the respective sub-contractors. In this respect, it is not always possible or practicable to provide him with drawings showing full details of the structure, together with sets of drawings indicating individual services, since he may have neither the time nor the capacity of comprehending what complications there may be or how they may effect the installation of the work.

(Continued at foot of page 163)

The Diagnostic X-Ray Tube

Part 3

By W. TENNET, C.Eng., M.I.E.E.,
X-Ray Division, Mullard Ltd.

Rating

Principles

The rating of any machine is a statement of the amount of work it can do in a given time. An example of this is the horsepower rating of a car. The main enemy of the X-ray tube is heat; its rating is, therefore, governed entirely by the temperatures to which each of its affected parts can safely be allowed to rise and by the relative success of the measures taken in design and manufacture to minimise and to tolerate such temperature rise.

In medical radiology, 'exposure time' can mean anything between a few milli-seconds and many minutes and in rating the tube we have to cover the whole of this range.

To clarify a point, by 'maximum safe temperature' we mean that temperature at which, during the time for which it persists, no serious damage is caused. 'Damage' is here defined as a deterioration in the properties of the part *as a component of an X-ray tube*. It is obvious, for example, that the temperature of the target must never be allowed to reach the melting point of tungsten, but even far below this point, very undesirable effects will occur. When tungsten is bombarded with electrons, the temperature gradient between the surface layer and those beneath is very steep. Differential thermal expansion therefore takes place between these layers. The resulting internal stresses are so high that minute cracks, increasing in number and depth with progressive cycles of heating and cooling, occur in the tungsten (see Fig. 13). This effect is called 'crazing' or 'erosion', and accounts for the drop in X-ray output during the life of the tube, the radiation generated deep in the cracks being severely attenuated by the surrounding 'cliffs' of tungsten. The incidence of this is dependent upon the temperature to which the target is allowed to rise.

A second factor to be borne in mind is the rate of evaporation of tungsten which is, of course, dependent upon temperature. Tungsten evaporated from either the target or the filament re-condenses on the inside surface of the glass bulb, where it forms a conducting film. This effect takes place inevitably in all tubes as life progresses, but, for reasons that will be explained later, in the interest of tube stability it must be delayed as long as possible.

A third temperature effect, significant only in the case of self-rectified tubes, is that of thermionic emission of electrons *from the target*. For example, if the focus is raised to a temperature of 2,300°C, an electronic emission of 0·4mA for every square millimeter of actual focus area will take place. If, as in self-rectification, the cathode becomes positive with respect to anode during alternate half-cycles, this target emission bombards the filament and other surfaces of the cathode. The filament tempera-

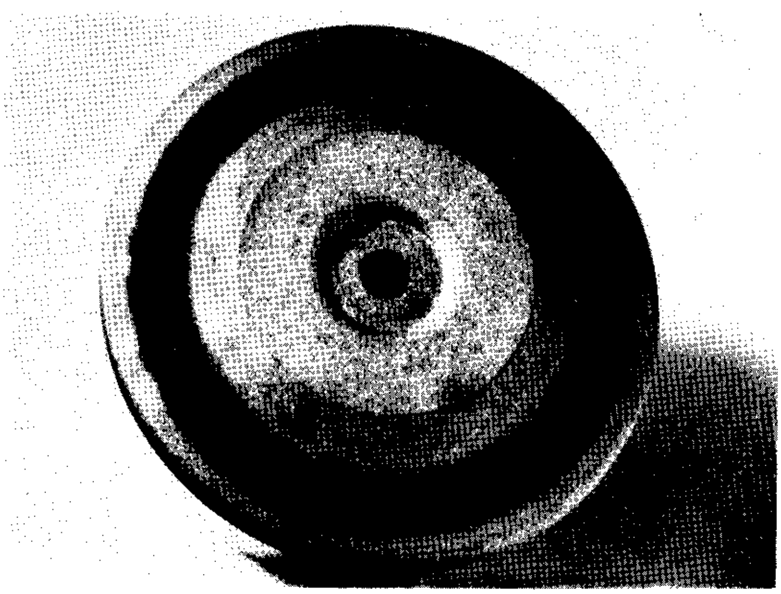


Fig. 13. Focal track "crazing" or "erosion".

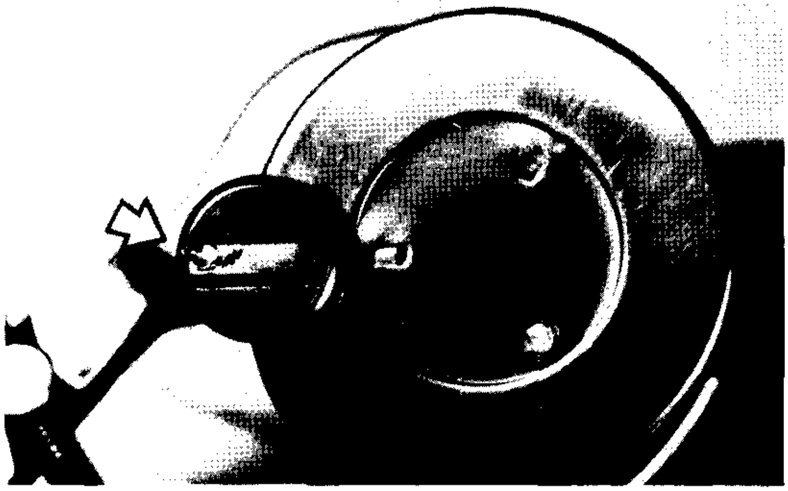


Fig. 14. The effect of reverse emission (1).

ture rises, causing an even higher current overload of the focus during the next half-cycle. This phenomenon is called 'backfire' and may escalate over several cycles until the tube breaks down (see Figs. 14 and 15). Target peak temperature is, then, our first criterion of rating and our first intimation that rating is not a hard and fast principle, but rather a compromise aimed at providing good diagnostic capability and at the same time adequate useful life. The one can be enhanced only at the expense of the other.

'Heat-path'

Whilst the tungsten skin temperature at the focal spot or track is, for the above reasons, an extremely important factor in determining the rating of a tube it is by no means the only one. Heat generated at the focus travels outwards to the external surface of the shield and thence to the surrounding air. On its way from focus to shield the heat passes through various parts of the anode, each of which has its own very definite thermal capacity and upper temperature limit. The temperature reached by each of these elements of the 'heat-path' is determined by the rate at which the heat arrives in and departs from the point in question. For a given amount of heat generated at the focus, therefore, the temperature reached by any intermediate point along the heat-path will depend upon:

(*a*) The degree of thermal insulation placed between the

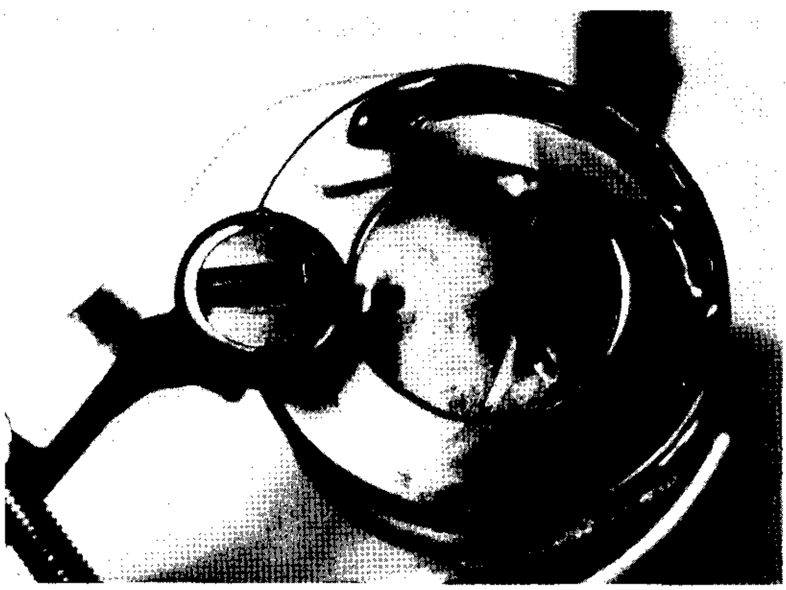


Fig. 15. The effect of reverse emission (2).

focus and the point in question (e.g. the slender Molybdenum stem between target and rotor).

(*b*) The proportion of heat which, by virtue of the above-mentioned thermal insulation and target surface-treatment, is induced to leave the target by radiation.

(*c*) The efficiency of the provisions made to cool the point in question.

This is just another way of saying that, for a given design of tube, the temperature reached by any point along the heat-path depends upon the rate at which heat is generated at the focus, in other words, upon the power of the exposure. Thus, the rating for a given exposure time t (in seconds) is the maximum power (energy per second) which can be applied via the focus so that the amount of energy introduced in t seconds will cause (either during or following the exposure) the temperature of the most thermally vulnerable element of the heat-path to reach, but not to exceed, its maximum safe level.

'Critical element'

We must now consider the effects, on the temperature distribution throughout the anode, of isolated exposures of varying duration, dealing now only with the rotating anode tube.

Short exposures (of the order of 0·1 seconds), whilst usually high in power, represent relatively small amounts of energy (energy = power × *time*). The effect of a single, isolated exposure of 0·1 seconds is to raise the surface of the focal spot or track to a very high temperature (about 2,300°C), but to leave the whole of the remainder of the target and anode cold. Clearly then the only factor limiting the rating for this order of exposure time is the temperature of the focal spot or track. In other words, at or around 0·1 seconds, the focal track is the 'most thermally vulnerable element' of the heat-path.

(N.B. Since we shall refer to this concept several times in the course of this explanation we shall call it more simply the 'critical element'.)

For longer exposures, of the order of 1 second, heat spreads from the focal track to some extent and begins to involve a wider annulus on the face of the target. The critical element is now the focal track plus the temperature tolerance and heat dissipation capabilities of the additional area of the target receiving a significant amount of heat. At about 2 seconds, as well as spreading even further over the face of the target, sufficient heat passes through the thickness of the disc to give rise to some thermal radiation from the back surface. In addition a significant amount of heat now passes by conduction to the centre of the target and slightly raises the temperature of the top end of the Molybdenum stem. As a result of this, heat begins to flow down the stem and into the head of the rotor to augment that arriving there by radiation from the back of the target.

At an exposure time of about 5 seconds, the whole of the mass of the target is raised to about 1,500°C (a bright-yellow heat), the focal track itself being, of course, very much hotter. Very large quantities of heat are now being radiated from the whole area of the target. The temperature of the top of the Molybdenum stem is now very high and the heat arriving at the Molybdenum-to-copper junction in the head of the rotor (by conduction and radiation) is attaining significant proportions. Since this junction must never approach, in temperature, 1,080°C (the melting point of copper), it constitutes the 'critical element' for this order of exposure time.

If this line of reasoning be continued until the exposure time is many minutes in length (fluoroscopy) the bearing lubrication, the thermal tolerance of the glass, the transformer oil, and all shield components are involved, and each in its turn assumes the role of 'critical element' for rating purposes.

Summarising, the rating characteristic of a rotating anode tube and shield depends upon the following design features.

(1) Focus size (effective).
(2) Target angle (actual focus size).
(3) Focal track diameter } These two factors
(4) Anode rotational speed } establish track speed.
(5) Target thickness.
(6) Target mass.
(7) Target surface area.
(8) Surface-treatment of target.
(9) Degree of thermal isolation of target with respect to rotor.
(10) Degree of thermal insulation of rotor with respect to bearings.
(11) Bearing assembly lubrication techniques.
(12) Thermal tolerance of the bulb glass.
(13) Thermal tolerance of the oil.
(14) Thermal tolerance of all other shield components.
(15) Volumetric capacity of shield oil-expansion bellows.
(16) Thermal capacity of shield shell.
(17) Thermodynamics of shield shell.
(18) Heat radiation properties of shield surface finish.
(19) Maximum desirable shield skin temperature.
(20) Air temperature in room (normally assumed to be 20°C).

Ratings in kilowatts

For any X-ray tube the rating characteristic is first estimated by calculation. Since, however, no practicable amount of mathematics can fully take into account the inter-play of so many variables, the calculated values are used merely as the basis for life tests in which many thousands of exposures are applied to sample tubes. The effects of these preliminary rating values on the life of the tubes is taken into consideration when compiling the final characteristics. An important criterion here is, of course, the incidence of focal track erosion measured in terms of drop in X-ray output with life.

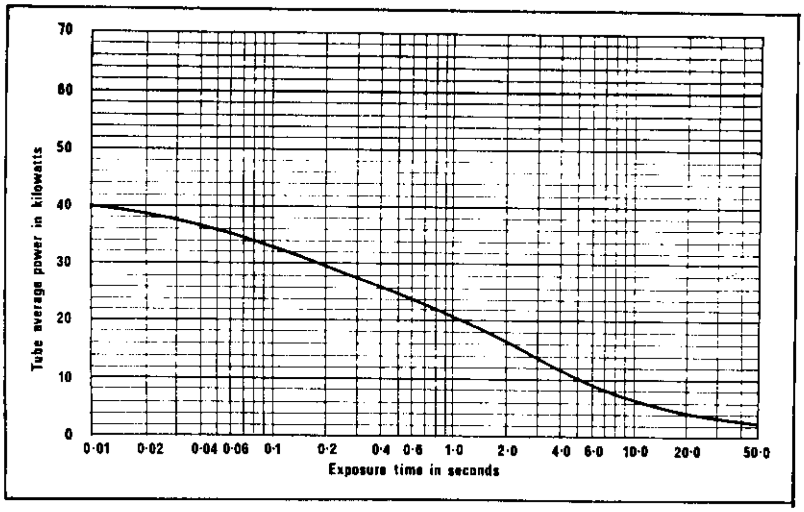


Fig. 16. Tube rating in kilowatts (1).

