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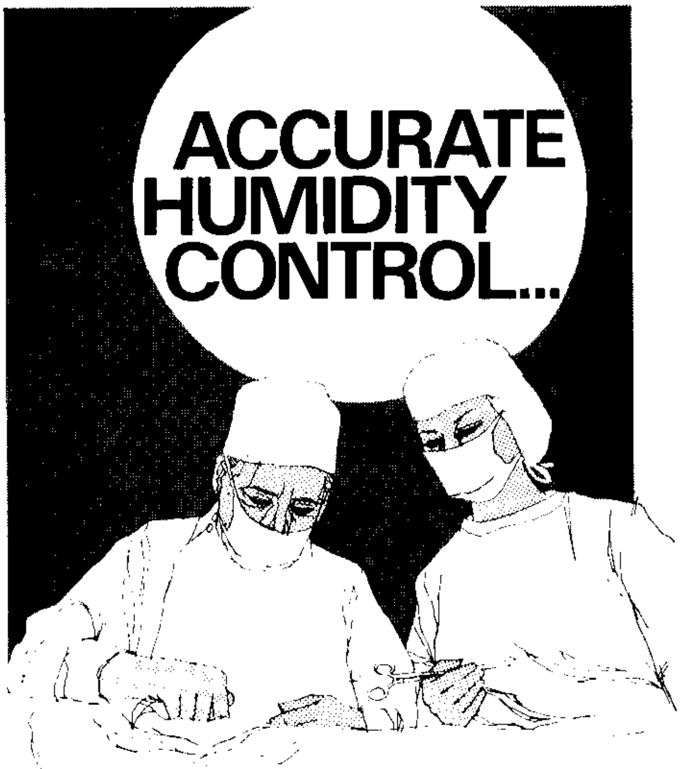

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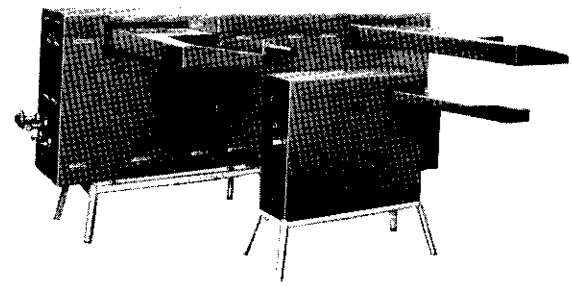

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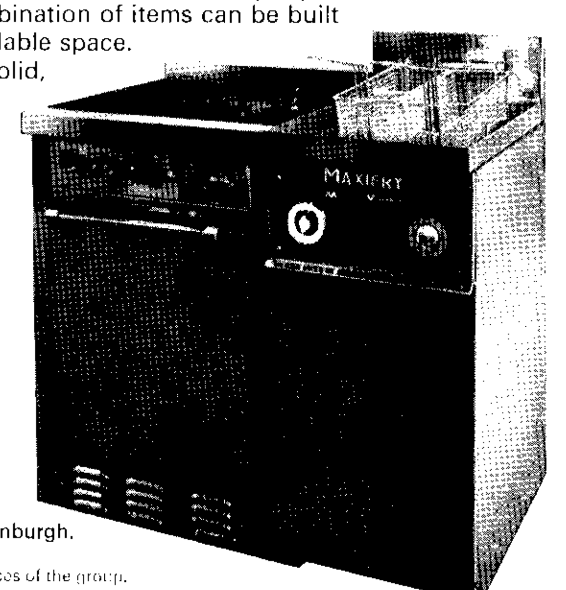

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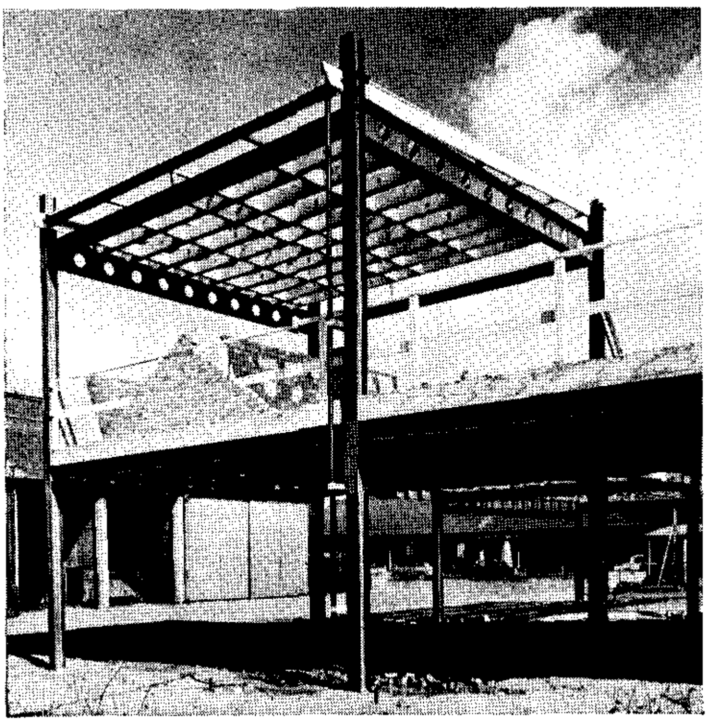

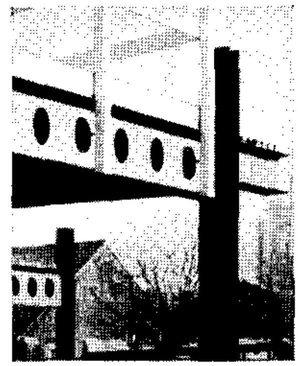

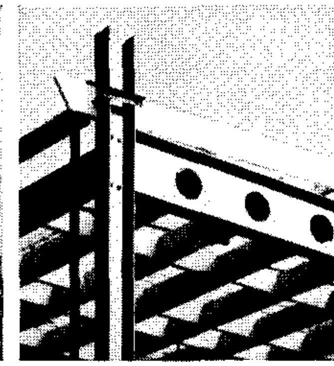

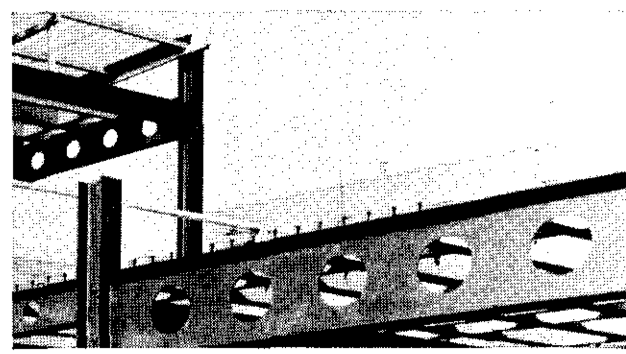

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The Diagnostic X-Ray Tube

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

Energy Conversion

The X-ray tube as an energy converter

ENERGY, defined as the capacity for doing work, exists in many forms and we have become very skilled in the art of converting one form of energy into another to suit our particular requirements. Energy conversion is now so commonplace that it frequently goes unnoticed, but if we look around us we cannot fail to appreciate how greatly our mode of life depends upon its use. Our own bodies, using fuel prepared from our food, can generate energy wherever and whenever it is required to maintain body temperature, to move and to work, either physically or mentally. We use the potential energy locked up in coal, oil, or gas, petrol and other fuels to obtain all the forms of energy we require. Some conversions are accomplished in a single step, for example, potential energy in fuel into heat; whilst for the more refined forms of energy, such as motion (kinetic energy), electricity, radio waves, visible light and X-rays, more stages are necessary. The form of energy which most lends itself to ease of conversion is electricity. It is, indeed, because of its extreme flexibility that electricity is in such great demand.

Efficiency of energy conversion

In any energy conversion process some "losses" take place. This does not mean that some of the energy ceases to exist, but only that it is converted into the wrong energy-form. As an example, let us consider the chain of energy conversions required to produce the light from a normal domestic 100 watt bulb. At the power station, coal is burnt in a furnace and heat energy is released. The heat is used to generate steam in a boiler and the steam drives a turbine. However, so much of the heat escapes in flue gases and into the air in the boiler room that the kinetic energy (energy of motion) delivered to the turbine shaft is only about 30% of the energy value of the fuel. The next change, from kinetic energy to electricity is, fortunately about 98% efficient, and the losses in the electricity distribution system are small enough to be ignored. Proceeding further, the efficiency conversion from electricity into light by an incandescent filament bulb is very poor. Of the 100 watts of electricity supplied to the lamp about 98 watts will be converted into heat and only 2 watts into light. When converting electrical energy into X-rays in a diagnostic tube the efficiency is even less; less than 1% of the energy supplied emerges in the form of X-rays. The remainder becomes heat, and this is one of the major factors influencing X-ray tube design and power rating.

The Nature of X-Rays

The electro-magnetic spectrum

X-rays belong to a family of energy forms known collectively as the electro-magnetic spectrum. This comprises, in descending order of wavelength, radio waves as used for broadcasting sound and vision, infrared rays (heat), visible light (red, orange, yellow, green, blue, indigo and violet), ultra-violet rays, X-rays, gamma rays from radioactive substances or very high-energy particle-accelerators, and cosmic rays from outer space. The most striking common property of all electro-magnetic waves is their ability to radiate, that is, to make their influence felt at a distance from the source, even when there is no medium between source and receiver, i.e. in a perfect vacuum. In this way they differ from sound waves, which require a compressible medium, such as air, in order to travel. Electro-magnetic waves travel in vacuum at a speed of appromixately 300 million (3×10^8) metres, of 186,000 miles, per second.

Radiation wavelengths

The various members of this family of energy-forms differ from each other in only one respect, namely wavelength. Each energy-form occupies a band of wavelengths and these bands, when taken in order of wavelength, comprise a continuous spectrum ranging from 10^{-11} centimetres (cosmic rays) to 10^{6} centimetres, X-rays occupying a band lying between 10^{-6} and 10^{-10} centimetres. The name given to any band of electro-magnetic waves is determined by its mode of generation, not by its wavelength. For example, radiation having a wavelength of 10^{-6} centimetres would be called respectively "ultra-violet rays" if produced by a UV tube and "X-rays" if produced by an X-ray tube. Since X-rays are so very short in wavelength, the unit of wavelength used to measure them is the Angstrom unit, which is equal to 10^{-8} centimetres.

The Mechanism of X-Ray Generation

How X-rays are generated

X-rays are generated when electrons, travelling at high speed, come into collision with any kind of matter, and an X-ray tube is simply a device designed in such a way that this process takes place as efficiently as possible. The requirements of medical X-ray diagnosis make particular demands upon an X-ray tube and thus strongly influence design and manufacture, but this aspect need not yet concern us. Let us first make sure that we understand the basic principles involved and the means by which they can be put into practice.

The basic X-ray tube

We require a source of electrons (or in other words, a cathode), some means of accelerating them to high speed and a target on the surface of which they can impinge, thus converting some of their kinetic energy into X-rays. The fact that heat will be the major result of this process is known to us, but we choose for the moment to ignore it.

The cathode (thermionic emission)

The most convenient method of obtaining a source of electrons is by the process of thermionic emission. This, as the term itself implies, is the ejection of electrons from a substance by the application of heat. Electrons, of course, constitute an essential part of the atoms of any element, but there is a class of element in which some of the electrons are rather loosely bound to the atoms. These are known as "free" electrons and (incidentally) their presence confers on the element a very useful property—that of being able to conduct electricity. Nearly all metals fall into this category, though some, e.g. silver and copper, have more free electrons and are therefore better conductors than others. When these metals are heated, sufficient energy may be given to their atoms to cause the free electrons to escape from the metal into the surrounding medium. This process has to take place in a good vacuum, or at least in the absence of oxygen, otherwise the metal would oxidise, or more simply, burn. The rate at which electrons are released from the metal depends upon three factors, namely the temperature, the area heated and the work-function. The work-function is a measure of the amount of energy required to cause electrons to escape from the substance and is characteristic of the substance itself. The emitting area is, of course, constant for a given cathode and, therefore, once the cathode is made, temperature is the only means whereby we can vary or control the number of electrons freed per second. Of all electron-emitting substances, tungsten has to date been found to be the most suitable for X-ray tube cathodes. One reason for this is that with tungsten the rate of emission does not rise too steeply with temperature and this is a valuable property when tube current is to be controlled almost entirely by the temperature of the cathode. Other reasons for choosing tungsten will emerge later. For the moment let it suffice that by sealing a tungsten wire or filament into a glass bulb and bringing out the ends so that the filament can be connected to a variable voltage supply we have provided ourselves with a variable source of electrons. If we pass only a small heating current through the filament very few electrons will be emitted, whereas, if we heat the filament to incandescence, as in an electric lamp bulb, copious electronic emission will take place and a cloud of electrons, or negative "space charge", will build up in the immediate vicinity of the cathode.

The anode

The next problem is to draw the electron cloud (space charge) away from the filament or cathode, accelerate the electrons to high speed, and so give them high kinetic energy. Since the electrons are negatively charged particles, the best way of doing this is to place inside our bulb a second electrode which, relative to our cathode, is at a high positive potential. We now have a two-electrode tube, i.e. a diode, the positive electrode being called the anode. Looking now at our third requirement, namely that the high speed electrons must be stopped as effectively as possible on arrival at the anode, let us consider our choice of material for this electrode.

The anode (physical considerations)

At this point we had better take a closer look at the physical problem of stopping missiles as minute as electrons. We have to realise that to anything as small as an electron (about 10^{-13}cm) there is no such thing as solid matter. All matter consists of atoms and atoms are almost entirely space. The most useful concept of the atom for our purposes is that propounded by the Physicist, Niels Bohr, in which the atom consists of a central, positively charged nucleus surrounded by orbital or planetary electrons. Elements differ from each other only in respect of the number of electrons orbiting each of their atomic nuclei, and this is numerically equal to the number of positive charges (protons) in the nucleus (known as the atomic number of the element). The atom, in its natural state, is, therefore, electrically neutral. Hydrogen, for example, is the simplest of the elements, having only one planetary electron. Its nucleus has one positive charge or proton and its atomic number is, therefore, 1; Helium has two electrons and a positive nuclear charge of 2—atomic number 2; Lithium 3, Beryllium 4, and so on. Elements exist having atomic numbers in the nineties and indeed, it is among the high atomic number elements that we have to look for our anode material. As stated previously, the atom is mainly space, this being true even when the atomic number is high. To assist perception here it is perhaps worthwhile to create an analogy. If a single atom could be enlarged to occupy the same space as St. Paul's Cathedral, an electron would be about the size of a tennis ball. Clearly, even if a hundred tennis balls were flying about St. Paul's, there would be a great deal of space left, and a tennis ball arriving from the outside at high speed (representing a cathode electron) would, in the vast majority of cases, pass right through without being at all influenced by the presence of those already there. Fortunately for us, in our efforts to generate X-rays, this is not the whole picture. We are dealing with tennis balls, but with negative charged electric particles and these do not need to *collide* with other electrons in order to have their energies converted into X-rays. It is sufficient if they enter an electric field of force and are, as a consequence, retarded or stopped. Such force fields exist within every atom, the mutual attraction between the positive nucleus and each (negative) planetary electron being precisely balanced by the centrifugal force due to the orbital speed (kinetic energy) of the electron.

"White" radiation

The atomic force fields of our anode material, then, constitute the net in which we have to snare our high-speed electrons from the cathode, and it is in this way that the continuous or "white" spectrum, in which we are primarily interested, is generated. This continuous spectrum extends from the short X-ray wavelength limit (determined by the maximum electron-accelerating voltage), right through the X-ray, ultra violet and visible light bands and into the infra-red (heat) region of the electromagnetic spectrum. The wavelength of the radiant energy produced by each cathode electron is determined by its kinetic energy and by the proportion of this energy given up in each reaction with the atomic force-fields of the anode material.

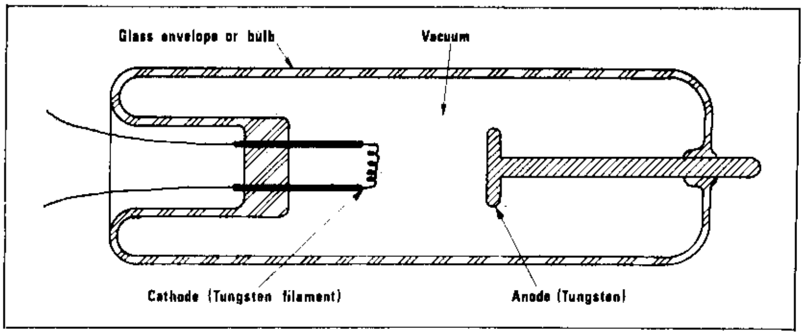
"Characteristic" radiation

Characteristic radiation is generated whenever a cathode electron collides with and dislodges an electron from one of the inner orbits of an atom of the anode. The resulting burst (quantum) of radiation is due to an electron from an outer orbit falling into the vacant space in the depleted inner orbit. The wavelength produced in this manner is "characteristic" of the anode material, and is independent (above a threshold value) of accelerating potential between anode and cathode.

The anode (physical requirements)

The above description of the true nature of so-called solid matter goes a long way towards explaining the very low efficiency with which electrical energy is converted into X-ray energy. One essential qualification for our anode material is, obviously, that it should possess a high atomic number. Further, we know that a great amount of heat is going to be generated and, therefore, such properties as high melting point and high refractory qualities are needed. We must also bear in mind that, ideally, the electrodes of the X-ray diode should be contained within a perfect vacuum. One reason for this has already been touched upon—the prevention of oxidation of the hot filament. There are, of course, other reasons. For example, the flow of electrons from cathode to anode would be seriously inhibited, or even prevented, if their transit were impeded by multiple collision with atoms of gas or vapour in the inter-electrode space. Further, if the vacuum were allowed to deteriorate too much, internal electrical breakdown would occur due to the so-called ionization of the gas by the high voltage. The process of ionization is one in which the negative charge of the atom is stripped away from the atom by the strong attraction of the positive anode leaving behind a positively charged remnant (or ion) which will be attracted to the negative cathode. Such a flow of electrons and ions is known as a gas discharge or gas current and is, in a high-vacuum X-ray tube, highly undesirable. Since there is no such thing as a perfect vacuum, some ionic bombardment of the cathode always takes place. The cathode material must, therefore, be capable of withstanding this, and here we have a further reason for choosing tungsten.

Fig. 1. A basic X-ray tube.



The materials we choose for our electrodes must, therefore, possess "good vacuum properties", that is to say, they must not degrade the vacuum by liberating vapour or gas, even when they are operating at their maximum working temperatures. This can only be ensured by choosing materials which have low vapour pressures, even at elevated temperatures, and can, furthermore, be most rigorously degassed, under vacuum at very high temperatures, both before being sealed into the tube and during the evacuation of the tube itself.

The material which possesses the best combination of all of these properties is, once again, tungsten, and having decided this, we now know the fundamental requirements of a simple X-ray tube (see Fig. 1).

There is a vast difference between our rudimentary tube for producing X-rays and the highly specialised tube designed as a tool for medical diagnostic radiology, but the underlying principles are the same. Having established these fundamental requirements a study of the behaviour of a simple vacuum diode will assist in understanding the difference between, on the one hand, a diode for the generation of X-rays and, on the other, a diode for rectification purposes.

Characteristics of the Diode

Experimental procedure

As we already know, the rate of liberation of electrons from a heated wire or filament depends upon the temperature to which the wire is heated, and ultimately, on the value of the heating current passing through the filament. This heating current is in turn dependent upon the voltage applied across the ends of the filament.

If we connect a vacuum diode into a test circuit, as shown in Fig. 2, we can carry out a simple experiment to show the behaviour of the device, i.e., to establish its characteristics. In the diagram (Fig. 2) the 2,000 volt battery (1) has a variable resistor R_1 connected across its terminals and by this means a variable, unidirectional voltage can be applied to the anode (A) of the diode. The other (negative) end of the battery is connected directly to point (B) on the diode, i.e. to the cathode. Thus, by varying the position of the slider of the potentiometer R^1 (denoted by the arrow in the diagram) the degree by which the diode anode is positive with respect to the diode cathode, i.e. the voltage measured by the voltmeter V_a, may be varied.

Similarly, by varying the position of the slider of R_2, the voltage applied across the ends of the diode filament (points B & C) and consequently the filament heating current measured by the current meter I_f can be varied.

The current meter I_a measures any current which may flow through the diode as a consequence of the voltages applied to it. The test will comprise setting the filament heating current I_f to a certain value and then varying the anode voltage V_a between zero and maximum (2,000 volts) in 200 volt steps, noting the anode current I_a at each step.

When I_f is zero, i.e., when the cathode is cold, the anode current is also zero (see Table 1).

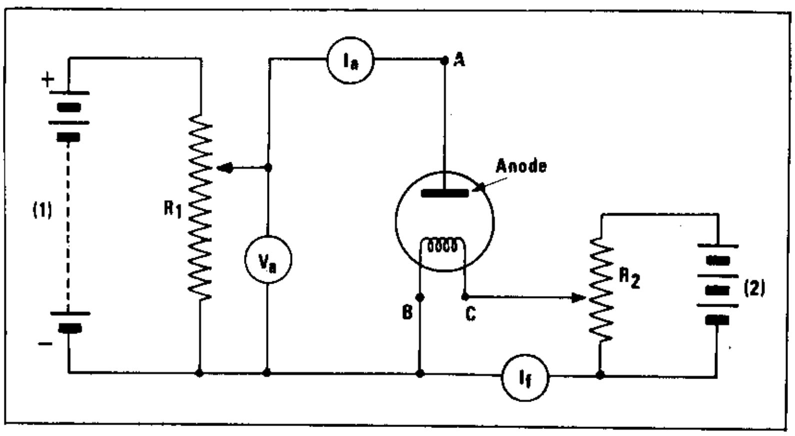


Fig. 2. The diode test circuit.

TABLE 1
$I_f = 0$

V_a	0	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
I_a	0	0	0	0	0	0	0	0	0	0	0

This shows that, even when the anode is 2,000 volts positive with respect to cathode, no anode current flows. This is to be expected, for anode current implies electron-flow between cathode and anode, and with the cathode cold, no thermionic emission takes place, and therefore, no electrons are available to be attracted to the anode no matter how high the positive potential.

Let us now return the slider of R_1 to its minimum position so that once again no potential difference exists between the anode and cathode of the diode, and let us adjust R_2 until a heating current of, for example, 8 amperes flows through the diode filament. The filament now becomes incandescent and we expect to find that free electrons are being liberated from its surface, i.e. that thermionic emission is taking place. This is immediately confirmed when, on adjusting R_1 to give a positive anode potential of 200 volts, the current meter I_a registers, not zero as before, but 33mA. On continuing, as before, to increase the anode voltage in 200 volt steps to 2,000 volts, anode current readings like those given in Table 2 are obtained.

TABLE 2
$I_f = 8{\cdot}0$ amps

V_a	0	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
I_a	0	33	105	177	248	320	392	448	480	497	500

On repeating this whole procedure with a filament current setting of 8·5 amps, yet another set of emission readings is obtained (see Table 3) and we would expect that at, for example, a filament heating current of 9 amps, a very much greater emission still would result. This is true, but we may find that our filament has a very short life at such high values of I_f and that the highest practical value on a continuous basis is 8·5 amps if a reasonable filament life is to be expected.

TABLE 3
$I_f = 8{\cdot}5$ amps

V_a	0	200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
I_a	0	45	160	310	461	612	762	881	948	985	1,000

It is of interest to note at this point that the mechanism by which a filament becomes discontinuous in a vacuum (neglecting mechanical shock and severe overheating) is by progressive thinning due to evaporation of the filament material. It is not normally correct, although this is frequently done, to refer to such an event as a "burn-out", for "burning" can only take place in the presence of oxygen.

Returning then to the tabulated results of our tests, let us plot the readings on linear graph paper in order to obtain a clear picture of what is going on.

If we do this (see Fig. 3) our first table gives a horizontal line on the X axis of the graph, showing that no anode current flows at any anode voltage between 0 and 2,000 volts.