As stated previously, the published rating characteristic is simply a compromise aimed at providing the best diagnostic capability consistent with satisfactory tube life. Higher ratings could be published for any existing tube but shorter useful life would be the inevitable result. By the same token, if the published rating is exceeded in use, whilst immediate failure may not necessarily occur, tube life will unquestionably be shortened.

The rating characteristic when finalized, as described above, is originally stated in terms of the average power (in kW) permitted for each value of exposure time (in seconds). It consists, for a given high voltage waveform, focus size, etc., of a single curve such as that shown in Fig. 16. It will be appreciated from earlier considerations that the extreme fluctuations of temperature experienced by the focal track are not reproduced in the more remote parts of the heat path, having been 'ironed out' by the thermal capacities of the more massive anode components (notably, of course, the target disc). This means that for those parts of the heat path which are significantly heated only by relatively long exposures, it is the *average* power of the exposure which is of importance. For such exposure times, therefore, the *average* value of the input power determines the rating.

By contrast with this, for those exposures which heat significantly only the focal track and its immediate surroundings, the criterion of rating is the *peak* instantaneous power existing at any point in time within the individual cycles of the supply waveform. The tube rating in watts is, therefore, *dependent* upon high voltage supply waveform over the short-time range and *independent* of this waveform over the long-time range, there being, of course, an intermediate range of times over which a smooth transition takes place from the former situation to the latter. Thus, for a tube designed to operate, for example, on either single phase full-wave rectified, or three phase full-wave rectified supply, two power rating characteristics are produced. Fig. 17 shows such a pair of graphs, curve B being identical with that shown in Fig. 16. In Fig. 17 it will be observed that below an exposure time of about 5 seconds the three phase curve is higher than that of the single phase, indicating that, over this time-range,

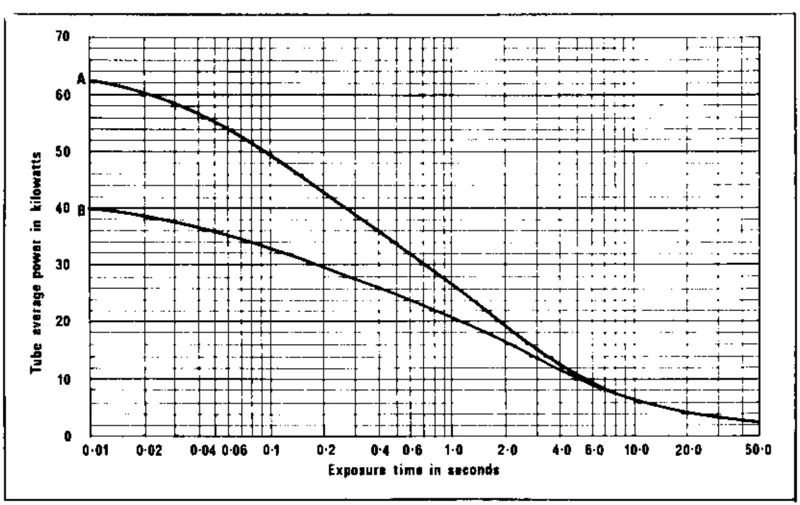


Fig. 17. Tube rating in kilowatts (2).

higher average powers may be used. This is because the three phase waveform is the smoother of the two and, therefore, a given peak value of power permitted by the rating represents a higher average value with three phase than with single phase.

N.B. By the same reasoning when using half-wave rectified waveform (in which power is supplied only during alternate half-cycles) the ratio of peak power to average power is about twice as great as with full-wave rectification; the half-wave average power rating of the tube for short times being consequently about half of that for full-wave.

Ratings in HU/sec.

The power of an exposure, in watts, is the product of kV (effective) and mA (effective). In practice, however, since it is the *peak* value of the voltage waveform which determines the short wavelength limit of the X-ray spectrum generated ($\lambda_{min} = \frac{12{\cdot}35\text{Å}}{\text{kVp}}$) and since moreover the instrument used to adjust such high voltages is the sphere gap (which measures *peak* value), the voltage is always expressed in kVp. The milliameter cannot possibly respond to the rapid fluctuations of tube current occurring throughout each cycle of the supply and, therefore, indicates the *mean* value of this current. To be of value to the set designer and radiographer, therefore, our rating characteristics must now be expressed, not in watts, but in units of power in which due allowance for the waveform of the supply has already been made. For this purpose, the X-ray world has created a special unit of energy known as the heat unit (HU) and a special unit of power known as the heat unit per second (HU/sec.). Thus energy in HU equals kVp $\times$ mA mean $\times$ secs. Power in HU/sec. equals kVp $\times$ mA mean.

Clearly, if we now take our rating curves in watts and convert them into HU/sec. by applying the correction factor appropriate to each waveform, we shall produce information of direct practical value.

Taking first the three-phase full wave case, the relationship is as follows:

$$\text{Power in HU/sec.} = \frac{\text{Power in watts}}{0{\cdot}96}$$

$$\text{Energy in HU} = \frac{\text{Energy in watt-secs.}}{0{\cdot}96}$$

If we, therefore, divide each of the values given in our three-phase full-wave rating (curve A Fig. 17) by 0·96, a new curve, this time in HU/sec., will result.

In the single phase full-wave case, the following relationship exists:

$$\text{Power in HU/sec.} = \frac{\text{Power in watts}}{0{\cdot}71}$$

$$\text{Energy in HU} = \frac{\text{Energy in watt-secs.}}{0{\cdot}71}$$

Familiar form of ratings

To obtain our HU/sec. curve for single phase full-wave operation, we must, therefore, divide all values given in curve B Fig. 17 by 0·71.

(N.B. From the above it will be apparent that in terms of *true* power the three-phase HU/sec. is $\frac{0{\cdot}96}{0{\cdot}71}$ or 1·35 times as great as the single phase HU/sec.)

These two new curves are shown in Fig. 18 (note 1kHU/sec. = 1,000HU/sec.).

To obtain the maximum permissible tube current for any combination of kVp and time, we simply take the HU/sec. value for the time in question and divide by the kVp (HU/sec. = kVp $\times$ mA). For example, on single phase full-wave (curve D) the rating at 0·1 secs. is 46,000 HU/sec. The maximum current at 100kVp, therefore, is $\frac{46{,}000}{100}$ or 460mA, whilst at 70Vp, $\frac{46{,}000}{70}$ or 658mA would be permitted.

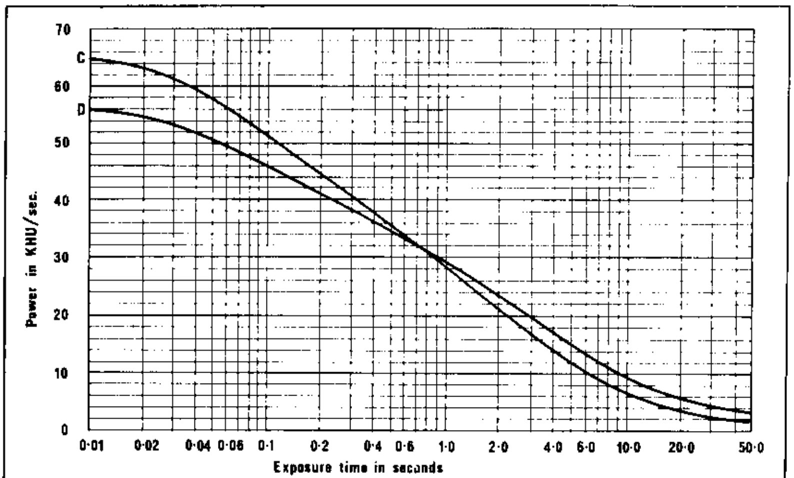


Fig. 18. Tube rating in kHU/sec.

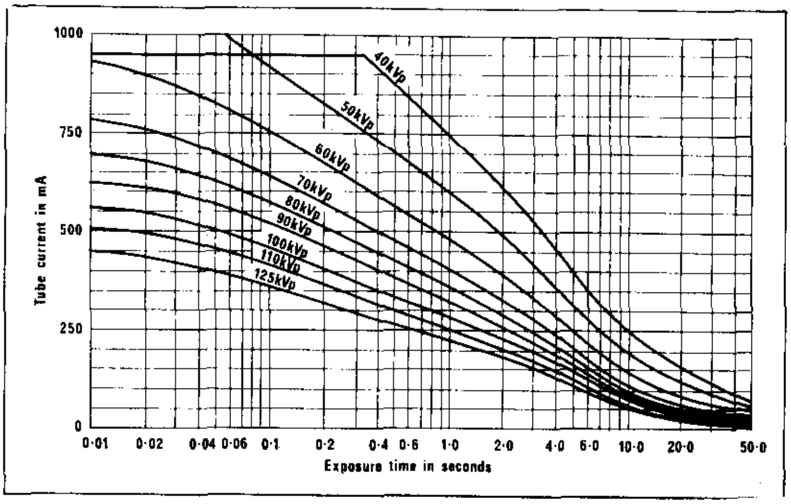


Fig. 19. Rating chart for single-phase, full-wave rectified operation.

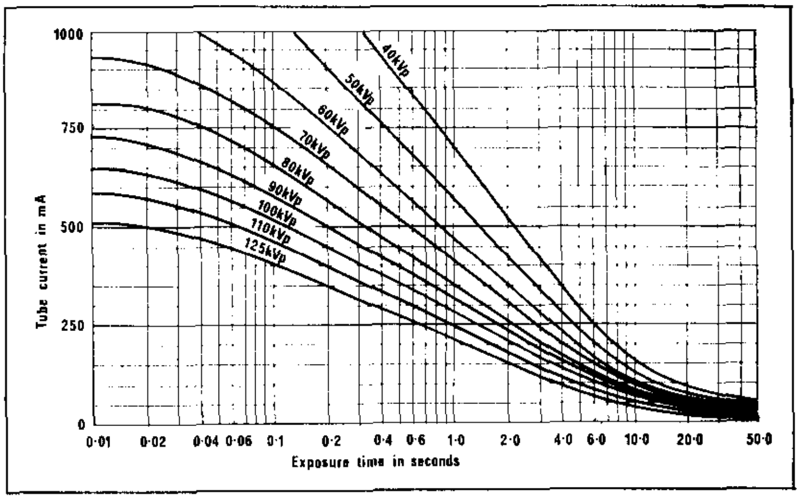


Fig. 20. Rating chart for three-phase, full-wave rectified operation.

Almost invariably the tube manufacturer takes the calculation to this stage and publishes characteristics of the familiar form shown in Figs. 19 and 20. These characteristics show the limiting mA values appropriate to each combination of kVp and time and were derived from curves C and D, Fig. 18, by the method described above.

Three-phase versus single phase

Incidentally, it will be noticed that, on exposure times longer than 1 second, the permissible mA values on three-phase are lower than those for single phase. This is seen most clearly from Fig. 18, the curves actually crossing at about 1 second. To explain this we must remind ourselves that, over the long-time portion of the characteristic, the *average* power is the criterion of rating. Curves C and D, Fig. 18, are expressed in HU/sec., and were obtained by dividing *true* power in watts by 0·96 and 0·71 respectively. Thus for a given value of kVp and mA (HU/sec.), the *true* power on three-phase is approximately 35% higher than on single phase, in other words, to produce the same true power, the HU/sec. values (and therefore the mA values) on three-phase must be lower.

Emission limitation

A further point of interest in passing is the way in which (in Fig. 19) the 40kVp characteristic is cut-off at 950mA. The reason for this is simply that, due to the very close cathode geometry required to focus the electron beam, the emission at maximum safe filament temperature is not adequate to satisfy the target rating at this low kV value. Such a tube would be said to be 'emission limited at 40 kV'.

It should be obvious from the foregoing that the user must be most careful to ensure that the chart selected is the correct one for the type, focus size, high voltage waveform, and stator supply frequency of the tube being used.

Anode heating and cooling curves

The radiographic rating chart has a very important limitation. It is based on the assumption that the tube is relatively cool prior to the commencement of each exposure. Thus, if, as is usually the case, a sequence of operation (radiography, fluoroscopy, or both), is involved, more information than that given in the rating chart is required to be sure of avoiding tube overload. Strictly speaking, of course, the radiographic rating of the tube *changes* with anode temperature, or in other words, with immediately previous use, but to attempt to deal comprehensively in published data with all possible combinations of conditions would clearly be impracticable. However, the manufacturer publishes another graph (see Fig. 21) called the Anode Heating and Cooling characteristic, and this, although strictly applicable to fluoroscopy only, can provide guidance in determining the time-scale along which we must spread our exposures to avoid overload. In Fig. 21 the rising curves show the energy content in single-phase units of the anode against time for a number of rates of heat input in single-phase HU/sec. They are, strictly speaking, valid only if the input is steady at the values quoted. The falling curve is the cooling characteristic, showing the energy content of the anode against time when the input is zero. This is valid irrespective of the manner in which the energy was applied. The upper limit of the graph shows the maximum permissible anode heat storage capacity. The maximum continuous rating of the anode is immediately apparent, being that value of input in single-phase HU/sec. at which the heating curve approaches, but never quite reaches, the line representing the maximum heat storage capacity. This level of power may be applied for an indefinitely long time provided that:

(*a*) It is applied steadily.