Our second and third tables are much more interesting, showing that the relationship between the anode current and the anode voltage of a diode is not quite so simple as the tables may have led us to believe. These two curves, corresponding to I_f values of 8·0 and 8·5 amps, though very different in height and slope have, nevertheless, a typical or "characteristic" shape, and indeed, were we to do the same experiment with another intermediate value of I_f, e.g. 7·5 or 8·2 amps, we would obtain curves again different in height and slope, but similar in overall shape.

Explanation of the characteristic curves

We must now take a closer look at this characteristic shape and try to explain it.

It will immediately be observed that each curve divides itself naturally into three parts, a lower bend represented by OA on the $I_f = 8{\cdot}5$ plot, a relatively straight or linear portion AB and an upper bend BC.

Since the steepness of the characteristic is a measure of the influence of the anode it follows that this electrode is at its most effective between points A and B. Elsewhere, i.e. at OA and BC, some factors are at work to make it more difficult for anode to attract electrons. These various portions of the characteristic are explained as follows.

(1) **Region 0 to A.** When an electron is emitted from the filament the atom from which it came is left with a net positive charge until either the emitted electron returns or another electron arrives to restore the atom to its natural, electrically neutral, state. Furthermore, electrons freed from the cathode, being all negatively charged particles, mutually repel each other. Both of these factors cause the attractive influence of the anode to be resisted to some extent and give rise to a tendency for an electronic cloud or "space charge" to build up in the immediate vicinity of the cathode.

(2) **Region A to B.** When the anode potential is raised beyond point A, (400 volts in our example) the anode influence is sufficiently strong partially to overcome the space charge effect and electrons are much more easily drawn from the cathode cloud, the cloud being replenished, without difficulty, by further emission from the filament.

This state of affairs continues, the space current of electrons increasing proportionately with increased anode voltage until point B is reached,

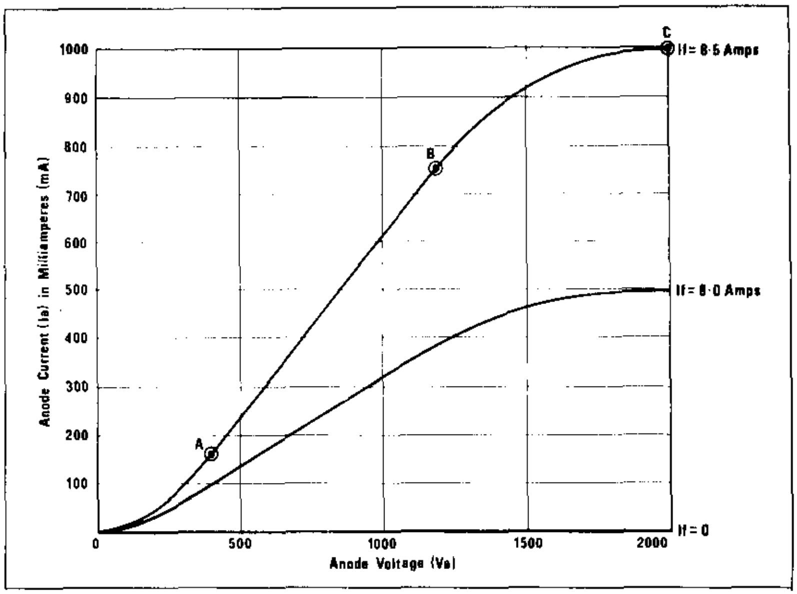


Fig. 3. The anode characteristics of a diode.

1,180 volts in our example. It is known as the "unsaturated" state of the diode, and is the condition in which a diode operates when working as a *rectifying valve*.

(3) **Region B to C.** After point B electrons are being drawn to the anode from the space charge at a higher rate than the cathode can replace them. The deficit is made up by the "pool" of electrons in the space charge which, consequently, diminishes. This continues progressively, the anode finding it increasingly difficult to obtain the electrons it requires until at point C the space charge is exhausted. The anode can now only obtain electrons at the rate at which they are being emitted by the cathode. Under these conditions the diode is said to be "saturated", the current at point C (1,000mA in the example) being the saturation current at that particular filament temperature.

The only effect of increasing the anode voltage beyond point C is to increase the *speed* or kinetic energy achieved by the electrons in crossing the gap. If we greatly increase the anode voltage, heat, light and *X-rays* are generated at the anode.

From this rather detailed study two most important facts have emerged:

(*a*) A rectifying valve is a diode operating in the *unsaturated* region of its characteristic.

(*b*) An X-ray tube is a diode operating in the *saturated* region of its characteristic.

The X-Ray Tube as a Tool for Diagnostic Radiology

Radiographic factors

Having dealt with the fundamentals we can now consider the specific requirements of medical diagnostic radiology and the means whereby the special features dictated by these needs are realised in a practical X-ray tube. The main problem we encounter will, of course, be the safe dissipation of the large amounts of heat generated as an unwanted by-product of the process of X-ray generation.

In diagnostic radiology we require a beam of X-rays, the penetrating power, intensity and duration of which are all independently controllable and capable of accurate preselection. The "radiographic factors" governing these variables are, of course, the voltage applied between the anode and cathode of the tube (kVp), the space current flowing between these electrodes (mA) and the time for which the current flows (seconds).

Since for a given kVp value the degree of exposure (or film blackening) is governed by the product of current and exposure time, it is customary to describe an exposure simply in terms of kVp and mAs.

The penetrating power of a beam depends upon the proportion of short wavelength X-rays present. This is determined by the ratio of fast to slower electrons in the space current i.e. ultimately, by the peak value and waveform of the applied high voltage and the emission characteristic of the tube.

We can, therefore, vary our penetrating power by operating the tube at different values of kV.

Half-value layer

The penetrating power of a beam can be conveniently expressed in terms of the thickness of an absorbing substance e.g. aluminium or copper which, when traversed by the beam, will reduce its intensity to half that of the unfiltered intensity. This is known as the "half-value-layer" of the beam.

As we learnt when studying thermionic emission, the current passing in a saturated diode is dependent entirely ourselves is "what will be the cross-sectional dimensions of the axial electron beam which, falling on a target angled at 14° with respect to the central ray, will generate a focus which, when viewed from the centre of the field, appears as a 2mm×2mm square?" For the answer we must refer to Fig. 4, thinking, for the moment only, of the target as a plane mirror. It is obvious by inspection that an electron beam of cross-section A impinging on a 14° target would give us our desired effective focus of 2mm×2mm as shown at C, and that the area bombarded, i.e. the *actual* focus, will be that depicted by the rectangle B. We must, however, now compute the actual dimensions of these two rectangles A and B, for A tells us how to design our cathode and B is the first criterion of the power rating of the tube. Of course, only the lengths of the rectangles change, the widths being equal to one side of the square effective focus C, i.e. 2mm. The length of rectangle $A = \frac{2}{\tan 14°}$ i.e. 8·03mm. The electron beam from the cathode must then have a rectangular cross-section of 8·03×2mm.

The area bombarded on the target face, i.e. the *actual* focus, corresponds to rectangle B, the length of which is $\frac{2}{\text{sine } 14°}$ i.e. 8·26mm.

Target angle and "anode heel" effect

At first sight then, a target angle of 14° is very favourable, giving an actual focus for heat dissipation of 8·26×2mm and an effective focus, for image sharpness, of 2×2mm—a "thermal advantage" of approximately 4—1. However, as intimated above, if we cut the target angle right down to that which would theoretically cover the desired field, we are making an incorrect assumption, namely that the X-ray intensity is uniform over the whole range of take-off angles. In fact, of course, X-rays are not generated *at* the "surface" of the target, but at varying depths *within* the target material. This means that radiation trying to emerge in a direction nearly parallel to the target face has to pass through much more of the target material (and is, therefore, much more severely attenuated) than that emerging at larger angles to the target face. For this reason the radiation intensity falls off very sharply at the anode-side margin of the field. This is known as the anode "heel" effect. Some allowance is made for this effect by increasing the target angle to 16° (approx.) for diagnostic tubes.

Cathode design

Having dealt in principle with the target of the tube, we should now turn our attention to the electron source or cathode. Here we meet the second compromise. Our tube is going to operate with very high voltages applied between anode and cathode, and there is a limit to the insulating properties of even the best vacuum we can produce. We can, of course, assist matters by rounding off the opposing corners of anode and cathode. Nevertheless, from the point of view of electrical security, the electrodes should be as far apart as possible. On the other hand, it is useless producing an anode which can stand high currents if, due to too large an anode-to-cathode distance (A C D), the anode influence on the electrons at source is too small to allow the current to be drawn. This is particularly important in the light of the fact that the highest currents are required at the lowest anode-to-cathode voltages. In practice anode-to-cathode distances vary approximately between 6 and 15mm, depending upon the maximum rated voltage of the tube.

The cathode design must be such as to produce an electron beam which, after traversing the cathode-to-anode gap, falls on a rectangular area measuring 8·26×2·0mm, orientated correctly with respect to the angled face of the anode. It must further be capable of accurate adjustment to deliver any current between a fraction of a milliamp and several hundred milliamps at a variety of anode-to-cathode voltages.

The metal used as the electron emitter in an X-ray tube is tungsten, which in addition to its high melting point and good general vacuum characteristics, has the following properties which render it a particularly suitable material for this purpose:

(*a*) Tungsten is not easily damaged by the high speed positive ions which, even in the best vacuum practicable, constantly bombard the cathode of any high voltage tube.

(*b*) Tungsten has a relatively low temperature exponent of emission. This simply means that the emission increases only fairly gradually with temperature, and that consequently, filament heating current values corresponding to various levels of space current are sufficiently different to allow accurate and reproducible pre-setting of milliamp values to be accomplished.

The X-ray tube emitter, then, consists of a helix of tungsten wire which has been carefully annealed to

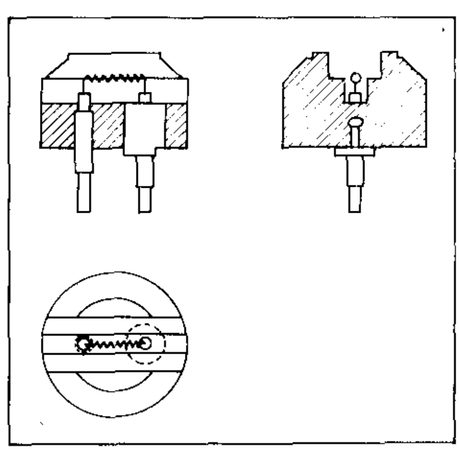


Fig. 5. The single-focus cathode.

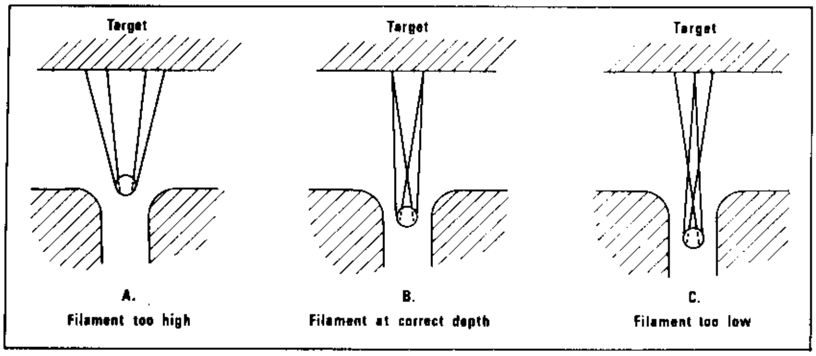


Fig. 6. The effect of filament depth setting.

ensure that no distortion takes place over its whole working temperature range. The length of the helix depends upon the major dimension of the rectangular cross-section of the electron beam required (rectangle A in Fig. 4).

The actual length of tungsten wire in the helix, together with the wire diameter, are chosen such as to provide the surface area to produce the required emission at temperatures consistent with adequate filament life.

The filament is set centrally in a slot in a solid metal block to which at one end it is connected electrically. The other end of the filament passes through an insulator in the cathode block. Such an arrangement, shown in Fig. 5, constitutes an electronic lens system, the focal length of which depends upon:

(*a*) The diameter of the filament helix.

(*b*) The width of the slot.

(*c*) The depth of the filament in the slot.