(*b*) The continuous rating of the shield is adequate.

Application of published data

The following examples indicate how the information contained in the anode heating and cooling curves may be used in conjunction with the rating charts to programme the X-ray tube.

CASE 1 Fluoroscopy only

For fluoroscopy only, the anode heating and cooling characteristic is direct-reading. Thus, for example, according to Fig. 21, 2,000 single-phase HU/sec. may be applied for 1 minute 45 secs., after which an interval must ensue. The maximum length of this interval depends upon what is required next. If, for instance, a further period of 50 seconds at 2,000 HU/sec. is required, the anode must first be allowed to lose this amount of heat, i.e. 2,000 × 50, or 100,000 HU. Following the cooling curve from the point of maximum heat storage (135,000 HU) down to 35,000 HU, we see that the necessary minimum interval is 4 minutes 15 secs. If, of course, the required input power were 650 HU/sec. or less, this, subject to *shield* cooling considerations, could be carried out continuously.

When dealing with low current operation, e.g. screening, it is essential to bear in mind that under such conditions, single phase full-wave rectified voltage, normally regarded as 100% sinusoidal, will assume a waveform similar, in terms of ripple, to that of three-phase full-wave, if the cable capacitance is greater than about 1,200pF per pole. The capacitance per metre of normal diagnostic cable is approximately 185pF. When screening, then, with high voltage cables of 6·5 metres (approximately 20 ft.) or more in length on a single-phase full-wave circuit, power in HU/sec. equals kVp × mA × 1·35 (see note on page 155).

Heating and cooling curves are not normally published in terms of three-phase HU as well as single-phase, it being sufficient, when computing energy-storage, to use the single-phase characteristic and multiply all kVp × mA or kVp × mAs values by 1·35 before applying them to the graphs. For the sake of clarity let us take two further examples.

Example 1

Screening *only* is required at 80kVp for an indefinitely long period. The apparatus is single-phase full-wave with short cables, i.e. less than 20 ft. From Fig. 21 we see that the maximum continuous rating is 650HU/sec. We have in this case no need to allow for smoothing, therefore, power in HU equals kVp × mA, and maximum permissible continuous screening current $= \frac{650}{80}$ i.e. 8mA approximately.

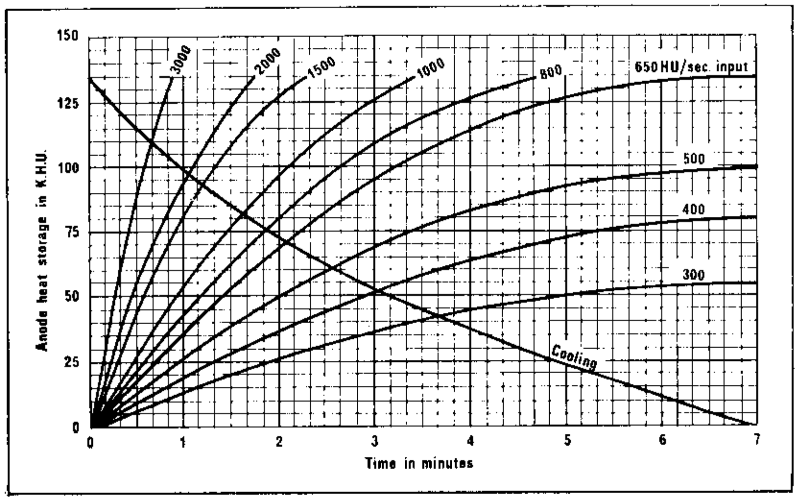


Fig. 21. The Anode Heating and Cooling Characteristic.

Example 2

Taking the same case with cables longer than 20 ft, power in HU/sec. equals kVp × mA × 1·35. Therefore, maximum screening current equals $\frac{650}{80 \times 1{\cdot}35}$, i.e. 6mA only.

CASE 2 Radiography only

To reiterate, the characteristics which govern all procedures involving radiography are the rating charts (e.g. Fig. 19), and the anode H and C curves (Fig. 21). The rating charts enable a *single* radiographic exposure on a cool anode safely to be made. Theoretically, however, when a radiograph or radiographic series is contemplated, consideration should first be given to the amount of heat already stored in the anode due to immediately previous use, i.e. use in the last seven minutes. The anode cooling characteristic enables this to be done.

Example 1

It is required, using a single-phase, full-wave rectified generator, to make an exposure at 100kVp 150mA, 5 secs. and to follow it as quickly as possible with a second identical exposure, there being no screening during the interval. It is seen from the rating chart that these exposures are permissible when considered separately. The minimum interval required can be determined as follows.

Assuming no work during the seven minutes prior to the first exposure (i.e. that the anode is cold), the anode heat content at the end of the first exposure is given by:

$$\begin{aligned} E &= \text{kVp} \times \text{mA} \times \text{seconds} \\ &= 100 \times 150 \times 5 \\ &= 75{,}000\text{HU} \end{aligned}$$

Now the maximum permitted anode heat content is, from the heating and cooling characteristic, seen to be 135,000HU. Therefore, the anode must be allowed to cool to 135,000–75,000, i.e. 60,000HU before we dare to apply the second exposure. From the cooling curve we see that the anode cools from 75,000 to 60,000HU in 45 seconds. This, then, is the shortest interval required between our two exposures to avoid overload.

Example 2

Assuming a three-phase full-wave supply and using the same factors as in example 1, the following reasoning applies.

Assuming no work during the six minutes prior to the first exposure, the anode heat content at the end of the first exposure is given by:

$$\begin{aligned} E &= \text{kVp} \times \text{mA} \times \text{secs.} \times 1{\cdot}35 \\ &= 100{,}000\text{HU approx.} \end{aligned}$$

The maximum permitted anode heat content (Fig. 21) is 135,000HU. Therefore, at the commencement of the second identical exposure the heat content must not be more than 135,000—100,000, i.e. 35,000HU. From the cooling curve we see that the anode cools from 100,000 to 35,000HU in 3 mins. 15 secs. This, then, is the shortest interval required between the two exposures to avoid overload.

It should now be clear that strict observance of minimum intervals between exposures is just as essential as is limiting the exposures themselves to the prescribed maxima given by the rating chart. However, the plotting technique of tube programme planning, described above, is only necessary where there is a danger of the heat storage capacity of the tube being used up in a particularly heavy diagnostic procedure. Otherwise, the following general rule should be observed:—

When taking radiographs without fluoroscopy in the intervals, single exposures may be applied indefinitely at full rating provided that:

(*a*) each interval in seconds is at least equal to the number of HU developed by the most powerful exposure divided by half the continuous rating of the anode in HU/sec.

(*b*) The average rate of heat input does not exceed the continuous rating of the shield.

This means, for example, that if the heaviest exposure is 80kVp 500mA (single-phase) 0·1 seconds, i.e. 4,000HU, the minimum interval $= \frac{4{,}000}{325}$ i.e. 12 seconds.

CASE 3 Serial radiography

When considering limited series of radiographs taken in very rapid succession, for example in angio-cardiography, the cooling which takes place during the intervals between individual exposures is negligible. Also, the heat transference by conduction from the focal track is reduced by high target temperature. In order to make allowance for these factors the following rule should be observed when programming angio, cine and similar series:—

Exposures may be made in rapid succession up to 80 *per cent* of full radiographic rating provided that:

(*a*) The total energy in HU developed by the complete series does not exceed 80 *per cent* of the energy permitted by the rating charts for a single exposure equal in time to the complete series, including intervals.

(*b*) All intervals in the series are equal.

(*c*) Each interval *between* series is at least equal to the total energy in HU/sec. developed by the most powerful *series* divided by half continuous rating in HU/sec.

Example 1 (Series-time known)

It is desired to make a series of exposures lasting 3 seconds, the individual exposure data being 90kVp 10mAs, i.e. 900HU. How many exposures are permitted? What is the minimum interval between successive identical series?

According to our rule the exposure time will be that which permits an energy input equal to $\frac{100}{80} \times 900$, i.e. 1,120HU per exposure. Examining our rating chart (taking the 100kV curve for ease of mental calculation) we find that at 0·02 seconds 100kVp at 550mA is permitted, representing an energy input per exposure of $100 \times 550 \times 0{\cdot}02$, i.e. 1,100HU. Since this is within 2 per cent of our requirements we decide to accept 0·02 as our individual exposure time. Our tube current for 10mAs will, therefore, be $\frac{10}{0{\cdot}02}$ i.e. 500mA.

From the rating chart we see that, at 3 seconds (our series-time), the permitted energy input is $100\text{kV} \times 200\text{mA} \times 3$ seconds, i.e. 60,000HU. Our rule permits us to use 80 per cent of this, i.e. 48,000HU. Therefore, the number of exposures in the series may not exceed $\frac{48{,}000}{900}$, i.e. 53, which represents an exposure rate of 17 per second.

The total exposure time of the series is $53 \times 0{\cdot}02 = 1{\cdot}06$ seconds, leaving 3·0—1·06 or 1·94 seconds to be divided into 52 equal intervals.

Each interval is then $\frac{1{\cdot}94}{52}$ i.e. 0·037 seconds.

Minimum interval between *series* $= \frac{48{,}000}{325} = 148$ secs. or $2\frac{1}{2}$ min.

Example 2 (Exposure rate known)

Exposures at 80 kV 20mAs are required at a rate of 6 per second. How long may the series last? What is the minimum interval between successive identical series?

Energy per exposure equals 80×20, i.e. 1,600HU. Individual exposure time, according to our rule, is that which permits an energy input of $\frac{1{,}600}{80} \times 100$, i.e. 2,000HU.

From the rating chart we find that at 0·04 seconds 100kVp 520mA is permitted, representing an energy input per exposure of $100 \times 520 \times 0{\cdot}04$, i.e. 2,080HU. We can, therefore, safely adopt 0·04 seconds as our individual exposure time. The series is to take place at 6 exposures per second, i.e. at an input power of $6 \times 1{,}600$ or 9,600HU/sec. The series time is, according to our rule, that time which would permit, in a single exposure, a power input of $\frac{9{,}600}{80} \times 100$, i.e. 12,000HU/sec.

Using the 100kVp curve on the rating chart (for convenience in calculation) we see that 120mA ($100\text{kV} \times 120\text{mA} = 12{,}000$HU/sec.) is permitted for 7 seconds. This then is our series duration time. The number of exposures in the series is 6×7, i.e. 42, each of which takes 0·04 seconds. Total exposure time of the series is, therefore, $42 \times 0{\cdot}04$ or 1·68 seconds, leaving 7—1·68, or 5·32 seconds to be divided equally into 41 intervals of 0·13 seconds. Minimum interval between *series* $\frac{9{,}600 \times 7}{325} = 206$ secs. or $3\frac{1}{2}$ mins.

CASE 4 Screening and Radiography Combined

There are, of course, several diagnostic procedures which demand fluoroscopy punctuated either by single radiographic exposures or by groups of exposures in fairly rapid succession. The former type of application corresponds to the type of work carried out in a department where screening and general radiography are practised as required throughout the day. A typical example of the latter situation is represented by gastro-intestinal investigation.

Since it is essential that the heat content of the anode shall never be allowed to exceed specified maximum heat storage capacity, the heat introduced during screening must be kept sufficiently low to ensure that, when radiography commences, enough of the heat storage capacity remains for the radiographically introduced heat safely to be accommodated.

The anode heating and cooling characteristics provide the information required when considering the permissibility of various combinations of screening and radiography.

Example 1

Starting with a cold tube a period of screening lasting for several minutes is required. This is to be followed immediately by a single exposure of 100kV 300mA. What is the maximum level of screening permitted? (The apparatus is single-phase full-wave rectified.)

The energy of the exposure is 100×300, i.e. 30,000HU. The maximum permitted heat storage capacity of the anode is, from the heating and cooling curve, 135,000HU. If, therefore, screening is limited so that the anode heat content due to screening cannot rise above 135,000 —30,000, i.e. 105,000HU, the radiographic exposure can safely follow.

On our chart we see that the 500HU/sec. curve flattens off at about the 100,000HU level. We can, therefore, regard 500HU/sec. (e.g. 100kVp 5mA) as our maximum safe level of screening prior to the exposure specified. Should the curves available not prove so conveniently situated as in this example and provided there are enough curves representing input below the maximum continuous rating, interpolation is satisfactory. For example, if our calculation had given a maximum energy level due to screening of 85,000HU instead of 105,000, we could safely have taken 450HU/sec. (midway between 400 and 500) as our maximum safe screening rate.