The effect of varying the depth of the filament in the slot is shown in Fig. 6.

At the design stage these critical dimensions are adjusted until a combination is reached which gives rise to sharp focusing of the electrons at the desired A C D on the required target area, coupled with adequate electronic emission from the cathode.

At the earliest possible stage in the manufacture of each tube the dimensions of its effective foci are measured to ensure that they fall within the specified limits. For this purpose a pinhole camera of known magnification factor is used. A radiographic exposure is made and this produces an image of the focus on a small dental film. The film is processed in a carefully controlled manner and the image is measured, using a magnifying lens.

The stationary anode X-ray tube

Fig. 7 shows a typical stationary anode diagnostic tube embodying the design-principles outlined above. The anode comprises the tungsten tablet, meeting the high atomic number and high melting-point requirements of an X-ray tube target, and the copper mass which provides the high thermal capacity, high specific heat, and higher thermal conductivity required efficiently to drain away the heat generated in the target. Cooling in a stationary anode tube is by *conduction* through the copper of the anode to the cooling medium (oil, water or air) outside the tube.

The stationary anode tube finds its particular application in therapy or industrial radiography, in both of which very long periods of continuous operation are involved. With a stationary anode the very high short time ratings demanded by medical radiography can only be realised by making the focus unacceptably large. Whilst it is true that some stationary anode tubes are still in use for diagnosis, they are restricted to small apparatus of very limited application, like dental radiography.

(*To be continued*)

The stationary anode X-ray tube

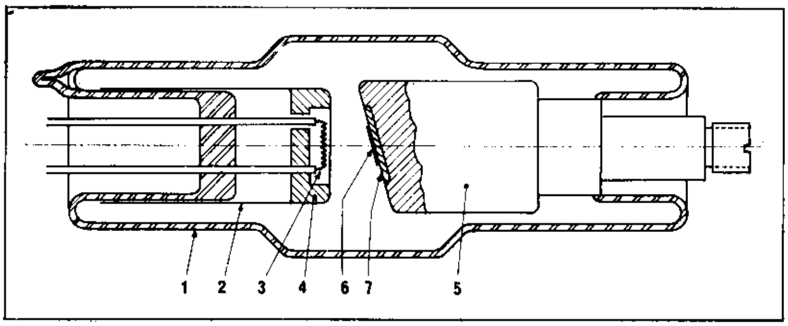


Fig. 7. A typical stationary anode X-ray tube. 1, bulb. 2, cathode. 3, filament. 4, cathode block. 5, anode. 6, focus. 7, target.

"New Town"

By L. A. BLACHE (Associate Member)

THE major problems which this country has had to face in the 20th century with regard to towns is the sudden growth of population and the subsequent increase in traffic. In the past, very little planning was done to allow for the future development of towns, thus Ribbon development and the 'back-to-backs' of many industrial areas occurred.

The approach required to this problem is that towns should be designed to house and supply work for a fixed number of people—to be, in fact, self-contained inasmuch as services and work are concerned and to rely on the surrounding farming areas as much as possible for food, thereby eliminating the necessity for commutation. The town should be designed for an approximate population of 500,000 with the future designed possibility of 1-2 millions, this being about as large as a town can become whilst still remaining efficient and retaining a high standard of living and economic comfort for the inhabitants.

The sites for such towns should be in areas which are non-productive from the farming point of view and yet close enough to be served by an agricultural district. A network of railways would be required, linking these towns, and also sea and airports, for transfer of raw materials and finished products, as well as for public use, although this would only consist of people travelling for pleasure or big business encounters.

Let us now turn to the town itself and its general layout which can be on a square or circular configuration. The centre of the town would, by necessity, house the Local Government offices, the specialised public services, such as the Courts of Law, large teaching hospital with resident specialists, Police and emergency services' headquarters. Also dealt with under Local Government is education, and the centre would include several colleges forming a university which would cater primarily for the town but could have graduates from other towns and countries. Accommodation facilities on university grounds would be included for the latter, the former continuing to live at home, thus solving the problem of 'digs'. For the public and trades points of view it would contain large luxury hotels for use by businessmen whilst visiting firms, the head offices of which would also be housed in the centre to facilitate trade encounters, also, of course, for visitors and tourists. Again, from the public point of view, the town would contain large stores, comparable to Harrods and John Lewis in London, which could not exist but for the market created by the whole population of a town.

Also in the town centre, entertainment would be catered for by a large theatre, cinema, opera house or ballet theatre, depending on the requirements and tastes of the town's population. Large churches of various denominations would also be located in the centre to serve the different religious amongst the inhabitants. Another possibility would be to have a multiple denominational church on the lines of the "Church of the Seven Doors" which houses seven religious denominations under one roof.

Moving out from the centre, there would be a belt of open area containing gardens and artificial lakes, playing fields and secondary schools. The open belt would be about a half mile wide and would very largely eliminate the housing congestion normally found around the centre of a town. It would also help to break up the town so that the occupants could enjoy open spaces without having to travel to the country to find them, thereby allowing for large storey blocks without the feeling of claustrophobia often encountered in such places as New York or Los Angeles. Due to the lakes and sports grounds, the population would have the possibilities of indulging in sports of their choice and outdoor activities which help to brighten a population and would also greatly help with another problem met in large towns; that of teenagers who have nothing to occupy their time. By having the schools built on this open belt, they are within easy reach of the playing fields and, also, not too far away from the residential districts which are in the next belt.

The residential belt is split up into districts, each of which is situated so that its occupants are close to their work if they are employed by the manufacturing and processing industries which are in the third belt and also close to the schools for their children. Included within these districts would be shopping areas on modern lines, placed so that a person can shop in any type of shop or store without having to travel far, since the shopping areas would be integral parts of the residential district buildings. The public services required by the residential district would also be included with it—i.e. the hospitals, public libraries, emergency services, swimming pools and recreational halls for the use of clubs and societies. Some churches would also be located here but would be smaller than in the town centre and would be of the predominating denomination in that particular area.

The housing in these districts would be of two main types, as far as accommodation goes, and two types in construction. The first type of construction would be on the lines of the 'Habitat' designed by Moshe Safdie which was used at the Expo 67 in Canada. These consist of pre-made units placed one on top of another, much as a pile of bricks would be built, but placed so that each unit has maximum privacy. These units may be of almost any size and combination of rooms desired so as to suit a wide variety of tastes and needs. Each also contains a small garden, somewhat like the roof gardens on certain large blocks of flats, each built on the roof of the unit below. As can be seen in the cutaway sketch and in the artist's impressions the services, shops, etc., required are built within this shell of units and form the support for them. Towards the base of the 'Pile', layers of garage space are available for the occupants. These are in the form of bays and incorporate servicing and repair facilities for the motorists. The stations of the public transport system would be within the 'Pile' for easy access to the population.

The two types of accommodation within the 'Pile' would be, firstly for families, consisting of at least two bedrooms, dining room, lounge, kitchen/breakfast room, bathroom and toilet and a small spare room for storing belongings or for use by the family for hobbies or pastimes; secondly, smaller bachelor flats consisting of bedroom, lounge, kitchen and bathroom. Heating in the units would be partly by electrical appliances and partly from a main central heating system in each 'Pile'. Included within each unit, normally in the lounge, would be an open fireplace in which smokeless fuel would be burned, as this is found to be psychologically beneficial. The chimney system would consist of several large common chimneys, serving a whole section of the 'Pile'.

Due to the size of the 'Piles' a very efficient disposal system would be required, both for sewage and for household waste. The household waste could be divided into two types, perishable and non-perishable. The latter would be disposed of by a chute, this waste being collected in the basement of the 'Piles' and transported to waste yards by trucks to be sorted and transferred to the usual disposal yards. Such as scrap metal is sent back to the metal manufacturers and broken glass to the bottle factories. The perishable waste would first be pulped by machine and then tipped into the sewage system which would be on the lines of present day sewage disposal in large blocks of flats, except that the pipes would be much larger in diameter to enable servicing teams to enter in the case of blockages. The waste would be taken from the 'Piles' to the sewage farms outside the city limits through large tunnels, which would also contain gas and water mains, power cables and telephone wires so that servicing and maintenance of these would be facilitated to obviate the

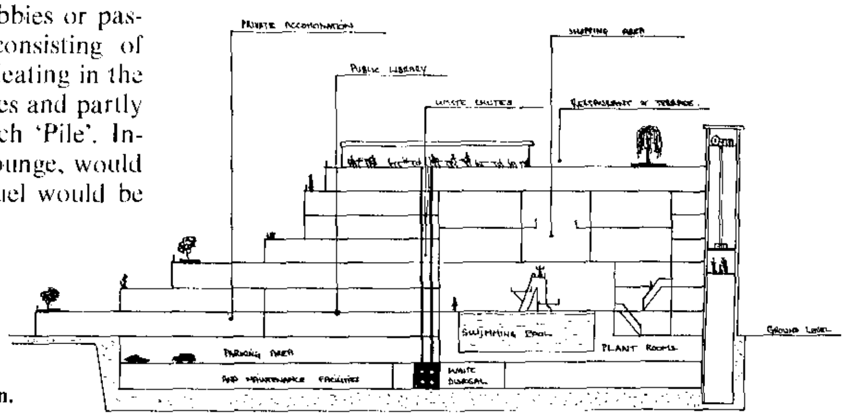


Fig. 1. Cutaway view of 'Pile' construction.

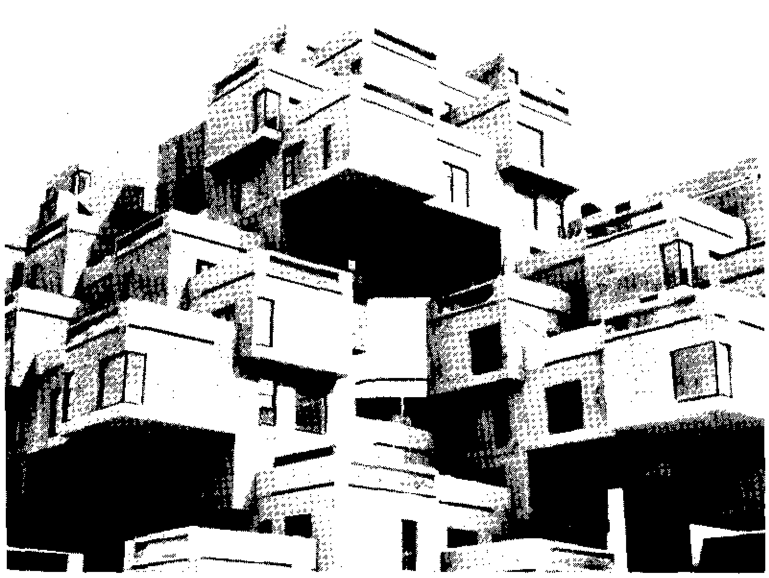


Fig. 2. The 'Habitat' type of construction designed by Moshe Safdie, and used in Canada at Expo 67.

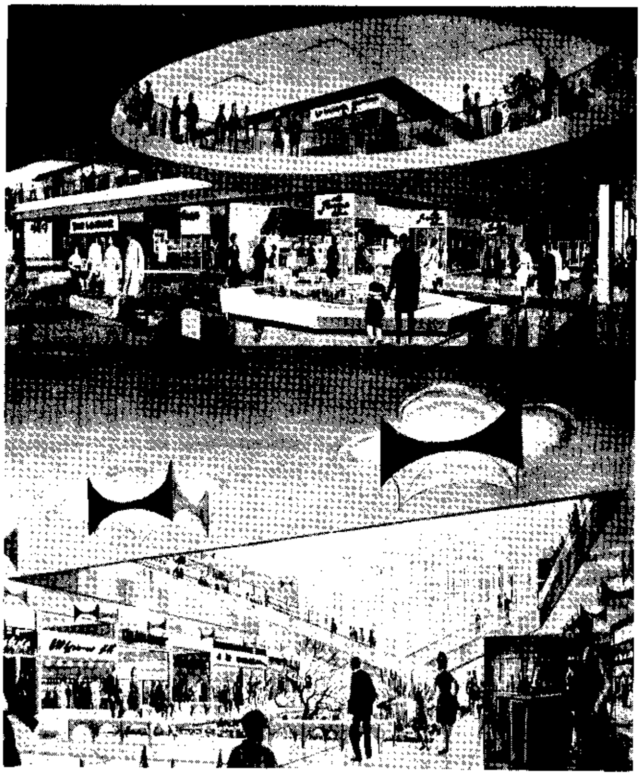


Fig. 3. Possible layouts for the 'Pile' Shopping Area.

usual inconvenience when large areas of roads are dug up for repair work to take place. Such a system may be seen in Paris where it has been in use for approximately 150 years. The water supply would come from one of a number of centralised works, which would supply several such towns. Gas would be handled in very much the same way and electricity would come off the National grid at sub-stations on the outskirts of the town. The tunnels could well continue under main roads linking towns, to ease the installation of extra or replacement facilities.