Example 2

Starting with a cold tube a period of screening lasting several minutes is required. This is to be immediately followed by a group of four exposures (each of 15,000HU), there being no significant cooling period between exposures. What is the maximum permitted screening rate?

The exposures must, in the absence of significant cooling intervals, be taken as a single pulse of $4 \times 15,000$, i.e. 60,000HU, the individual exposure times and the minimum series time being governed by the '80/80 rule', as previously described. In order that 60,000HU shall remain available after screening the heat stored due to screening must not exceed 135,000—60,000 = 75,000. This, as seen from the heating and cooling characteristics, corresponds to a screening power of 400HU/sec. (or say, 100kV, 4mA) approximately.

In the absence of heating curves corresponding to the lower values of heat input rate the cooling curve can be used to provide the answers. Thus, in the above example, if we wish to limit the heat content due to screening to 75,000HU, this would be achieved if the anode heat content were to stabilize at this value, in other words, if the rate of heat input equalled the rate of heat output (cooling). By drawing a tangent to the cooling curve at the 75,000HU level we see that the slope corresponds to a rate of cooling of 120,000 in 5 mins. 10 secs., or about 390HU/sec.

It should be appreciated that the calculation technique in the above examples is included mainly to demonstrate the significance and interdependence of the published data. Such calculations are only necessary whenever the proposed work schedule is unusually heavy or when evaluating the heaviest work schedule envisaged for a particular set prior to specifying the type of tube required. In practice it is normally sufficient to abide by the following rule:—

Combined screening and radiography may continue indefinitely provided that:

(*a*) screening is limited to not more than half continuous rating.

(*b*) each interval between single exposures is at least equal to the energy developed by the most powerful exposure divided by half the continuous rating.

(*c*) each radiographic series conforms to the '80/80' rule already described.

(*d*) each interval between *series* is at least equal to the total energy developed by the most powerful series divided by half the continuous rating.

(*e*) the average rate of heat input does not exceed the continuous rating of the shield.

In practice the work is of such a varied nature and precalculation frequently so impracticable due to technical complexity and lack of time, that only by ensuring that the tube fitted has a reasonable safety margin in terms of heat storage capacity can satisfactory tube life be expected.

Part 4 of The Diagnostic X-Ray Tube, the concluding section, will be published in the August issue of "The Hospital Engineer."

ELECTRO-HYDRAULIC LIFT FOR SLOUGH HOSPITAL

AN ELECTRO-HYDRAULIC lift has been installed at Upton Hospital, Slough, as part of an extensive conversion.

Prior to the current conversion, Upton was a general hospital in the Windsor Group. It is now to become a specialist hospital with emphasis on obstetrics and gynaecology. There is, in addition, a geriatric unit, and it is there that the electro-hydraulic lift has been installed.

The geriatric unit consists of four wards—two on the ground floor and two on the first floor—with a total of 50 beds, together with all necessary supporting facilities. The unit will be the Windsor Group's main assessment unit for geriatric patients.

Because of the need to move the elderly patients from floor to floor without causing discomfort, it was essential for the geriatric unit to be equipped with a lift which would be extremely smooth and quiet in operation, and capable of accurate levelling at both landings.

By choosing an electro-hydraulic lift it was possible to ensure levelling within a quarter of an inch at both landings, combined with smooth acceleration and slowing. In the event of power failure the lift can be lowered immediately by a hand valve.

To provide ample room for a patient in bed, together with attendant staff, the lift car is 7'-9" wide by 5'-4" deep internally. Two-leaf doors are fitted at each landing giving a clear opening of 7'-0". The car walls are finished in grey Formica and the floor is linoleum covered.

The working capacity of the lift is 3500lb; the raising speed is 35ft/min and the lowering speed is 50ft/min.

To house the lift, an existing stairway was removed and the lift installed in the location of the old stair well. Because all loading is transmitted from an electro-hydraulic lift direct to the foundations by the hydraulic rams, the shaft need only be a light non-load carrying structure.

The electro-hydraulic lift is powered by a quiet-running, compact pump unit. Together with the control equipment, this unit is housed in a small motor room close to the lift at ground level so that only a minimum of headroom is required at the top landing. Again, only a 20-inch pit is needed for an electro-hydraulic lift. At the hospital, to ensure absolute quietness in operation, the power unit has been surrounded by a sound-proof box.

SHOREHAM CONTRACT TOPS £80,000

Electrical Contractors Locke & Soares Ltd. are to carry out work worth £84,000 as part of Phase I of Southlands Hospital, Shoreham-by-Sea, Sussex. At Shoreham, the South West Metropolitan R.H.B. has awarded Rice & Sons Ltd. of Brighton the overall £673,000 contract for the project.

At the hospital, the electricity authority is bringing in a new 11 kV service, and Locke & Soares' work entails providing consumer's 11 kV transformer and switchgear equipment—all medium voltage distribution—and standby generator equipment. Coupled with this work is the provision of services in four operating theatres, and x-ray departments.

The Consultant Architect with overall concern in the areas of design, quantity surveying and structural, electrical, and mechanical engineering, is J. G. L. Poulson in association with the Architect and Engineer to the Board.

BROMPTON HOSPITAL
New Intensive Care Unit

1. The Hospital

Brompton Hospital was initially founded for the treatment of patients suffering from pulmonary tuberculosis since no other hospital would readily admit this group of cases, and the international reputation of the hospital was established on its standards and methods of treatment of this disease.

The decline in the need for treatment of tuberculosis coincided on the one hand with dramatic developments in surgery of the heart, and on the other with developments in the medical treatment of respiratory and cardiac conditions, including bronchitis, emphysema, asthma and coronary disease. Brompton Hospital has been one of the leaders in these fields and patients come from all over the world for treatment here.

In four years' time the oldest part of the hospital is to be demolished to make way for a new Cardio-Thoracic Centre. When this is built, Brompton Hospital will join forces with the National Heart Hospital to create a postgraduate chest and heart centre which will be unique in the world.

2. The intensive care unit

(*a*) *Origins*

The special requirements of cardiac surgery led to the setting aside of a special room in which to nurse the patients post operatively as long ago as 1960, at a time when the concept of intensive care units was little known. In 1964 two further rooms were added in order that all the critically ill patients, including those requiring medical intensive care, might be looked after by specially trained nurses of the highest calibre. It was recognised at the time, however, that these rooms, which were no more than converted wards, fell far short of the high standards required for intensive care, and a start was made in planning the unit which is now nearing completion.

(*b*) *Size*

The new Intensive Care Unit consists of:—

A large open area equipped for up to 8 beds: this will be occupied by patients for 24 to 48 hours after operation, when they will be transferred to the post-operative ward.

An adjacent area of five single rooms: these will be occupied by patients who have developed complications after operation; who are infectious; or whose lungs are not functioning properly.

A separate area of five beds, consisting of one room of two beds and three single rooms: this area will be used primarily for patients who have had 'coronary' attacks; it is also suitable, with a minimum of modification, for nursing patients after transplant operations.

Various ancillary rooms: such as changing rooms, sluices, a doctor's office, sister's office, conference room, laboratory, treatment room, nurses' rest room and relatives' room.

An intensive care unit has been defined as a unit for patients requiring the assistance of mechanical devices for the support of life; it is natural therefore that this unit, serving as it does a hospital of over 350 beds entirely for patients with defective hearts and lungs, should be one of the largest of its kind. It will accommodate all the critically ill patients in the hospital except the babies, for whom a small unit has been established in the paediatric ward.

(*c*) *Features*

Visitors to the unit, before it is in use, may be surprised at its apparent spaciousness compared with an ordinary ward. The reason for this is the great amount of equipment which may be, and often is, needed for each patient, and to provide for this there are at the head of every bed up to twelve electric points as well as outlets for oxygen, anaesthetic gas, compressed air and medical suction, all brought by pipeline from elsewhere in the hospital.

The Unit is situated on the top floor of the hospital's South Block and panoramic views over Chelsea, Kensington and beyond can be had from it. Although the majority of the patients will be too ill to notice these, they will be appreciated by the staff working there. The nurses' rest room is particularly fortunate in this way and nurses taking their short tea and coffee breaks will be able to look right over the hospital's North Block towards Hampstead and Muswell Hill.

A unique feature is a new type of respirator system, the provision of which has been made possible by a generous grant from the King Edward VII Hospital Fund for London. Developed by one of the hospital's consultant anaesthetists in consultation with a manufacturer of medical equipment the system consists firstly of a single compressed air plant delivering sterile air to every bed; at the bed there is a simple respirator for controlling the rate and quantity of air entering the patient's lungs; and, finally, at the base of each bedhead unit there is a pipe which carries away the air after it has left the patient's lungs. This system has many advantages over the conventional respirators, but by far the greatest is the fact that the air breathed by a patient connected to the respirator is quite independent of the air in the unit. This will reduce the risk of cross-infection, a major hazard in units of this sort.

Of course, not all the patients are connected to respirators all the time, and a further precaution against cross-infection has been the installation of a forced air ventilating system which changes the air in the whole unit up to twenty times every hour.

There will be a plentiful supply of cardioscopes for measuring the electrical activity of the heart; in addition, there will initially be one full-scale monitoring system: this one, developed at St. Thomas's Hospital, measures, displays and, when required, records both the heart's electrical activities and the blood pressures inside the chambers of the heart.

Many small but important design features have been incorporated into the unit to make it function more efficiently and so provide as good as possible a service to the patients. The general ward lights, which are coloured to match almost exactly the colour of daylight on a cloudy day, can be serviced and maintained from above the ceilings; they have special diffusers to obviate glare in the patients' eyes. The walls of the single rooms are made from plastic laminates which can be wiped clean without difficulty; large double-glazed panels with integral blinds give maximum facilities for observation coupled with privacy when required. Two rows of special rails are installed on the walls in each ward: on these can be hung all types of equipment as well as shelves; very little will need to stand on the floor. The floor itself is covered with an impermeable polyvinyl chloride sheeting which is foam-backed to reduce noise to a minimum.

(*d*) *Staffing*

For every patient in an intensive care unit there must be four nurses to give a 24-hour service seven days a week. This type of nursing makes the greatest demands on the staff, but it also brings very high rewards. The patients are critically ill, so much so that until a few years ago many would have had no chance of surviving. Great skills of observation and interpretation are developed by the nurses there, and the condition of the patients, coupled with the complexity of the equipment in use, means that there is a much closer involvement of the various disciplines—medical, nursing and technical—than usual. It is factors such as these that bring to the hospital staff who enjoy the challenge which such work brings.

(*e*) *The Future*

The staff of Brompton Hospital are working on the frontiers of knowledge in the field of chest and heart medicine and surgery. Heart transplantation is a development which has caught the public eye and one which obviously in the course of time will have a part to play in the hospital's work; it will doubtless be followed by lung transplantation and eventually, perhaps, by the insertion of man-made hearts and lungs. In the meantime, more and more sophisticated drugs and methods of treatment enable patients to live longer and more useful lives. In all these developments the new Intensive Care Unit will play its part in providing an environment as near ideal as possible for the care of patients poised between life and death.

RESEARCH IN TRANSPLANT SURGERY AT EAST GRINSTEAD

THE FUTURE development of 'spare parts' surgery depends heavily on a recent yet already vital surgical technique. This is microvascular surgery—the rejoining of severed veins and arteries which literally supply the life blood without which transplanted organs or tissue cannot live.

Apart from replacement of major organs such as the heart, kidney and liver, microvascular surgery has made possible the reimplantation of partially and sometimes totally amputated fingers. The same techniques on a larger scale have, in several known cases, allowed successful reimplantation of arms severed above the elbow.

Of the many branches of surgery that can and are benefiting from research, plastic surgery has perhaps the most to gain and can make the most immediate progress. Work on the reimplantation of digits has already made remarkable strides. Now the 'one stage' tissue graft is being perfected. At the moment it is necessary to leave attached to the donating area, the flap of skin that is being transplanted, simply to keep its blood supply until the graft has 'taken' into the transplant bed. By joining up suitable supply vessels to feed the new tissue, it is hoped that second and sometimes third operations will become unnecessary. Results are also more satisfactory. Better skin colour and texture matches are possible as the choice of new skin is less restricted, and may eventually include donated tissue. Shrinkage of new tissue is also avoided. Donated skin can and is used in plastic surgery at present, but only as an intermediary as its life is limited.

At the research unit of the Queen Victoria Hospital at East Grinstead, world famous for its plastic surgery unit started by the late Sir Archibald McIndoe, there is a programme of advanced experimental research in microvascular surgery. Tissue and organ transplants in rats are already providing valuable new knowledge and experience in the technique of rejoining fine blood vessels as well as the problems of immunity—the body's rejection of a 'foreign' tissue.

One of the hospital's six consultant plastic surgeons is conducting a series of experimental operations. The technical problems of working on tiny blood vessels 1mm. in external diameter and less, are mainly of technique and precision. Stitching has proved to be the most satisfactory of the several methods of joining these blood vessels. But stitching together the elastic walls of a vein less than the thickness of a pencil lead, or the width of a pinhead, demands exceptional skill and precision. Any restriction in the channel resulting from inaccurate anastomosis causes obstruction resulting in thrombosis. Half a millimetre of narrowing in a vessel of 1·5 mm. is disastrous.

Meticulous care and exactitude made work on all but the larger vessels unreliable until the introduction of the use of the operating microscope. The ophthalmologist's loupe (a magnifying glass worn on the forehead) was useful but the likelihood of success was greatly increased by more sophisticated instruments. Once the surgeon is accustomed to magnification it is an enormous advantage and soon becomes indispensable. For working on vessels of 1mm. or less an operating microscope is essential.

Carl Zeiss of West Germany brought their optical knowledge to surgery with the original operating microscope for E.N.T. surgeons over ten years ago, and now manufacture high precision instruments for virtually every branch of surgery and medical research. The Zeiss Diploscope installed last month at East Grinstead magnifies up to 20 times. Stereoscopic or three dimensional binocular viewing is possible for two people, with individual magnification changers. The angle of vision is identical, so two surgeons can work with total co-ordination. This can reduce operating time to less than half. Suture of a single 1mm. vessel normally takes over thirty minutes, but between two surgeons can be reduced to less than fifteen.

At East Grinstead, the instrument is currently being used to perfect kidney transplants in rats. Liver transplants will follow. Rats are used because inbreeding through about twenty-five generations produces genetically identical animals. The problems of transplant immunology can therefore be reduced to negligible proportions using animals with identical genetic makeup. By comparing the effects of similar operations on organically compatible pairs of rats and unrelated animals, immunologists are able to study the effects of suppressing the rejection process. Already, laboratory experience has made possible operations on humans which could not otherwise have been undertaken. This has been in the field of reimplantation of partially amputated digits. The most notable was the rejoining of an almost totally severed ring finger from a two and a half year old boy. An artery only 0·7mm. had to be rejoined and was the smallest human vessel on which the surgeon had ever operated.

Hand in hand with surgical research is immunology which is developing a new science of tissue typing. This is similar to categorising blood groups, except that for tissue is a good deal more complex. Bone and nerve suture is also involved in digital transplants and the nerve endings can be very accurately rejoined under high magnification to give quicker and more 'real' return of sensations from the limb's extremities.

Operations can be photographed, filmed or televised without hindering the surgeon by replacing the second set eyepieces with a camera. This records exactly what the surgeon himself sees, and in the same perspective. Its value is obvious in introducing other surgeons to microvascular techniques which may well be the key to the next major step forward for virtually every field of surgery.

UNIQUE DISH WASHING EQUIPMENT AT WEST CUMBERLAND HOSPITAL

A COMPLETELY unique conception in Dish Washing equipment, contrasting with the traditional conveyorised and cabinet machines which employ racks for crockery and cutlery, are the Dawson-MMP In-Trolley machines, two of which are installed in the West Cumberland Hospital. This is one of Britain's newest hospitals and with its reputation for advanced medical techniques it is fitting that in the important process of washing-up, it should be equipped with plant which is not only completely different from anything previously thought of, but, more important, is perfectly suited to both the layout of the hospital and the high standard of hygiene it maintains.

Located in a purpose-built room, the two Dawson machines serve sixteen wards which on average have about 30 patients per ward, the furthest being about 300 yards from the wash-up point. The principle is simple. Each ward has its own specially built trolleys which Dawson-MMP supplied with the machines, and the crockery and cutlery is kept on these at all times, only being removed when the meals are actually served. Apart from going to the wash-up room the trolleys stay in the ward and, between meals, the tableware is protected by a fabric cover which envelopes each trolley. When a meal is finished the ward staff load the crockery and cutlery onto the trolley and this is wheeled to the wash-up room. At the front of each washing machine is a roll-back stainless steel door which is raised automatically, to enable the operator to push the trolley into the cabinet. The operator then closes the door and switches on the automatically timed and controlled treatment cycle. Jet pipes positioned inside the machine project between the shelves of the trolley, as well as above and below, and during the treatment process these move slowly from side to side, ensuring comprehensive coverage with the powerfully jetted treatment. The two stages of treatment are hot detergent solution wash at 145°F (63°C) followed by a scalding fresh water rinse at 190°F (88°C). This removes every trace of detergent and leaves the items hot for quick self-drying. As well as the moving jets, stationary jet pipes located on the inside walls of the cabinet augment the washing and rinsing processes. When the treatment cycle has been completed the machine automatically cuts out. The trolley is allowed to remain in the machine for something less than a minute, by which time, because of the residual heat from the scalding final rinse, the crockery and cutlery is virtually dry. The cover is then immediately placed over the trolley, which is returned to the ward where it remains until the next meal. Both the trolley and its cover are marked with the appropriate ward number so that there is no interchange of crockery and cutlery.

There are three types of trolley in use: The breakfast trolleys are suitable for fruit and cereal bowls, small plates and the general ware used at this meal. Those for dinner take soup bowls, dinner plates, cups and other appropriate dishes, and are also used for lunch. The third trolley is for tea-time items such as cups, saucers, tea plates etc.

Mr. Cook, the Catering Officer at West Cumberland Hospital, considers that this is the best system of dish washing he has ever experienced. In its simplicity of operation it is superior to any other and probably its biggest asset is that there is less manual handling of crockery and cutlery than with any other system. Not only does this contribute substantially to the high standards of hygiene maintained at the hospital but also it considerably reduces the risks of costly breakages.

A Cheaper Hospital?

(Continued from page 150)

In the critical early planning of a hospital unit it is of the utmost importance that great care is exercised in determining from the medical users their exact requirements, bearing in mind the fact that the completed hospital would not be available until some years after the planning exercise, but including an allowance for an element of future development in the field of medical science.

Knowing all the requirements of the user, and with the full knowledge that these requirements would not be changed, with such co-ordination as described, the site supervisory staff would have more time for quality control. Without the necessary drawings, and with a view to minimising the amount of money which would otherwise need to be spent on site alterations, more site supervisory staff would be required having the ability to be constantly anticipating where conflictions may occur and having the authority to make on-the-spot decisions for minor changes to overcome otherwise future expensive remedial work.

Failure to provide money for co-ordination in the design stage may, in the long run, prove far more costly by site alterations.

On the Market

A review of new equipment and materials and their development

NEW HEAVY DUTY PACKAGED UNITARY AIR CONDITIONER

J. Samuel White & Co. Ltd., of Cowes, Isle of Wight, have introduced a new heavy duty packaged unitary air conditioner designed primarily for single and multi-room applications.

Named the Fairline Gladiator Model E225, it has a nominal cooling capacity of 2·25 RT (27,000 Btu's per hour).

It is designed for through wall or window mounting, or installation remote from the conditioned space, thus providing either free-blow or remote ducted multi-zone environment control.

When installed for remote ducted applications, the fascia panel is discarded and the duct spigot provided as standard is connected to ducting. This allows conditioned and return air to be handled by means of the ducting.

For ducted applications the Gladiator is provided with a remote thermostatic control unit.

The basic free-blow window/wall model is a cooling only unit. A 4 kW heater battery is available as an optional extra.

Multi speed fan delivery is provided giving air flows of approximately 750 CFM, 810 CFM and 900 CFM by a centrifugal type evaporator fan.

A propeller type condenser fan fitted with a slinger-ring affords maximum condensate pick-up. Excess condensate is atomised through the condenser. Dehumidification capacity is approximately five pints (2·85 litres).

Fresh air intake and stale air exhaust facilities are built-in as standard.

Long-life filters which can be cleaned by vacuum cleaner or washing are provided to trap dirt, dust and pollen.

The dimensions of the Gladiator are: 27 inches (685 mm.) wide, 21½ inches (545 mm.) high, and 35¼ inches (895 mm.) long. When installed it projects only 3⅝ inches (92 mm.) into room space.

ELECTRICAL INDICATING THERMOSTATS

Ward Brooke & Co. Ltd., Loudwater, Bucks., are now producing a range of electrically operated indicating thermostats designed for use in applications such as temperature control and indicating in cold stores, refrigerating systems, incubation cabinets, blood banks and general process heating systems.

These units, which incorporate the features of clear temperature indication and switch setting positions plus close switch differential, are available for a variety of different operating temperature bands ranging from −80/+80°C. (−110/+160°F.) to 150/350°C. (350/650°F.). Operation is by means of a liquid filled bulb which is connected to the main unit by a capillary tube.

The system is robust and rigid with ample power to operate the switches without significant loss of indicated accuracy. A simple yet fully adjustable mechanical linkage system operates the switch control mechanism. A variety of standard micro-switches are used according to the electrical duty imposed on the switch.

Two sub-miniature micro-switches operating in tandem can be supplied and these are simultaneously adjusted from the same setting scale and are also factory set to operate at either the same or different temperatures. In addition, 'fail-safe' switches can be built-in.

ALLEN YGNIS EXTEND '606' BOILER RANGE

Allen Ygnis Boilers Ltd., Princes Road, Tipton, Staffs, announce that they have extended their range of model '606' boilers to include two new models with respective outputs of 20 million and 24 million Btu/h. These latest additions to the '606' range mean that a total of 19 sizes is now available with outputs ranging from 400,000 Btu/h which will permit larger applications to be catered for.

Suitable for either oil or gas firing, the boilers are constructed for working pressures of up to 150 lb./in.^{2} and have operating efficiencies between 81 and 83%.

PLASTIC COATED TRU-WEL TUBE NOW AVAILABLE

A further development in Tru-Well central heating tube has been announced by **Tube Products Ltd.,** a TI Company.

In addition to their range of plain tin/zinc-coated mild steel tube, Tube Products are now offering the same tube in a version coated with plastic sheathing. This sheath permits Tru-Wel central heating tube to be buried in walls, floors and concrete. Previously it has been necessary to give this tube some further form of protection under these conditions such as a larger diameter sleeve.

This tube has the considerable advantage of low stable price compared with copper tube, enabling approximately £15 to be saved on an average domestic installation. Plastic sheathing makes only a marginal difference in price per ft. compared with plain tube.

Plastic sheathed Tru-Wel tube is available in ½, ¾, 1, 1¼ and 1½ in. nominal bore sizes and is packaged in 20 ft. lengths.

NEW CIRCULATING PUMPS FROM P.E.P.

Precision Engineering (Pumps) Ltd. of Congleton, Cheshire, have increased their range of circulating pumps for L.P.H.W. heating and domestic hot water service systems by the introduction of a completely new range of Inline pump sets. These are of the close coupled fullway pattern.

Initially, three sizes of pump are being introduced, these are for 1 in., 1½ in. and 2 in. connections. The 1 in. pump follows metric convention and is designated size 26. This pump is capable of circulating 20 gallons per minute against a head of 3 feet and 10 gallons per minute against a head of 10 feet. The performance of the $1\frac{1}{2}$ in. and 2 in. (sizes 41 and 51) pumps are identical. These sizes of pump will deliver 60 gallons per minute against 2 feet head and 10 gallons per minute against 20 feet head.

For use in heating and primary domestic hot water circuits the pumps are produced with cast iron castings and impellers, for secondary domestic service systems an "all gunmental" construction is used. The glands are all of the dripless mechanical seal type. The electric motors fitted as standard are supplied suitable for use on either single or three phase electric supply. The motor bearings are pre-packed and require no further attention in service. Pump size 26 has $\frac{1}{8}$ h.p. motors and sizes 41 and 51 $\frac{1}{4}$ h.p. motors.

NEW STATIC SWITCH FOR INVERTER BY-PASS DUTY

English Electric-AEI Industrial Controls Ltd. of Rugby, Warwickshire (part of GEC-Elliott Automation), announces a new range of static by-pass switches for use in inverter "no-break" power supply applications. The switches are available in ratings complementary to the English Electric-AEI series of standard no-break inverters which have outputs of 1, 2, 4, 8, 10, 15 and 20 kVA.

In "no-break" systems, the incoming a.c. supply is rectified and then fed to an inverter which supplies a.c. to the load. The rectifier also maintains storage batteries at full charge and, in the event of mains failure, the batteries provide the inverter input and maintain completely uninterrupted a.c. supply. Where the application makes it imperative that there be no supply breaks in any circumstances, provision must be made for inverter maintenance, and for the unlikely event of inverter failure. This is achieved by means of a by-pass switch. Conventional electro-mechanical contactors have been used for this duty, but suffer from the inherent disadvantage of comparatively slow operation. The new English Electric-AEI static switch overcomes this problem, and will by-pass the inverter automatically in less than one milli-second, thus ensuring completely guaranteed power supply. Once having changed over to the by-pass supply, the logic circuits in the switch will lock out the inverter, and will not transfer back automatically. To return to inverter supply, the logic circuits must be reset manually.

HIGH-PRECISION, PORTABLE THERMO-HYGROGRAPH INSTRUMENT

The latest development between Turbojet and Haenni of Switzerland is the portable, high precision Thermo-Hygrograph instrument for continuous chart recording of the ambient relative Humidity and Temperature. It has been specially designed for use in Laboratories, Computer rooms, Hospitals, Factories etc. and wherever an accurate record of the humidity and temperature is required.

The basic standard range is 0-100% r.H. and 0° to 100°F or −10° to +50°C with an exceptional high accuracy of ±1%.

The cadmium-plated bi-metal temperature coil and the doubled hair-strand hygrometer element are incorporated within the chromium-plated element stems as seen on the photograph.