An attempt would be made so that people living and working within a 'Pile' would think of it as a village or unit, in order to develop some form of identity and to this end the 'Pile' would house approximately 3,000 people.

The second type of construction would consist of very much the same room layout as the first but would only have one bedroom and would be slightly smaller in dimension. This second type of construction would be on the lines of a Roman villa, and would house three elderly couples or invalids who could no longer cope with the way of life of the 'Pile' where most things are on different levels, requiring considerable movement. Food and supplies would be available from small shops, located amongst these 'Villa' constructions, and anything not available from these would be delivered by the firms concerned from the 'Pile' shopping areas. The 'Villa' buildings would be situated between the 'Piles' and the open belt to help further in keeping the town centre uncongested and to afford a pleasant view for the old people. Also built between the 'Piles' and the open area would be the infant and junior schools which have to be close enough to the 'Piles' to allow easy access by the parents who have to take their children to school and collect them each day, but far enough away from the 'Piles' to allow open space for the children. The waste disposal for the 'Villa' dwellings and the primary schools would be, as at present, by Council trucks, and sewage by the conventional system.

When the town was first built, the housing would belong to the Town Council and, when people came to live in these districts, they would purchase a unit by placing a deposit and then paying a monthly sum. Business premises, such as shops and offices, could either be bought outright, rented from the Council or purchased as for private units.

The next belt out of town would be for industry, and the firms would buy up land as required within the industrial area and also the rights to do business. They would then be given a free hand in design and construction, so long as the factories and works did not rise above four storeys, with the exception of chimneys and cooling towers, and that these be designed on aesthetic lines. The firms would also have to provide gardens around their buildings so as to keep the general pleasant layout of the town. There would also be stringent regulations concerning smoke and waste from the factories to ensure against the dirt and spoilt surroundings which many towns now endure, even though of recent construction. This could be achieved by making greater use of electric power, and fitting smoke filters where chimneys must be used. Unsightly things such as stockyards could be hidden by screens of trees or hedging which would also help to enhance the views in the industrial section. As in the 'Piles', the factories would have underground parking facilities for those employees who wish to travel by private transport, but the population would be encouraged to use public transport as much as possible to remove congestion. The factories or works, such as the steel industry, which are by necessity unsightly would be situated several miles out of any town and would have fast public transport communications with the town for personnel, and also efficient road and rail communication. As for these factories, such as the steel and gas works, screens of trees would be planted, as slag heaps are very unsightly and difficult to dispose of. Although this problem cannot be dealt with in this paper, one of the possible solutions to it is to dump the slag in the sea off the west coast to help with the sea defences as that coast is being eroded. In time it would be possible to start land reclamation by using slag of the furnace waste type as a base for sea walls and dykes.

This brings us on to what is probably the biggest 'headache' for the present day town planner and that is the problem of transport. We can best deal with

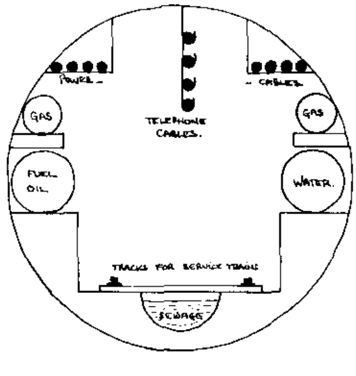


Fig. 4. Sectional view of service tunnel.

this, as with layout, by starting at the centre and dealing with each belt in turn.

The centre would consist of two levels; one for traffic and one for pedestrians which would be sealed off from each other, although arrangements would be made for Police and emergency service vehicles to travel in the traffic-free zone when necessary. The purpose of having roads entering the centre would be for deliveries to the large hotels and stores, hospitals and university and to allow access for ambulances to the main hospital and taxis and cars to the hotels and theatres. All vehicles entering the town centre would find parking space in whichever building they were visiting. A point which would require special attention would be to ensure that vehicles did not use the town centre streets as a short cut, although this could be dealt with by the layout of the approach roads and by making it less complicated and quicker to travel around the centre.

The open area would not have any roads at ground level but the wide concrete paths could again be used by the Police and emergency services and by council vehicles used for the upkeep of this belt and the buildings within it. The roads leading to the centre would pass through this belt but at a lower level, in cuttings, thereby keeping the traffic-free concept.

These cuttings would extend through the 'Villa' district of the residential belt, although certain arrangements would be made for slip roads which would be required for vehicles delivering stores from the shops to the elderly people. The roads at ground level would be used by private cars visiting people living in these districts. The cuttings would finally come up to ground level between the 'Piles' and the ground level roads forming rings around the town thus serving the residential belt and the industrial belt and then joining a system of fast highways between towns.

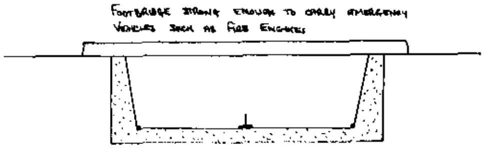


Fig. 5. Sectional view of traffic cutting.

Public transport for the town would be in two forms —a monorial system on the lines of the Linear-motor-powered Hover Monorail being experimented with at present and express coaches. The monorail system could be in the form of a clover leaf and two concentric circles so as to cover the town with maximum efficiency in both ease of travel from any one place to another and in the minimum of tracks. There would be a station in each of the 'Piles', at strategic points in the 'Villa' and open areas, and a main station in the centre. The clover leafs would also cover the industrial belt, stations being situated for the most efficient use of personnel.

The coaches would be used mainly for taking children to school, conveying old and invalided people and would travel mainly in the residential and open areas. From the pedestrian point of view, large direct and well made paths and suspended walk-ways would link the 'Piles' and other buildings in the residential areas and would cross the open area to the centre. These would be large enough to allow use by pedestrians and cyclists, whilst maintaining the safety of all who used them. A further means of transport would consist of taxis, although their number would be limited.

On the national scale of transport, there would be a network of roads and railways linking these towns with seaports, airports and to each other. The highways would terminate at a town by joining a ring road. The railway stations would be on the outskirts, beyond the factories, and would be linked to the town by the monorail system. Airports would be placed close to the sea, away from towns, so as to minimise nuisance due to take-off and landing noise and sonic booms.

In conclusion, I will list the main points to take into consideration with regard to a new town. The town is to be laid out in the form of concentric belts with as much open area as possible between them. To combat overcrowding and congestion, factories, offices and living accommodation are decentralised and the factories and living accommodation are grouped collectively in their own belts.

The living accommodation is of two types, the 'Piles' on the lines of Moshe Safdie's 'Habitat' design and triplicate bungalows on the lines of Roman villas. These are surrounded by parkland and gardens. Traffic would be kept separate from the pedestrians, the residential areas and the town centre by the use of different levels and cuttings.

These points of view have been thought of before but, between now and the end of the century, town problems such as accommodation and transport will have to be faced and towns such as that covered in this paper could solve the problem so long as the town planner and architects are not tied down and people are educated to move out from the large cities and form new, well-integrated societies.

Problems of Planned Maintenance

A Conference on the Problems of Planned Maintenance, sponsored by the King's Fund, was held at The Hospital Centre, London on January 8th.

The report of the proceedings, given below, is continued from our February and March issues and is herewith concluded.

CAPITAL AND MAINTENANCE — ECONOMIC COMPARISONS

by B. A. HERMON, C.Eng., F.I.Mech.E., M.I.H.V.E., M.I.Hosp.E., Deputy Regional Engineer, Birmingham Regional Hospital Board

The Whole Cost Concept

Design engineers have for many years been trained to take into account the effect that their solutions will have on the running costs of the finished project. Heating and ventilation engineers have for many years been conscious that the selection of the most economic fuel is important to his client and that these economics must take into account the cost of handling, stoking, ash clearing, cleaning and maintenance. They have insisted on all reasonable measures to conserve heat by insulation with a view to reducing costs. Electrical engineers have taken the same point of view towards lighting by trying to make the most of daylight factors by limiting deep planning and investing in the higher capital cost of fluorescent lighting in the knowledge that the running costs will be lower. There are many other decisions of this type which require the engineers continually to advise and, if necessary, criticise the architect's preliminary design in order to arrive at the most acceptable all-round economic solution.

This is the whole cost concept.

The Present Value Approach

The most satisfactory way of making these economic comparisons is to express all the calculations in some common form and to bring them to some common point in time. The best time datum is the present.

The "Present Value" (PV) approach provides the facility for expressing the capital costs to be incurred now and in the future and all annual maintenance costs in present value terms. These calculations take into account the compound interest that the money would have earned if it had been invested. This method can easily be adapted to allow consideration to be given to "Discount Cash Flow" (DCF) comparisons where financial events are changing significantly from year to year during the life of the project.

There is insufficient time at this conference to expand on these theories for those of you who are not already familiar with them because I want to show briefly how these considerations are linked with planned maintenance, but the system does permit a ready means of comparing solutions where the cost factors are of prime importance.

Component Life

One of the difficulties that the engineer is faced with is to forecast with any certainty the life of a component, yet the calculations for economic comparisons are dependent upon these forecasts. The quite rapid development of engineering components since the hospital building programme began has made this forecasting even more difficult. If the designer has to wait until a component has reached the end of its life before he is certain whether the choice has been wise, he may find that it is no longer being manufactured or he may have installed many more of them before he discovers that they will not give the length or standard of service expected of them.

Performance Data and Planned Maintenance

This problem can be eased if all components are regularly inspected and if any irregularities or failings are logged and reported back to the designer this is a facility which can be readily available when planned maintenance is adopted. I know that some engineers feel that the scheme described in HTM.13 does not in fact provide this facility but there is no reason why it should not be extended or modified to do so once the basic system is in operation.

Planned Maintenance and Extended Life

Whilst there seems to be plenty of evidence that regular planned maintenance will improve the service given by a component, it is not easy to prove that the extended life will be achieved with overall total economy. The design engineer must make his forecast on the assumption that the component will receive proper and regular attention.

The effect of Extended Life on Economic Costs

To demonstrate the effect of extended life on national hospital economics, one can estimate the capital replacement of the engineering components of the hospitals in the Birmingham Region which is usually about 1/10th of the national picture.

To make a correct assessment of capital value we should try to break the engineering content down into numerous components with varying life expectancies but for the purpose of this exercise assume an average life of 20 years and see what the effect would be if this average is extended to 22 years.

Estimated value of the capital replacement cost of the hospitals in the Birmingham Region:

22,000 acute beds x £8,000	=	£176m.
18,000 psychiatric beds x £5,000	=	£90m.
		£266m.

Assume the value of the engineering services are about 35%, say £100m. and assume that these services are being installed today, then:

PV of the replacement cost on a 20 year cycle in perpetuity at an interest rate of 7% p.a. would be £100m. x 0·35=£35m.

If the cycle is extended to 22 years the PV of the cost of replacement in perpetuity would be:

£100m. x 0·29=£29m.

The PV of the saving is £6m. or 6% of the capital cost.

Nationally the figure would be about £60m.

The cost of implementing Planned Maintenance

Many engineers have argued that they are unable to set up planned maintenance schemes because of shortage of staff which, in turn, is due to a shortage of finance. But what is the amount of finance in question?

Assume that all the HMC's in this country (about 350) were to appoint an additional assistant engineer for the next five years, the PV of their salary at an average of £2,000 p.a. including overheads, etc., would be:

350 x £2,000 x 4·1 = £3m. approx.

Experience is showing that the number of craftsmen/technicians required for planned maintenance varies from 1 to 3 per 100 beds depending upon the complexity of engineering services. Therefore for 500,000 beds we may require about 7,500 men. The number at present is around 5,000 men; therefore to carry out full planned maintenance using the frequencies recommended in HTM.13, we may need an additional 2,500 craftsmen.

The PV of their wages, insurances, etc. at say £1,500 p.a. in perpetuity would be:

2,500 x £1,500 x 14·3 = £54m. approx.

On these figures the present value of the extra cost is quite close to and less than the present value of the saving.

Obviously, a great deal more research would be necessary before such figures could be used to decide the future levels of staff but they do suggest that such research should be embarked upon.

Treasurers may well ask where the extra revenue of £4m. p.a. will come from to pay for the craftsmen, but this is only about 0·6% of the total revenue which exceeds £675m. p.a.

This other similar calculation poses the question whether the present system of financing building and engineering construction, operation and maintenance from separate capital and revenue pockets needs to be examined.

PLANNED MAINTENANCE — SOME OF THE PROBLEMS

Summary of points raised by:

K. J. EATWELL,
C.Eng., F.I.Mech.E., M.I.H.V.E., M.I.Hosp.E.,
Regional Engineer, South West Metropolitan RHB

1. Is planned maintenance necessary? Need and desirability usually accepted, but translation of this into a workable scheme is more difficult. "Spirit is willing but the flesh is weak."
2. Planned maintenance is not merely an engineering exercise, but concerns all disciplines from consultant to porter.
3. Assessment of basic norm of maintenance a very necessary procedure.
4. Should direct or contract labour be used?
5. Problems in integration of breakdown of planned maintenance.
6. Is planned maintenance necessary in new buildings?
7. Relationship of planned maintenance to commissioning.
8. In old buildings which must be kept in use, maintenance costs are often disproportionately high.
9. Effect of tight revenue budget. "A stitch in time saves nine".
10. Relationship between maintenance and running costs (electrical, gas, oil firing, etc.).
11. Recruitment and retention of suitable labour.
12. Training of suitable labour.
13. Effect of incentive bonus scheme on working of planned maintenance system.

DISCUSSION

Subsequent to the Papers the eighty or so audience, which comprised administrative and technical personnel from the Hospital Service together with representatives from industry, went into syndicate discussion, there being six syndicates for the purpose.

The main opinions expressed later by a spokesman for each syndicate are quoted below in note form.

Syndicate A. There was a lack of communication between design and maintenance staffs—the employment of main engineering staffs for a pre-handover period of, say, six months would be of great value—the issue of maintenance norms by the Ministry would greatly help—minor capital works should be deleted from maintenance budgets—a "flying squad" of experts should be available to help where necessary—semi-skilled labour could be used to better effect—staff should receive training—the turnover of staff was unlikely to alter but they should be more intelligently used.

Syndicate B. Direct labour was generally better but it should be supplemented by contract arrangements where suitable—the employment of specialist labour is expensive—a contractor was useful to cover statutory requirements and usually had facilities not available to direct labour but was less flexible, not familiar with hospital routine and breadth of coverage was sometimes difficult—could a contractor always provide a 24-hour service?

A contractor could well be used on a regular basis but too many disciplines, when it was not really their responsibility, dealt with contractors.

Suitable direct labour was not always available for minor capital works, nor were facilities when wanted.

Syndicate C. Suggested the use of more contract labour and advised that some specialist equipment should be maintained by R.H.B. teams—engineering problems should be better "sold" to other Service disciplines.

Syndicate D said that costs were high for the maintenance of so much old plant—planned maintenance must be con-

(Continued on page 120)

DOCTORS DIAGNOSE VENTILATION PROBLEMS

OPENING the window is not the best way to improve ventilation in a surgery, according to a group of Bolton general practitioners. This merely lets in cold air and causes uncomfortable draughts with the risk of patients catching a chill in winter.

The doctors report: "From our experience the most effective way of ventilating a surgery at any time of the year is to use an extractor fan, which supplies a constant draught-free change of air without discomfort to patients. It is also a considerable asset in hygiene control".

These were some of the points stressed by the doctors when asked to assess the performance of an installation of Xpelair fans, which have now been operating for more than a year at the Halliwell Health Centre in Bolton.

The centre, which provides individual furnished suites for seven general practitioners, is one of the first in Lancashire to accommodate private medical practice along with a wide range of local authority health services. It was opened by the Bolton Corporation in October, 1967.

Each suite, comprising a consulting room and an examination room, is equipped with a six inch Xpelair extractor fan with a capacity of 10,000 cu. ft. of air per hour. The full installation of fans—all GXC6 models—are mounted in the windows of the consulting rooms.

When not in use, a shutter on the fan prevents outside air from blowing into the surgery. Both shutter and fan switch are operated simultaneously by a single pull-cord.

The services at Halliwell include clinics for child welfare and schools, dental care, hearing assessment, chiropody, family planning, post-natal care and cervical cytology. Classes are also held in pre-natal relaxation and mothercraft.

NEW WING ADDED TO DUCHY HOUSE NURSING HOME

A NEW, two-storey wing has been built onto the Duchy House Nursing Home in Queens Road, Harrogate, at a cost of £77,000.

The new wing adds ten beds to the Home, bringing total patient accommodation up to 35. The new patients' rooms are on the first floor of the extension; the ground floor has been used to provide a new operating theatre suite and a diagnostic X-ray department.

The equipment for the X-ray department was supplied by Watson & Sons (Electro-Medical) Ltd.—a member of the GEC group of companies. The main items of equipment in the Duchy House include a Carlton tilting table and Autoptic image intensifier which will be used for fluoroscope techniques, and a Roentgen 8 3-phase generator and tubestand.

These latest improvements complete the transformation of the former small 20-bedded home into a modern 'mini-hospital', fully equipped to undertake major surgical operations.

The Duchy House Nursing Home was in danger of closing in 1959 on the retirement of the then owner, the late Dr. Sinclair Miller, but the premises were purchased, modernised and enlarged by Nuffield Nursing Homes Trust, a charity sponsored by BUPA.

Extensive modernisation, including the addition of a three-storey extension, was completed by the Trust in 1961, who made a grant of £57,000 towards the cost of the project, which totalled £107,000. The remainder came through a local appeal, which raised the sum required within four months.

Since it was formed in 1957, Nuffield Nursing Homes Trust has modernised or built from scratch 14 'mini-hospitals' throughout the country.

WORK BEGINS ON COMPUTER-LINKED HEALTH SCREENING CENTRE

WORK has now started on interior structural alterations and on the design and decoration of the £250,000 Cavendish Bio-Medical Centre, Britain's first independent health screening centre linked to computer, which is due to open in London early this summer. The Centre will occupy 10,000 square feet of a new building at 99, New Cavendish Street, London, W.1.

Contracts totalling £36,500 have been awarded to: Rodwell and Sons Ltd., of Camden Road, London, N.W.1, the main contractors; to Christy Brothers of Chelmsford, electrical contractors; to How-Kinnell Ltd., of Southwark Street, London, S.E.1, heating and ventilating contractors; to Cunic, of Buckingham Gate, London, S.W.1. (a subsidiary of the Cubitt Group), who are erecting partitioning, and to Insulatall of Holloway Road, London, N.1, for false ceilings to lower the original roof level throughout both floors which the Centre will occupy.

Phi Project Management Ltd., are retained as overall management and systems consultants. Architects to the Cavendish are Paul, Bath and Lowman of London. Electrical consultants are Power Engineering Associates Ltd., and Parsons Brown and Partners are retained as heating and ventilation consultants.

The Centre is designed so that patients will take approximately two hours to complete a series of 11 health screening examinations. The cost of the complete health check will be £21. Patients will move comfortably and smoothly from one testing room to the next. They will be examined in complete privacy and the findings of each test will be marked on the patient's personal computer card.

The Centre's computer will occupy a prominent position in a glass enclosure on the ground floor, close to the main entrance. Results from all the medical tests will be fed into the computer, processed and printed out in the form of reports for early despatch to the patients' doctors.

In addition, the Centre will incorporate an automated pathology laboratory, containing equipment worth £6,000, which will occupy approximately one-third of the first floor area. The laboratory will conduct over 20 tests on each blood sample, in addition to standard urine investigations. Included within the Centre will be a lounge area in which patients will be able to relax, make private telephone calls and complete a health questionnaire at leisure.

Within a year the Cavendish Board of Directors expect to see the opening of linked screening centres in the main provincial cities throughout the country. The first is likely to be in Manchester. Provincial centres will make use of the London computer by connecting into it through a G.P.O. telephone line.

The only existing centre comparable to the Cavendish is the Kaiser Permanente Centre in Oakland, California, which was visited by Cavendish Directors during the early planning stages of the Cavendish Bio-Medical Centre.

YORK WATER CHILLING EQUIPMENT FOR NEW VIENNA HOSPITAL

Climaco GmbH, of Vienna, have been awarded a contract to supply and install water chilling systems for the first construction stage of the Allgemeine Krankenhaus Hospital. When completed, in 1975, this new general hospital situated in the centre of the City, close to the University of Vienna which it will also serve, will be the largest in Austria with 2,500 beds.

The completed complex will comprise six major fully air conditioned building blocks. Three blocks have now been constructed and, to air condition this first stage, Climaco will deliver refrigeration equipment supplied by the York Division of Borg-Warner International, Zurich. It comprises two semi-hermetic single-stage RH Turbopak and two absorption water chilling systems.

The compressors are electrically driven and the absorption systems are powered by hot water. Total capacity of this first stage is approximately 8 million kcal per hour. Cooling capacity for the completed complex is expected to attain 25-30 million kcal per hour.

B.S.I. News

Metrication

The code letters printed on the right hand side of the titles of relevant standards have the following significance:

- M — Standards in which the requirements are specified only in metric units (in some instances, approximate imperial conversions are included).
- M+I — Standards in which the requirements are specified in both metric and inch units, so that either set of units can be used exclusively to meet those requirements.
- N — Standards which by their nature are independent of any system of units, e.g. colour codes and glossaries.

Standards not coded are still expressed in imperial units; they generally include approximate metric equivalents.

NEW BRITISH STANDARDS

BS 919:—Screw gauge limits and tolerances

919: Part 3: 1968 Gauges for ISO metric screw threads 36 pp 16s — M

Covers GO and NOT GO screw plugs, rings and callipers; check plugs for adjustable screw rings and callipers; check plugs and wear check plugs for solid screw ring gauges; GO and NOT GO plain plug, calliper and ring gauges. Describes and explains the uses of the various types of gauges, specifies tolerances and certain general design features and gives details of inspection procedures and the settlement of disputes. Supersedes references to gauges for metric threads in BS 919, Part 2. (SBN: 580 00384 1)

B.S. 4361: Woodworking machines

4361: Part 1: 1968 Components 6s

Gives dimensional and other requirements for different machine components, each shown in a separate section. (SBN: 580 00348 5)

4361: Part 2: 1968 Accuracy Tests 32pp 12s — M+I

Contains test charts showing tests for checking the geometrical accuracy of woodworking machine tools and gives guidance on the use of these charts. (SBN: 580 00356 6).

B.S. 4372: 1968 Engineers' steel measuring rules 16pp 8s — M

Recommends lengths and sections of steel rules and steel folding rules. Has clauses relating to material and finish, accuracy and marking. Shows typical examples of rules which comply and proposes simplified scales for use in the future. (SBN: 580 00371 X)

B.S. 4376: 1968 Electrically operated blood storage refrigerators 24pp 10s — M

Relates to all sizes of refrigerators, of both 'reach-in' (up to 2.5m³ gross internal volume) and 'walk-in' types (up to 25m³ gross internal volume) designed and equipped for the preservation of whole blood, fluid blood plasma and fractions, at a temperature of 4°C to 6°C for the use of hospitals and blood collecting centres in temperate and/or tropical climates. Requirements for construction, materials, equipment, controls and instruments and performance tests are given. (SBN: 580 00381 7)

SPECIAL ISSUE

B.S. PD 6031: 1968 Use of the metric system in the construction industry 20pp A4 size 7s 6d

Gives more detailed information and guidance than the first edition on the application of the metric system to various construction industry activities. Information relates to units of measure, metric notation, use of unit symbols, choice of multiples and sub-multiples of SI units, linear measurements on drawings and preferred scales. Tables of units for units for use in specific sectors of the industry are included as an appendix, together with conversion factors. (SBN: 580 00470 8)

INDUSTRIAL ELECTRICAL PLUGS AND SOCKETS

A new British Standard, B.S. 4343 *Industrial plugs, socket outlets and couplers for a.c. and d.c. supplies (metric units)* gives requirements and tests for these accessories, including the arrangement of contacts and dimensions essential for interchangeability of the accessories for the standard ratings, also the necessary gauges. The accessories are for single-phase and three-phase supplies with a voltage between phases not exceeding 750 V. and a frequency not exceeding 500 Hz, or for d.c. supplies, with a rated current up to 125 A, for use either indoors or outdoors in industry, agriculture, or in ships.