These were specifically designed to ensure highest sensing acumen giving at the same time utmost exposure to the ambient air but eliminating the usually experienced problems of radiation and contamination through dust and airborne dirt particles etc. resulting in subsequent inaccuracies. Both elements can be adjusted and recalibrated with the special keys supplied for this purpose.

A precision Swiss lever movement rotates the charts on a daily or weekly basis.

An attractively styled, lockable dust and shockproof grey-lacquered metal casing, with three-dimensional glass front gives one week's view of the charts.

The size of this compact instrument is 12″ × 10″ × 7″, the weight is 12 lbs. Its price of £72 10s. 0d. includes the supply of charts for one year, special ink and pens.

Delivery for Fahrenheit or Centigrade models is ex stock direct from **Turbojet Ltd.**, 21, Foxley Lane, Purley, CR2 3EH.

AIRPAC AIR HANDLING UNITS

New Airpac handling units, developed by **Woods Fans Ltd.**, Colchester, introduce wide scope and flexibility in meeting air conditioning requirements.

The units provide for alternative assemblies of sections for the supply of conditioned air. The sections include filters, heaters, coolers, humidifiers, eliminators, fans and silencers. Any combination can be supplied.

Thirteen sizes are offered, the air movement capacities ranging from 600 ft.^{3}/min. to 40,000 ft.^{3}/min. at static pressures up to 12 in. H_2O. Fully tested, the performance ratings are guaranteed.

To meet hospital specifications, the designs allow for sterilisation of the interior surfaces by steam to prevent bacterial growth. Thermal insulation can be applied externally, and interior surfaces are finished with white non-toxic polyurethane paint. Ease of maintenance is a feature of the design.

Of modular construction, the sections have cross-sectional dimensions based on a 10 inch module. The sections are connected by external flanges, gaskets being supplied for all joints, and lifting ring bolts are fitted. Brief details of the component sections are as follows:

(*a*) Inlet mixing section, can have inlets on any one, two or three of five sides, with fresh air and recirculation proportioning dampers.
(*b*) Filter section, can be throw-away, washable, automatic roll type, absolute, bag, carbon or electrostatic.
(*c*) Pre-heater, can be for hot water, steam or electricity.
(*d*) Cooler, chilled water coil or direct expansion.
(*e*) Humidifier, can be spinning disc type, spray washer, spray coil or steam.
(*f*) Eliminator.
(*g*) Re-heater, hot water, steam or electric.
(*h*) Diffusing chamber.
(*j*) Fan section.
(*k*) Diffusing chamber.
(*l*) Silencer—splitter type.

Full details and selection data are given in Woods loose-leaf publication AP1-9.

Notes for Members

Richard Emrys Rogers

OBITUARIES

Mr. R. E. Rogers

We regret to announce the death, suddenly, of Mr. Richard Emrys Rogers on 27th May at his home at Blean in Kent. He had not been in very good health for some months. The cremation, at which the Institute was officially represented, took place on 2nd June.

Mr. Rogers was a co-founder of The National Association of Hospital Engineers, later to become The Institution of Hospital Engineers and, in January 1967, to be Incorporated as The Institute of Hospital Engineering.

Having spent the first part of his career as an engineer in the Merchant Navy, during which time he obtained a 1st Class B.O.T. Certificate, Mr. Rogers entered the Hospital Service when he was appointed Chief Engineer at Whitchurch Mental Hospital, Cardiff in 1936. He became Group Engineer to the South Warwickshire H.M.C. in 1951 where he remained until his retirement in 1967.

Mr. Rogers' devotion to the cause of hospital engineering, and the plight of the hospital engineer, led him to call a meeting of the Chief Engineers of all hospitals in England and Wales in 1943, and to this he invited representatives from the Institution of Engineers-in-Charge and from the London County Council Engineers Association. The meeting was held at the City Hospital, Nottingham, and the aims and objects of the organisation that he proposed were outlined. The prime object was to raise the standard of hospital engineering and of the engineer, and to introduce into the Service a certificate of competency, a land counterpart of the B.O.T. Certificate open to sea-going engineers. The subject was discussed at great length and it was finally resolved that The National Association of Hospital Engineers be formed. The first Council and Officers were elected and Mr. Rogers became the Hon. Secretary/Treasurer. He strived unceasingly to establish facilities for the training of hospital engineers and for the holding of examinations of a standard acceptable to the Ministry of Health.

At some time, Mr. Rogers had held practically every office within the administration of the Institution. He had been Chairman; he had been a Member of Council from the inaugural meeting until 1966; he was a member of the delegation formed to establish joint conciliation committees with the Mental Hospitals Association and with the British Hospitals Association; he was for some years Chairman of Whitley Council Committee 'D'; he was elected a Vice-President and a Fellow of the Institution. Amongst his private interests Mr. Rogers was keen on radio and motoring. He was Chairman of the Fiat Car Club at one time.

A great tribute will be paid by all those who knew Mr. Rogers for his efforts on their behalf.

Mr. S. R. Penman

We regret to announce the death, at the age of 47, of Mr. Scott Russell Penman.

Mr. Penman served an apprenticeship with the Caledon Shipbuilding & Engineering Co., and attended Dundee Technical College during this time and subsequently. Following his apprenticeship, he served as an Engineer in the Merchant Navy until 1949, and obtained a First Class B.O.T. Certificate. He followed this for a short period as a Surveyor with the Scottish Boiler and General Insurance Co., and entered the Health Service as Senior Engineer at Stoneyettes Hospital, Chryston in 1951. In 1954 he joined the Lennox Castle and Associated Hospitals B.O.M., subsequently becoming Group Engineer to the Board.

One of the earliest members of the West of Scotland Branch, Mr. Penman was a one-time member of the Council of the Institution.

1969 ANNUAL CONFERENCE AND DINNER

The 1969 Annual Conference and Conference Dinner were held as planned, although, as members were advised, the Hospital Convention and Conferences, including that of this Institute, were switched to the Earl's Court Exhibition Centre.

In spite of this change of venue and other unfavourable factors, such as attendant strikes, the Conference can be counted a marked success. The Conference was opened by J. Bolton, C.Eng., A.M.I.C.E., M.I.Mech.E., A.M.Inst.F., F.R.S.H., Chief Engineer, Department of Health and Social Security, and the first paper, 'The Role of the Engineer in the Hospital Service', was given by A. S. Marre, C.B., Second Permanent Under-Secretary of State, Department of Health.

This, and the four succeeding papers, covering a wide range of subjects, all attracted good audiences of between 100 and 150.

It is intended to publish in the JOURNAL some of the papers given.

The special Conference Dinner was also a success, 110 attending, and it is hoped to publish the after-dinner speeches.

SOUTH WEST AND WELSH BRANCHES

A joint meeting of these two Branches was held at Manor Park Hospital, Bristol, on Saturday, 31st May, and was attended by the Secretary of the Institute, Mr. J. E. Furness. The meeting commenced with a talk by Mr. Furness, who traced the developments and major occurrences over the past two years since Incorporation, and spoke of some of the hopes for the future.

After tea, the company re-assembled for a domestic meeting of the South West Branch. A most lively discussion led to a decision to try alternating meetings on a mid-week evening with the current Saturday meetings. In addition, a number of suggestions were forthcoming for subjects to be dealt with at future meetings, and also as to possible visits the Branch could make. The new Branch Committee can look forward to a lively time planning a most interesting programme.

YORKSHIRE BRANCH

The Yorkshire Branch held their May meeting in midweek on the evening of Thursday, 22nd May. The usual good attendance was maintained, and the number included several who had been unable to attend the Branch meetings held on Saturday afternoons.

The meeting commenced with a talk by Dr. R. A. J. Ord-Smith, B.Sc., Ph.D., F.I.M.A. of Bradford University. The talk was followed by a conducted visit around the Computing Laboratory, of which Dr. Ord-Smith is Director.

SCOTTISH BRANCHES

The Scottish Branches will hold their Joint Conference this Autumn in Aberdeen, in the Royal Infirmary. The dates will be 16th to 18th October.

The President of the Institute, Mr. G. A. Rooley, will attend the Conference, as will the Secretary.

Full details of the programme will be published later.

MID-SCOTLAND BRANCH

The Mid-Scotland Branch held a meeting at Aberdeen Royal Infirmary on 29th March.

The meeting began by electing Branch Officers for the year 1969/70, and further discussion took place on the possibility of holding Branch meetings on mid-week days.

A sub-committee was formed to proceed with arrangements for the 1969 Joint Scottish Branches Conference.

A further meeting was held on 10th May at Sunnyside Royal Hospital, Montrose.

SOUTH WEST BRANCH

A meeting of the Branch was held on 22nd March at Glenside Hospital, Bristol.

Prior to the election of Officers, etc., the question of attendance at meetings was discussed. Several members also spoke on the formation of an Association of Group Engineers within the Region, there being a general feeling that this body would conflict with the aims of the Institute. Mr. H. A. Adams spoke on the function of these Associations, and said that they were formed to work in conjunction with Engineers and Architects of the South Western R.H.B.

Mr. J. D. Lewis said that in the areas in which he had previously served similar Associations had existed since 1948, and he could not envisage anything detrimental to the Institute from their meetings. In fact, he considered that there had been many occasions when Institute members had benefited.

The subject having been fully aired, the Chairman, Mr. F. W. Ilett, called for nominations for Branch Officers and the Branch Committee, and these were put forward and elections completed.

WELSH BRANCH

A meeting of the Welsh Branch was held at the Temple of Peace and Health, Cardiff, on 15th March.

Mr. H. F. H. Dolling, Chairman of the Branch, introduced Mr. J. Henderson, Deputy Engineer to the Welsh Hospital Board, and deeply concerned with many matters of training within the Region, to address the meeting. Apprenticeships were well established in the Middle Ages, the speaker said, but to regularise matters the Government enacted in 1563 a very important regulation, known as the "Statute of Artificers", which laid down for the first time national conditions for the training of craft apprentices. Unfortunately, the Industrial Revolution led indirectly to the breakdown of the system, due to the development of factory production resulting in the division of labour. Till the 1940s apprentices tended to lose their status, and the Government set up a Committee to investigate the problem. The first recommendation was Government Training Centres, and a long-term result was the introduction of the Industrial Training Act of 1964, which allowed for the setting up of Industrial Training Boards.

The Hospital Service, as a Crown Authority, does not come under this Act, though several schemes are in being to provide training which includes apprenticeships at H.M.C. level for the training of craftsmen.

In the South Western R.H.B. there is the combined effort of Filton Technical College, the Board, and the H.M.C.s to train hospital engineers.

Two years ago the Ministry set up an Advisory Committee on Hospital Engineering Training, which is now looking into the general question of how to recruit and train the future generations of engineers and craftsmen in the Hospital Service.

Following a period devoted to domestic matters, the Annual General Meeting of the Branch was held.

Mr. Dolling, the Chairman, said that he was very pleased with the progress made in the Branch during the previous year, though he felt obliged to give further encouragement to members of the Branch to give papers at subsequent meetings, because he felt that there were many hidden talents. He was certain there were many hospital engineering activities that could be brought out in the form of papers of considerable interest to everybody.

The Hon. Secretary, Mr. P. Jackson, said that in the twelve months since he took office there had been seven meetings, and two of the papers read at these meetings had been published in the JOURNAL. He hoped that a third would shortly appear.

With reference to the subject of members moving from the district, he appealed to those who did to advise their changes of address and employment so that continuity in correspondence would be maintained, and unnecessary expenditure in tracing such members saved.

The meeting closed with a review of Branch accounts and the election of Branch Officers and Committee for the year 1969/70.

PERSONAL

Mr. C. B. Denne (*Associate Member*), Hospital Engineer, City General Hospital, Stoke-on-Trent, has been appointed Deputy Group Engineer to the Stafford Hospital Management Committee.

NEW CLADDING CUTS HOSPITAL BUILDING COSTS

Pressings and Stampings Ltd., of West Ealing, London, has been nominated by the Oxford Regional Hospital Board as suppliers, at a value of £75,000, of a new type of prefabricated exterior wall cladding for a hospital to be built at Battle, Reading, Berks. Architects are Yorke Rosenberg Mardall.

The company has already completed twelve large hospital schemes and has been nominated for further work in this field approaching a worth of over £200,000.

The total unit range comprises 150 variants in a modular cladding system. The units were developed over a period of two years as a result of joint research by the Oxford Hospital Board (architect Mr. A. L. Arschavir) and Pressings and Stampings.

The system considerably reduces construction time and costs. Minimal site labour is required and wet trades are not necessary. All claddings are delivered on site glazed and with windows fitted as required. Jacking bolts under each panel ensure ease of positioning.

Erection is speedy—100 sq. ft. in 20 minutes and no scaffolding—and work on interior decoration can be begun immediately. The panels are made of Stelvetite plastic-coated steel in-filled with polyurethane, are immensely strong and have a 10-year guarantee. Maintenance-free durability is a basic feature of all units.

ST. THOMAS' HOSPITAL PILING CONTRACT

The installation of piled foundations for the second stage of the rebuilding of St. Thomas' Hospital, London, is to be carried out by Foundation Engineering Ltd., a member of the Costain Group.