Accessories specified in B.S. 4343 are interchangeable with those conforming with Publication No. 17, second edition, of the International Commission on Rules for the Approval of Electrical Equipment (CEE), which is now being printed. A summary of the differences between B.S. 4343 and the CEE publication is given in an appendix.

Included in this standard are numerous tables of information, appendices on metric cable sizes and more than 80 pages on standard sheets and figures giving dimensioned drawings and data on the accessories, and the test apparatus is described.

B.S. 4343, price 40s.

On the Market

A review of new equipment and materials and their development

AUTOMATIC INSTRUMENT WASHING

The Helpex S.10 Automatic Washing Machine is one of the specially designed range of Acic Washers produced for hospital use distributed in the United Kingdom by **Sierex Ltd.,** 15/18 Clipstone Street, London, W1P 8AE.

This washing machine works on the principle of a rotating drum into which perforated baskets containing items to be washed are placed. Although the Helpex is called a "washing machine", it goes beyond the washing-rinsing cycle because it dries the instruments by centrifugal action and also by hot air.

The complete operation of washing, rinsing and drying is controlled by a punched card control system so that the entire washing cycle is completely automatic.

Tests have shown that heavily soiled instruments from the operating theatre including forceps with boxed joints and serrated teeth are thoroughly cleaned.

The time cycle for a complete washing operation for 45 lb. in weight (or all the instruments from 6 major operations) is seven minutes and the machine takes very little space (base measurement, approx. 42" wide x 32¼" deep) and needs to stand only 16" away from a wall.

"WELEX" STEEL PARTITIONING

To meet the increasing demand for flexibility in office lay-outs, **The Welconstruct Co. Ltd.,** of Camden House, Parade, Birmingham 1, are now producing a double range of their new "Welex" Executive Steel Partitioning. This has been designed to supplement their industrial partitioning.

The double range consists of standard partitioning 7' 9" high and barrier partitioning 5' high. Panels are made of 18G and 20G steel, with an entirely new interlocking device which provides a flush finish and a rigid structure without the use of mullions. Panels are stove enamelled grey or any other B.S. colour and doors are made of sapele veneered wood with mastered lock.

Glazing consists of one piece of glass held in position by rubber-strip; any types of glass can be supplied and fitted. Panels are infilled with 'Fibreglass' to provide sound resistance.

Accessories available, including sliding hatches, telephone shelves, ventilator units and roofing sections. Welconstruct provide services for advice, measuring, erecting and glazing in all parts of the U.K.

NEW CLEANING PAPER CUTS MAINTENANCE COSTS BY MORE THAN 60 PER CENT

A new cleaning paper for industrial use which offers considerable cost savings over rags and cotton waste has been introduced by **D.S.O. Supplies Ltd.,** of 14 Lillian Road, London, S.W.13.

Named "Paperag", it has a good wet absorbency and can be used in place of rags for removing grease, solvent, oil and water spillages in workshops, laboratories and kitchens, or for polishing tableware and cleaning work surfaces.

Unlike rags, there is no danger of cross infection with Paperag, since each piece is used only once and thrown away.

Paperag is available in 6,000 feet rolls of 10 in. wide paper, supplied in 2 roll packs at £6 15s. 0d. per packet. Special floor stands to house the paper are obtainable at £2 each and discounts are available for quantity purchases of Paperag rolls. One roll of Paperag is roughly equivalent to two hundredweight of rag or cotton waste.

TEMPERATURE MEASURING INSTRUMENTS

A range of low cost, high accuracy, electronic temperature measuring instruments covering a wide range of industrial applications, from checking refrigeration systems through balancing heating systems etc., is available from **Polkinghorne Industries Ltd.,** Lillyhall Industrial Estate, Winscales, Workington, Cumberland.

The Mini-T is produced in three basic models covering respectively −50 to 100°F; 100 to 250°F, and 250 to 400°F. and is suitable for liquid, gas and surface temperature measurements.

A range of low cost multi-channel temperature controllers are in the process of development to cover ultimately the three basic temperature ranges.

Outstanding features of the three basic measuring instruments include:

1. Accuracy ±2°F. (guaranteed) with linearity of 0·2%.
2. Time constant average five seconds.
3. Miniature thermistor sensor housed in a probe extendable to three feet.
4. Rugged and attractive construction in high impact polystyrene case.
5. Small handling size 3" x 2¾" x 2½".
6. Battery operation with zener and transistor regulation providing long term stability and extendable battery life.
7. Full compensation for ambient temperature variations.

NEW AIRLESS SPRAY OUTFIT

Of special interest to the maintenance painter is a new all-electric portable Airless spray outfit announced by **The DeVilbiss Company Ltd.,** Bournemouth.

Designated the QBE-60410, and to be known as the "Hustler", it supersedes the well known and widely used QBE-501 Electric Airless outfit.

The principle of operation involves a single phase electric motor coupled to an hydraulic motor, which in turn drives an hydraulic reciprocating paint pump. The latter is of heavy duty construction, runs well within its maximum rating, and delivers a full 40 fluid ounces per minute of material to the Airless spray gun at pressures up to 3,000 psi. The electric motor can be adapted to operate off 210-250 volts or 105-125 volts supply.

The Hustler is quiet running and therefore suitable for use indoors as well as outdoors. Its compact dimensions, low weight and large wheels enable it to be moved easily through doorways and up flights of stairs.

Servicing is facilitated by an access panel which when removed exposes the entire mechanism. An integral solvent reservoir makes cleaning up a quick and simple operation.

NEW CONSOLE UNIT FOR CONTINUOUS-FLOW GAS BLENDING AND CONTROL

A standardised console unit for gas blending has been introduced by **G. A. Platon Ltd.,** of Basingstoke. Called the 'Flostat MN Gas Blender', it provides for flow measurement, and automatic flow control to storage, of up to six constituent gases so that an accurate blend is achieved and maintained despite variable and intermittent demand. Variations in 'down-stream' gas pressures are automatically and accurately compensated for by self-acting, flow controllers. Solenoid valves with selector switches, in series with non-return valves for each gas and outlet manifold, complete the basic unit which, for a 4-way blender with 400 c.f.h. maximum output, now costs £200. Optional equipment includes: pressure switching and 'Floscan' flow alarms in component gas supply to cut the operation if required values are not maintained, output pressure regulator, etc.

Flow outputs are to a maximum of 400 c.f.h. or, alternatively, they can be increased to a maximum of 1,000 c.f.h. at a cost increase of no more than 25 per cent.

Apparatus for the production of accurate but widely variable mixtures of gases is in demand over the range of medicine, surgery, etc. 'Flostat' Gas Blenders are already in use, for example, in thoracic surgery and anaesthesia. The new Gas Blender will allow precise settings to blend as accurately as 10,000 : 1.

HIGH SPEED STEAM STERILIZERS WITH FIELDEN RECORDERS

A Fielden Bikini temperature recorder is used as standard in each of the Hi-Speed Slidelock range of sterilizers produced by **Manlove Alliott & Co. Ltd.,** the recorder being used to provide a continuous 6 hour temperature record, and to initiate a control signal for process advancement.

One of the important developments in the Slidelock range is the use of a number of pulses of steam interposed with evacuation to give more effective purging of residual air from porous loads such as dressings; air being evacuated before the first steam pulse is injected into the jacketed chamber under pressure. The final steam pulse is injected at a pressure of 32 p.s.i.g. to achieve the required sterilizing temperature and thus destroy bacteria and micro-organisms present in the load.

The recorder, produced at the Manchester works of Fielden Electronics Limited, monitors the temperature in the sealed chamber by means of a thermocouple temperature sensing element. The main condition that it watches for is the occurrence of a drop in temperature following the final steam pulse, as this signifies the presence of residual air in the load and thus the non-attainment of a sterile condition. Under such a condition, a 'fail' warning lamp is illuminated automatically.

The Bikini recorder is a compact instrument which fits into less than $\frac{1}{4}$ft.^{2} of panel space and yet provides a clear 6 hour recording on a 6 in. circular chart, with instantaneous indication shown on a 13 in. scale.

A robust servo motor drives the index and a simple quadrant connects with the recorder pen; there are no pivots and no galvo or mechanical chopper. The instrument is potentiometric in operation and is calibrated to an accuracy of better than 1 per cent.

NEW MULTI-PURPOSE PORTABLE DE-IONISER

The Permutit Company Ltd., Pemberton House, 632/652 London Road, Isleworth, Middlesex, announce the introduction of a new low cost, portable de-ioniser designed to provide a reliable source of purified water at a cost of only a few pence per gallon.

Known as the Mark 17, the new de-ioniser is a multi-purpose ion exchange unit of the cartridge type which produces a continuous supply of de-ionised water ranging from ultra pure to distilled quality at flow rates of up to 26 gal/h. Compact in size and of lightweight construction, the unit can be readily carried to any locality requiring a supply of purified water. It may be connected to the nearest convenient water tap by means of flexible hose and adapter. Applications in a wide variety of fields include de-ionised water for making-up solutions in path. labs; sterilizing; instrument and glass washing, etc.

The unit, which is housed in a neat fibreglass cabinet, incorporates a single polythene cartridge of the mixed bed type charged with "Zeo-Karb" 225 and "De-Acidite" ion exchange materials. A battery operated conductivity meter built into the unit checks the quality of the water and also indicates when the ion exchange resins are exhausted.

Cartridge removal and replacement is easily and quickly accomplished and is backed by a rapid cartridge exchange service operating on a nationwide basis.

The Mark 17 de-ioniser is supplied ready to use, complete with service cartridge, and is priced at £22 0s. 0d. Spare cartridges are priced at £8 0s. 0d. each and replacement cartridges are £1 10s. 0d. each. Overall weight of the unit is 18 lb.

REMOTE MONITORING UNIT

The Scientific Systems type 8014 transistorised Monitor Unit provides an accurate but inexpensive (under £15) method of monitoring a wide variety of parameters at a remote point, for indication, recording or control purposes. With suitable signal transducers the unit can monitor: Rotary or Linear Position, Liquid Level, Pressure, Temperature, Load, etc.

The compact instrument (approx. $6\frac{3}{4}$" x $4\frac{1}{4}$" x 3") operates from mains or battery supplies, and gives a 0-1 mA output proportional to the value of the parameter being measured, into any load up to 4,000 ohms.

A major feature of the unit is the wide adjustment range of the Scale and Zero controls, which eliminates the need for close matching of the transducer to the actual working range of values being monitored.

Further details from **Scientific Systems Ltd.,** Stover Trading Estate, Yate, Bristol BS17. 5PD.

H.E.M.S.—EUROPE'S MOST IMPORTANT HOSPITAL EXHIBITION

THIS YEAR British manufacturers are again demonstrating their regard for Europe's foremost Hospital Exhibition by filling the Grand Hall, Olympia, from the 2nd-6th June, 1969, for the 7th International Hospital Equipment, Medical Engineering and Services Exhibition. It is sponsored by the Institute of Hospital Administrators and "The Hospital".

This biennial Exhibition is a valuable opportunity for members of hospital staffs and others to view and discuss the complete ranges of equipment exhibited by manufacturers. An important two-way flow of information between manufacturers and relevant members of the medical profession raises the standards, quality and effectiveness of hospital equipment and ultimately the effectiveness of the whole medical profession.