Under a £210,000 contract the company will install 1,463 24-inch diameter auger piles, and 26 17-inch piles to depths of between 80 and 90 feet.

The work involves drilling through 30 feet of water-bearing ballast into the London clay beneath to provide foundations for three buildings—treatment, ward and residential blocks.

Work on the eight-month contract is due to begin in April.

The main contract is being carried out by John Laing Construction Ltd. The architects are Yorke Rosenberg Mardall and the consulting engineers, Felix J. Samuely & Partners.

The quantity surveyors are Franklin & Andrews, the services consulting engineers, Steensen Mulcahy & Partners.

The architects are Liverpool Regional Hospital Board; consulting engineers, Cairns and Byles.

BRITISH RELAY GET £186,000 ORDERS AND NOMINATIONS

British Relay Ltd. has secured £186,000 worth of contracts and nominations during the first quarter of 1969 for communications and/or TV/radio installations in hospitals in the U.K. and and five countries overseas.

The contracts include Addenbrookes Hospital, a ward block of King's College Hospital, Northwick Park Hospital, stage 2 of St. Thomas' Hospital, Westminster Hospital and an overseas hospital to a total value of £61,000.

The company has received nominations for hospital communications installations in other overseas countries to a value of £125,000.

Published for the Institute of Hospital Engineering by John Marchant Publications, Ltd.
Printed by The Hillingdon Press (Westminster Press Ltd.), Uxbridge, Middlesex.

POLYPLAN COURSE ON PLASTICS IN BUILDING

Polyplan Ltd, independent consultants dealing with costing, design, and fitness-for-use specifically on plastics for building, now plan a further course, Polyplan's seventh, for 22-26th September, 1969, at Beaumont Hall, Leicester University.

During the four day course, lecturers and discussion groups will cover the fundamentals of plastics and shaping them, and such aspects of plastics specification and design as: use under The Building Regulations; weathering and durability; their economics and applications; and using them structurally. Great value comes from the opportunity of a small group (limited to 20) to question lecturers and tackle problems individually.

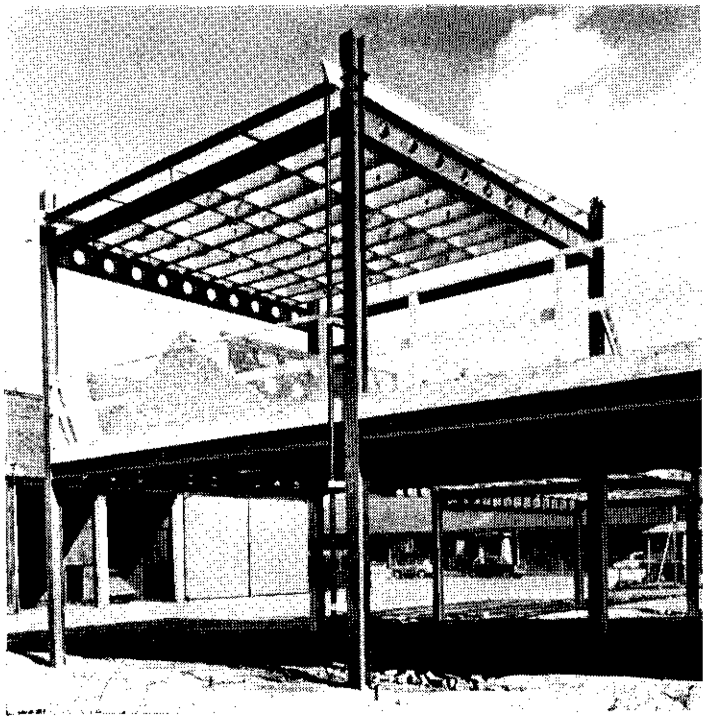
Lecturers will include Richard Fitt, A.R.I.B.A., David Kirby, A.R.I.B.A., Dr. J. Crowder, R. G. B. Mitchell and Professor Z. S. Makowski, as well as Polyplan staff.

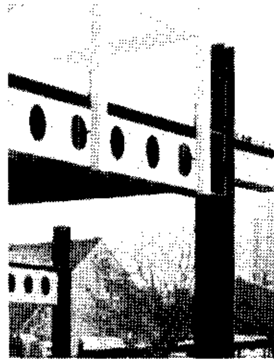
The cost of the course is 28 guineas, with accommodation at Beaumont Hall and arranged evening activities extra at cost. The course is approved for CITB grant.

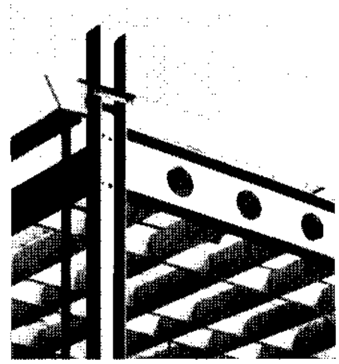
Registration forms and a course prospectus are available from The Course Director, Polyplan Ltd, 97 Princess Road, Leicester. Telephone: Leicester 26562.

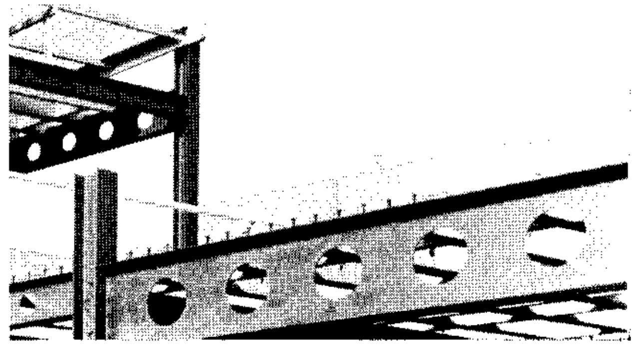
ARBIGRILL

Method building for hospitals









A new industrialised construction medium for easy installation of services.

Because the Arbigrill structural steel frame has been integrally designed with a Grillcon pre-cast concrete floor, it achieves a considerable reduction in the combined thickness of beam and floor over traditional methods.

Arbigrill offers other noteworthy advantages: Low Cost ● High Performance specification ● Cuts in planning time ● Complete architectural freedom ● Fast site erection ● Maximum provision for services ● Factory made components.

You are invited to inspect a full-scale two storey Arbigrill prototype, specially erected in London to illustrate its many benefits.

Contact Redpath Dorman Long at Bedford or The Consulting Civil & Structural Engineers: Alan Marshall & Partners, Federal House, 2 Down Place, London W.6. Tel: 01-748 8771.

REDPATH DORMAN LONG

Special Contracts Division, Redpath Dorman Long Limited, RDL House, Goldington Road, Bedford. Telephone: Bedford 55261 (12 lines). Telex: 82230 (a/b Redorm Bedford) or Terminal House, 52 Grosvenor Gardens, London, S.W.1. Telephone: 01-730 2275.

BRITISH STEEL CORPORATION **NORTHERN AND TUBES GROUP** STRUCTURAL AND ENGINEERING DIVISION

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ALL METALS UP TO 4in. DIAMETER — COPPER CALORIFIER TUBES A SPECIALITY

SHEET METAL WORK UP TO 10 S.W.G. — WELDING FOR THE TRADE

WORKERS IN COPPER, BRASS, ALUMINIUM, ALLOY, STAINLESS STEEL and MILD STEEL

KEW COPPER & SHEET METAL CO.

63 BIDEFORD AVENUE, PERIVALE, MIDDLESEX Tel. PERIVALE 9455

UNIVERSITY COURSES

Current Practice in Fuel Efficiency

The one week Annual Refresher Course for Managerial and Technical Staffs at Southampton University during the period 14 to 19 September 1969

Economics — Developments — Control Safety — Availability — Ancillaries and Training

Organised successfully for fifteen years by the National Industrial Fuel Efficiency Service, now with Portsmouth College of Technology supported by the Southern Regional Council for Further Education

Fees: Residential £35. Non-residential £25

Details from Dr. M. E. Horsley,
Department of Mechanical Engineering,
Portsmouth College of Technology,
Anglesea Road, Portsmouth, PO1 2EG
Portsmouth 21371 extn. 19 or Locksheath 2759

E8842 ED

SITUATIONS VACANT

EASTBOURNE HOSPITAL MANAGEMENT COMMITTEE
APPOINTMENT OF GROUP ENGINEER

Applications are invited for the post of Group Engineer. Major hospital developments planned for the Group, including a new District General Hospital which is at present in the advanced planning stage. Major developments are being carried out at other hospitals in the Group under the direct responsibility of the Group Engineer. The Group comprises seven hospitals with a total of 723 beds.

The salary range is £1,650—£1,930 plus £100 special responsibility allowance.

Applicants must possess one of the following qualifications:—

(1) Higher National Certificate or Higher National Diploma in Mechanical Engineering with endorsements in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, if this was not taken as a subject of the course; or

(2) Higher National Certificate or Higher National Diploma in Electrical Engineering with endorsements in Industrial Organisation and Management and including (at S.III or O2 level, or with endorsement in) Applied Heat and Applied Mechanics, provided he has suitable practical experience in mechanical engineering.

Applications giving full particulars of qualifications and experience, and including the names and addresses of three referees, to be addressed to the undersigned by 28th July, from whom further details and job description can be obtained.

C. R. Dyte, Group Secretary,
Eastbourne Hospital Management Committee,
29, Bedfordwell Road,
Eastbourne.

LEWISHAM GROUP HOSPITAL MANAGEMENT COMMITTEE

DEPUTY GROUP ENGINEER required. This is a new post in a busy acute hospital group. Salary £1,635—£1,870 p.a. including London Weighting and special responsibility allowances. Applicants must be experienced in accordance with P.T.B. 191 (or an equivalent approved by the Department of Health). Job description and application form (returnable by 26th July) on request from Group Secretary, Lewisham Hospital, High Street, London, S.E.13.

WREXHAM, POWYS AND MAWDDACH H.M.C.

HOSPITAL ENGINEER

Responsible to the Group Engineer for the operation and maintenance of all engineering services at the Maelor General Hospital, Wrexham. (561 beds.)

Applicants must have completed an apprenticeship in Mechanical or Electrical Engineering and have acquired a thorough practical training as appropriate to the duties and responsibilities of the post. They should also have a sound knowledge of the efficient operation of steam boiler plants and a wide experience of mechanical or electrical services preferably in the Hospital Service.

Applicants must possess one of the following qualifications or an approved equivalent:—

Higher National Certificate or Diploma in Mechanical or Electrical Engineering with appropriate Endorsements

or

City and Guilds Mechanical Engineering Technician's Full Technological Certificate (Part III).

Salary scale £1,270—£1,500 plus special responsibilities allowance of £50 per annum

Application forms and further particulars from the Group Secretary, Wrexham, Powys and Mawddach Hospital Management Committee, Group Offices, Maelor General Hospital, Croesnewydd Road, Wrexham, to be returned not later than 16th July, 1969.

BRO MORGANNWG HOSPITAL MANAGEMENT COMMITTEE PARC HOSPITAL, BRIDGEND (1,132 BEDS)

HOSPITAL ENGINEER

Applications are invited for the above post. This appointment entails responsibility to the Group Engineer for the mechanical and electrical maintenance services at this large Psychiatric Hospital. Applicants must have completed an indentured apprenticeship in electrical or mechanical engineering or have otherwise acquired a thorough practical background as distinct from a purely craft training. They should be familiar with planned maintenance procedures and have a sound knowledge of boiler plant, mechanical and electrical equipment and wide experience in their maintenance and should possess one of the following qualifications or an equivalent qualification approved by the Ministry of Health:—

(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 O2 level) Applied Heat and Applied Mechanics provided they have suitable experience in Mechanical Engineering.

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

Experience in a large hospital or Group will be an advantage and consideration will also be given to applicants having a wide hospital experience but not possessing qualifications stipulated above.

Salary scale based on a pointage of 24½ or more points, i.e. £1,370 to £1,605 per annum plus £75 special responsibilities allowance. A house is available, if required, at a reasonable rental.

Application forms obtainable from the Group Secretary, Garthmor, Old Road, Neath, Glam.

PETERBOROUGH AND STAMFORD HOSPITAL MANAGEMENT COMMITTEE

Stamford and Rutland Hospital

HOSPITAL ENGINEER required, to be directly responsible to the Group Engineer for the maintenance of all engineering services at the following:

Stamford and Rutland Hospital, Stamford
St. George's Hospital, Stamford
Group Central Laundry, Stamford
Bourne Chest Hospital, Bourne
Bourne Butterfield Hospital, Bourne

Applicants must have acquired a thorough practical training appropriate to the responsibilities and duties of the post and must hold one of the following qualifications, or an approved equivalent:

1. Higher National Certificate or Higher National Diploma with endorsement in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, if this was not taken as a subject of the course.
2. Higher National Certificate or Higher National Diploma in Electrical Engineering, with endorsements in Industrial Organisation and Management and including (at S.III or O.2 level, or with endorsement in) Applied Heat and Applied Mechanics, provided he has suitable experience in Mechanical Engineering.
3. City and Guilds Mechanical Engineering Technicians Full Technological Certificate (Part III) which must include Plant Maintenance and Works Service.

National Health Service Whitley Council Conditions of Service; present salary scale £1,270 to £1,500 (up to 24 points), 6 to 10 units. Special responsibility allowance of £50 per annum will be paid.

Applications, stating age, qualifications and experience, together with the names of three referees, to be sent to the Group Secretary, Peterborough and Stamford Hospital Management Committee, Peterborough District Hospital, Thorpe Road, Peterborough.

HOSPITAL ENGINEER

COLINDALE HOSPITAL

COLINDALE AVENUE, N.W.9

HOSPITAL ENGINEER required to be responsible to the Group Engineer for the maintenance of the electrical and mechanical engineering service in three hospitals.

The successful candidate will be based at Colindale Hospital (246 beds) which at present is under development. A new oil-fired central boiler house is now being commissioned. Responsibility includes a new psychopathic unit and a powered limb research unit.

Experience in the running of Mechanical engineering services comparable to those of a modern hospital essential. Must hold or be studying for the Higher National Certificate or equivalent qualification.

Salary scale £1,270—£1,500 plus £90 London Weighting Allowance plus £25 R.A.

Three bedroomed house available at moderate rental.

The hospitals may be visited informally by contacting the Group Engineer (01-952 2381). Job description and application form available from Group Personnal Officer, Edgware General Hospital, Edgware, Middx.

SOUTH WESTERN REGIONAL HOSPITAL BOARD ENGINEERING TRAINING CENTRE FOR THE NATIONAL HEALTH SERVICE, EASTWOOD PARK, FALFIELD, GLOS.

A number of instructional staff are needed at this newly acquired residential Centre accommodating 60 trainees situated between Bristol and Gloucester. The Centre will provide short-term instruction in a wide range of hospital installation subjects for hospital staff, including design engineers, maintenance engineers and craftsmen in England, Wales and Scotland. Installation of hospital plant later will assist practical demonstrations.

For two posts applicants should be Chartered Engineers (salary scale £1,722—£2,415). Applicants with acceptable alternative qualifications will also be considered but on a lower scale. For the other posts candidates should preferably be qualified to H.N.C. standard (salary scale £1,596—£1,964). All applicants should have practical hospital or similar experience. National Health Service conditions of service will apply. Some housing accommodation is available.

Further details and application form, stating for which post, from the Secretary to the Board, 27, Tyndalls Park Road, Bristol BS8 1PJ.

Closing date for applications 23rd August, 1969.

PETERBOROUGH AND STAMFORD HOSPITAL MANAGEMENT COMMITTEE

Applications are invited for the post of ASSISTANT ENGINEER, Peterborough Hospitals. The post offers opportunities for gaining an all-round experience in hospital engineering and of participating in the commissioning and maintenance of new buildings.

A new Boiler House, Engineering Workshops, etc., was commissioned in 1962, and a new District Hospital of 340 beds in August, 1968. Work on a further extension of 127 beds will commence shortly. A new Maternity Hospital of 97 beds is now under construction, to be commissioned in June, 1970.

Candidates must have served a recognised engineering apprenticeship or had equivalent experience and hold the Ordinary National Certificate in engineering or other approved qualifications.

Salary scale £975 per annum, rising by annual increments to a maximum of £1,270 per annum. Candidates with suitable experience may start at a point higher in the salary scale than the minimum.

Applications, giving names of three persons to whom reference may be made, should be addressed to the Secretary, Peterborough and Stamford Hospital Management Committee, District Hospital, Thorpe Road, Peterborough.

WAKEFIELD HOSPITAL MANAGEMENT COMMITTEE

Applications are invited for the appointment of HOSPITAL ENGINEER at Pinderfields General Hospital (575 beds).

Applicants must have completed an apprenticeship in mechanical or electrical engineering and should possess one of the following qualifications or an equivalent qualification approved by the Department of Health and Social Security:—

(1) City and Guilds Mechanical Engineering Technicians Certificate (Part II) which must include Plant Maintenance and Works Service; or

(2) City and Guilds Certificate in Plant Engineering; or

(3) Ministry of Transport First Class Certificate of Competency if it includes an Ordinary National Diploma or Ordinary National Certificate.

Preference will be given to an Engineer with a primarily electrical background.

Salary scale £1,270 x £45(4) x £50 to £1,500 plus special responsibility allowance of £75 per annum.

Application forms from GROUP SECRETARY, Pinderfields General Hospital, Wakefield.

HOSPITAL ENGINEER

Applications are invited from suitably qualified engineers for the post of Hospital Engineer. The post offers considerable interest and responsibility.

The following qualifications are required: H.N.C. or H.N.D. in Mechanical or Electrical Engineering or City and Guilds Mechanical Engineering Technicians Full Technological Certificate (Part III) including Plant Maintenance and Works Service.

The salary, which includes responsibility allowance and London Weighting, starts at £1,370—£1,605 per annum plus £90 London Weighting plus special responsibility allowance.

Applicants with suitable experience but without the above qualifications may be considered, but with salary adjustment. Accommodation is available if required.

Apply, giving full details of experience and qualifications and names of two referees, to House Governor, St. George's Hospital, S.W.1 by 24th July, 1969.

HUDDERSFIELD HOSPITAL MANAGEMENT COMMITTEE
APPOINTMENT OF GROUP ENGINEER

Applications are invited for the post of GROUP ENGINEER.

Much development of a major nature has taken place in the Group, including the provision of a new District General Hospital of 528 beds and the complete redevelopment of an existing Hospital now providing 440 beds.

The salary range applicable to this post is £1,850 to £2,180 p.a. plus £150 special allowance for responsibility units.

Applicants must possess one of the following qualifications:—

(1) Higher National Certificate or Higher National Diploma in Mechanical Engineering with endorsements in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, if this was not taken as a subject of the course; or

(2) Higher National Certificate or Higher National Diploma in Electrical Engineering with endorsements in Industrial Organisation and Management and including (at S.III or O2 level, or with endorsement in) Applied Heat and Applied Mechanics, provided he has suitable practical experience in mechanical engineering.

Applications, giving full particulars and including the names and addresses of three referees, to be addressed to the undersigned to arrive as soon as possible after the appearance of this Notice.

H. J. JOHNSON, Group Secretary, Huddersfield Hospital Management Committee, St. Luke's Hospital, Crosland Moor, Huddersfield, HD4 5RH.

BOARD OF MANAGEMENT FOR THE BANFFSHIRE HOSPITALS
HOSPITAL ENGINEER

Applications are invited for the post of Hospital Engineer to Ladysbridge Hospital (Mental Deficiency), approximately 500 beds.

He will reside at the hospital in a house provided to rent. The successful applicant may be required to deputise for the Group Engineer. Applicants must have a thorough practical training in Mechanical Engineering and a sound knowledge of the principles and practice of the efficient operation of major steam boiler plants together with experience in electrical engineering. Candidates should have passed an examination in Engineering Technology and hold a first class Certificate of Competency in Marine Engineering (including Ordinary National Certificate) or an equivalent or higher qualification.

Salary £1,295 to £1,525. Whitley Council Terms and Conditions of Service.

Applications stating age, present post, qualifications and experience together with the names of two referees to be lodged with the Group Secretary, St. Catherines, Banff, not later than 11th August, 1969.

BROMLEY GROUP HOSPITAL MANAGEMENT COMMITTEE

ASSISTANT ENGINEER

ASSISTANT ENGINEER required for Group Engineer's Department. Must hold O.N.C. or O.N.D., have served an apprenticeship in mechanical or electrical engineering and have own transport. Post offers excellent training for young man wishing to progress to Hospital Engineer and Group Engineer. Duties involve plant efficiency tests, planned maintenance surveys, preparation of heating and lighting schemes. Day release plus Hospital Service training and courses with plant manufacturers arranged for suitable man.

Salary scale—£1,065 by eight increments to £1,360 a year including London Weighting, but an experienced man could start at £1,135 or higher if now a craftsman in the N.H.S.

Further particulars from and applications to: Group Engineer, "Bassetts'", Starts Hill Road, Farnborough, Kent. (Farn. 53333).

BOARD OF MANAGEMENT FOR DINGLETON HOSPITAL
Melrose, Roxburghshire
HOSPITAL ENGINEER

Applications are invited for the post of Hospital Engineer at Dingleton Hospital, which is a psychiatric hospital of 418 beds and run on therapeutic community lines.

Applicants must have completed an appreticeship in mechanical or electrical engineering or have otherwise acquired a thorough practical training appropriate to the duties and responsibilities of the post and possess one of the following qualifications:—

(i) City and Guilds Mechanical Engineering Technicians Certificate (Part II) which must include Plant Maintenance and Works Service; or

(ii) City and Guilds Certificate in Plant Engineering; or

(iii) Ministry of Transport 1st Class Certificate of Competency, if it includes an Ordinary National Diploma or Ordinary National Certificate.

Salary scale up to 24 points £1,270 rising to a maximum of £1,500 plus £25 special responsibility allowance.

Attractive 4-roomed cottage type house in pleasant surroundings available.

Applications, giving full particulars of age, details of training, experience, qualifications and the names and addresses of two referees of professional standing, should be sent to the Group Secretary and Treasurer within 10 days of this advertisement.

COLINDALE HOSPITAL, COLINDALE AVENUE, N.W.9.

ASSISTANT ENGINEER

This is an excellent opportunity for a young man, preferably with an O.N.C. in Engineering. He will be responsible to the Hospital Engineer for the operation and maintenance of Engineering Services which includes a new oil-fired central steam raising boiler house. Opportunities for day release for further study will be given.

Salary scale £975 p.a. rising by seven increments to £1,270 p.a. plus £90 London Weighting.

Applications to Group Personnel Officer, Edgware General Hospital, Edgware, Middx. Tel: 01-952 2381.

HOSPITAL ENGINEER

HIGHCROFT HOSPITAL, ERDINGTON, BIRMINGHAM, 23

1,175 PSYCHIATRIC BEDS

Applications are invited for the above post. Salary scale £1,370 rising to £1,605 per annum plus special responsibility allowance of £50. Extra duty allowance payable. First class opportunity for man with go-ahead ideas. Complete Works Department with all trades represented and adequate supervisory assistance. Applicants should have a wide experience in the maintenance of engineering and building services, and the control of men and materials. The successful applicant will be directly responsible to the Group Engineer.

Qualifications: H.N.D. or H.N.C. Electrical or Mechanical Engineering with endorsements in Organisation and Management and either Electro-Technology or Applied Heat and Mechanics; or equivalent qualifications approved by the Department of Health.

A rented house is available if required.

Applications within seven days, with names of two referees to: Group Secretary, North Birmingham & District Hospital Management Committee, Good Hope General Hospital, Sutton Coldfield, Warwickshire.

THE DAVID LEWIS EPILEPTIC COLONY

Warford, Nr. Alderley Edge, Cheshire, SK9 7UD

ASSISTANT HOSPITAL ENGINEER required, resident. Candidates must have served an engineering apprenticeship and should hold an Ordinary National Certificate in Mechanical Engineering. Some electrical experience required. It would be considered an advantage to have been employed in a hospital, or to have knowledge of the maintenance and operation of oil fired boilers. Whitley Council P.T.B. conditions of service and salary within the scale £975—£1,270 p.a. abated by £100 p.a. if the successful candidate does not hold the specified qualifications. Local Government Superannuation Scheme. N.H.S. Superannuation transferable. Temporary accommodation available until house available about September, both at a nominal rental.

Applications stating age, qualifications and experience, with names and addresses of three referees, should be forwarded to THE GROUP ENGINEER.

BIRMINGHAM REGIONAL HOSPITAL BOARD

ENGINEERS

The following vacancies have arisen in the Regional Engineer's Department due to promotion and retirements. The Board has a large programme of capital works rising to £10m a year. Candidates should have had considerable experience in the design of hospital engineering services.

DEPUTY REGIONAL ENGINEER
(£3,071 to £3,780) (ref E5)

To deputise for the Regional Engineer in all matters, to control the organisation of the Department and promote special projects as required.

ASSISTANT REGIONAL ENGINEER
(£2,730 to £3,255) (ref E6)

To develop the engineering planning policy in one of four Areas of the Board. To brief design engineers and direct engineering functions in project teams.

ASSISTANT REGIONAL ENGINEER
(£2,730 to £3,255) (ref E69)

To control a Research and Development Section and other special activities of the Regional Engineer's Department. A flair for directing investigations, preparing and interpreting statistical information is required.

Candidates must be Chartered Engineers and corporate members of the Institute of Civil or Mechanical or Electrical or Electronic and Radio Engineers.

Further details quoting appropriate reference number obtainable from Secretary, Regional Hospital Board, 146 Hagley Road, Birmingham 16, to whom application should be sent by 28th July 1969.

BIRMINGHAM REGIONAL HOSPITAL BOARD

MISCELLANEOUS

CIRCULATING PUMPS and Steam Turbines, Complete units, electric and steam, spares and service. TURNEY TURBINES Ltd., 67, Station Road, Harrow. Tel: 01-427 1355 and 01-427 3449.

Stethoscopes, Eartips, Headphones and Pillowphones—Supplies and Service. Workshops for the Disabled, Northern Road, Cosham, Portsmouth. Tel: Cosham 76533.