Over 95 per cent of the exhibitors will be British and it is confidently expected to exceed the 1967 figure of more than 1,700 overseas visitors.

U.K. venue for worldwide Surgeons Congress

This year, for the first time in Britain, the European Federation Congress of the International College of Surgeons will be held at Olympia.

Founded in Geneva in 1935, the International College of Surgeons is the only world-wide organisation dedicated to the teaching and advancement of the science and art of surgery. Surgical Specialists from 64 member nations participate in a wide programme of Educational and Scientific advancement. The College is governed by an International Board of Governors, consisting of 140 members from every part of the world, and by an International Executive Council.

It is now hoped that a minimum of 400 members of the International College of Surgeons will be present during the course of the Exhibition. Registrations for enrolment as delegates have been received from the following countries:

United Kingdom	Spain	Poland
France	Italy	Australia
Germany	Czechoslovakia	Morocco
Switzerland	Dutch Antilles	The Dominican Republic
Holland	U.S.A.	
Belgium	Canada	Iran
Japan	Hong Kong	Finland

During the Congress, scientific meetings will be held, at which delegates will present papers on the major subjects of surgery. Among the eminent overseas surgeons delivering papers at the scientific meetings will be:—

Prof. P. Soler-Roig, Barcelona—Cancer of the Breast.

Prof. Max Sagessor, Berne—Carcinoma of the Thyroid.

Prof. Kuntscher, Vienna—Orthopaedics.

Prof. Louros, Athens—Obstetrics & Gynaecology.

Prof. Dr. Darget, Bordeaux—Urology.

Dr. Earl Conway Smith, U.S.A.—Obstetrics & Gynaecology.

The delegates to the Congress will also be taken on conducted tours, and exhibiting manufacturers will be invited to meet these members to arrange individual programmes.

Five other Conferences

During the Exhibition week, there will be conferences organised by the Hospital Caterers' Association, Guild of Public Pharmacists, National Association of Supplies Officers, Institute of Hospital Engineering and Institute of Hospital Building Supervisors.

The Exhibition fills over 250,000 square feet of space at Olympia and covers an enormous range of products and services from hospital furniture, through aids for spastics, to the latest equipment for bio-chemical analysis. Many of the products will be shown to the world for the first time and the H.E.M.S. will be used as one of the main springboards for product launching.

The 1969 Exhibition will be the most comprehensive yet attempted and should again prove a valuable contribution towards the care and recovery of sick people the world over.

Seven Ontario Companies at Olympia

Canada is making its first appearance at Olympia, 2nd-6th June, with a display of specialised equipment, reflecting the advanced technology and high treatment standards in Canadian hospitals and medical centres.

Seven companies from Ontario will form a group exhibit sponsored and organised by the Ontario Department of Trade and Development through their London Office.

(Continued from page 115)

Problems of Planned Maintenance

sidered with new plant from the beginning and an improved quality of staff was required—Regional Boards should make special grants for outstanding maintenance needs—Group Engineers should be allocated funds of which they have full control.

Syndicate E. Maintenance should be a separate item of costing and minor capital works should be deleted as a direct labour responsibility.

If two officers exist in a Group to manage engineering maintenance and building maintenance, they should co-operate without the need for a supervisor.

Syndicate F. There was a need to train staff in P.P.M. —the introduction of planned maintenance would result in an initial increase in work load and it should be brought in progressively, being started in the more critical areas—Regional Boards should bring in Group Engineers at an earlier stage in the construction of new hospitals and should help more with old hospitals—Regional Boards could help very much with financial guidance and more clerical assistance was needed.

Notes for Members

ANNUAL GENERAL MEETING

The Second Annual General Meeting of the Institute was held at the R.N.V.R. Club, London, W.1, on Monday, 21st April, 1969. Towards the conclusion of the meeting the retiring President, L. G. Northcroft, O.B.E., B.Sc., handed over to his successor G. A. Rooley, C.Eng., M.I.C.E., F.I.Mech.E. Mr. H. A. Adams, Chairman of Committees, expressed the warm gratitude of all Members to Mr. Northcroft for the unique contribution he had made during his two year term of office as the first President of the newly Incorporated Institute.

PRESIDENT OF THE INSTITUTE

Following his retirement from the office of President, Council agreed unanimously to elect Mr. L. G. Northcroft a Companion of the Institute.

THE COMMITTEE OF INQUIRY ON HOSPITAL BUILDING MAINTENANCE AND THE WORK OF BUILDING SUPERVISORS

As invited by the Committee, the Institute has now completed a Memorandum on this subject and this has been submitted to, and received by, the Committee of Inquiry.

It is intended that the contents of the Memorandum will be published in due course.

THE BENEVOLENT FUND

The Secretary of the Institute would be most grateful if any Member who has a copy of the rules of the Benevolent Fund of the previous Institution of Hospital Engineers would get in touch with him at 20 Landport Terrace, Southsea, Hampshire.

THE CONFERENCE OF THE INSTITUTE OF HOSPITAL ENGINEERING

The 26th Annual Conference will be held in the Gallery Conference Hall, Grand Hall, during the Exhibition.

The contributions being made by the Department of Health and Social Security are noted, with appreciation.

The Conference is arranged, primarily, for Members of the Institute of Hospital Engineering. There will not be a Registration Charge.

Visitors

Visitors from other societies and bodies, and from the Hospital Service, are welcome to attend any technical session of the Conference. There will be no admission fee. No tickets of admission will be required.

I.H.E. Conference Programme

Monday, 2nd June

2.15 p.m. OFFICIAL OPENING of the Conference 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.

2.30 p.m. 'The Role of the Engineer in the Hospital Service'

Speaker: A. S. MARRE, C.B., Second Permanent Under-Secretary of State, Department of Health and Social Security.

Chairman: G. A. ROOLEY, M.I.C.E., F.I.Mech.E. President, The Institute of Hospital Engineering.

Tuesday, 3rd June

10.30 a.m. 'Disposal of Hospital Waste'

Speaker: E. M. DAVIES, C.Eng., M.I.Mech.E., Deputy Regional Engineer, South West Metropolitan Regional Hospital Board.

Chairman: I. L. COOPER, M.I.P.C., Director of Cleansing, Westminster City Council.

2.30 p.m. 'Some Aspects of Medical Engineering'

Speaker: MALCOLM BROWN, B.Sc. (Eng.), Research Engineer, Department of Medical Electronics, The Royal Hospital of St. Bartholomew, London.

Chairman: L. G. NORTHCROFT, O.B.E., B.Sc., C.Eng., F.I.Mech.E., Immediate Past President, The Institute of Hospital Engineering.

Wednesday, 4th June

10.30 a.m. 'The Engineering Services of the New St. Thomas' Hospital'

Speaker: POUL HANSEN, M.Sc., M.Ing.F., Partner—Steensen, Varming Mulcahy & Partners.

Chairman: R. G. HODGE, C.Eng., M.I.Mech.E., A.M.I.H.V.E., Regional Engineer, North West Metropolitan Regional Hospital Board.

2.30 p.m. 'Engineering Aspects of the Best Buy Hospitals'

Speaker: B. R. JOSEPH, C.Eng., M.I.C.E., M.I.Mech.E., M.I.E.E., Department of Health and Social Security.

Chairman: K. J. EATWELL, C.Eng., F.I.Mech.E., M.I.H.V.E., Regional Engineer, South West Metropolitan Regional Hospital Board.

BRANCH OFFICERS

The elections of Branch Officers have resulted as follows:

EAST ANGLIA

Chairman: H. Holtz.
Hon. Secretary: R. G. Freestone, Group Engineer, Addenbrooke's Hospital, Trumpington Street, Cambridge.

EAST MIDLANDS

Chairman: G. Pidcock.
Vice-Chairman: G. Metcalfe.
Hon. Secretary: R. R. Blagborough, 70, Malton Road, North Hykeham, Lincoln.

GLASGOW AND WEST OF SCOTLAND

Chairman: D. M. Moir.
Vice-Chairman: J. Cadenhead.
Hon. Secretary: G. Doherty, 18, Dixon Road, Glasgow, S.2.
Hon. Treasurer: R. Urquhart.

LANCASHIRE

Chairman: D. H. Mellows.
Vice-Chairman: T. Dickinson.
Hon. Secretary: T. Hardacre, 21, Ormont Avenue, Cleveleys, Lancs.
Hon. Treasurer: E. Graham.

LONDON

Chairman: E. Peck.
Vice-Chairman: R. S. Adlington.
Hon. Secretary: W. A. Askew, 17, Bristol House, Southampton Row, London, W.C.1.
Hon. Treasurer: W. P. Lawrence.

MIDLANDS

Chairman: F. J. Williams.
Vice-Chairman: S. C. Stapley.
Hon. Secretary: H. R. Martin, 3, Churchill Road, Hasbury, Halesowen, Worcs.

MID-SCOTLAND

Chairman: W. Ewing.
Vice-Chairman: W. Runcie.
Hon. Secretary: A. R. Hunter, 9, Pitroddie Gardens, Dundee.

NORTH EAST

Chairman: G. C. Elliott.
Vice-Chairman: W. J. Richards.
Hon. Secretary: C. R. A. Meyer, 23, Green Acres, Kirkhill, Morpeth, Northumberland.
Hon. Assistant Secretary: E. Parker

SOUTHERN

Chairman: W. A. J. Whiffin.
Vice-Chairman: L. R. F. House.
Hon. Secretary: J. Finney, 73 Torrington Road, North End, Portsmouth.

SOUTH WEST

Chairman: J. Wallace.
Joint Hon. Secretaries: B. R. Eddolls, 24, Durville Road, Headley Park, Bristol, 3.
K. A. Sweet, 12, Forest Edge, Hanham, Bristol.

WALES

Chairman: H. F. H. Dolling.
Vice-Chairman: C. R. Davies.
Hon. Secretary: P. Jackson, 'Roundway', University Hospital of Wales, The Heath, Cardiff, CF4 4XT.
Hon. Treasurer: N. Coy.

YORKSHIRE

Chairman: J. Deen.
Vice-Chairman: J. C. Shelton.
Hon. Secretary: J. Black, 'Uplands', Storthes Hall Hospital, Kirkburton, Nr. Huddersfield.
Hon. Treasurer: A. Duffield.

LONDON BRANCH

A domestic meeting of the London Branch was held at Westminster Medical School, S.W.1, on Saturday, 22nd February.

The agenda included a discussion on items proposed for inclusion in the programme for 1969.

It was agreed to hold some of the Branch meetings on week-day evenings to cater for those Branch Members who were prevented, through one reason or another, from attending meetings held on a Saturday afternoon.

As will be seen from the lists of Branch Officers published in these columns, the Annual General Meeting of the London Branch saw a change in the office of Branch Hon. Secretary.

Mr. P. C. Vedast joined the London Branch in 1947. He joined the Branch Committee in 1952 and shortly afterwards assumed the office of Branch Hon. Secretary. He has just retired from this office, then, after a spell of service of nearly 17 years.

His contribution during that time, to the London Branch in particular and the Institute in general, cannot be measured in words. Those who know Mr. Vedast will know that his efforts will not cease with the giving up of office.

YORKSHIRE BRANCH

The Annual General Meeting of the Yorkshire Branch was held at High Royds Hospital, Menston, Nr. Ilkley on Saturday, 22nd March.

The Secretary of the Institute, Mr. J. E. Furness, attended, and spoke to the meeting on the progress and achievements of the Institute during 1968.

The retiring Branch Chairman, Mr. K. F. M. O'Rourke, thanked Branch Officers, Branch Committee and Members for the support they had given him during a year which had seen a programme of Papers of high standard.

Mr. O'Rourke's successor as Branch Chairman, Councillor J. Deen, spoke with enthusiasm and optimism for the future and said that he hoped to see a widening range of programme events with technical papers, too, covering a wider variety of subjects.

Mr. D. Goldthorpe, who had been Branch Hon. Secretary during the preceding year, is leaving Yorkshire for Scotland and he is succeeded by Mr. J. Black of Storthes Hall Hospital, Kirkburton, Nr. Huddersfield.

NORTHERN BRANCHES JOINT MEETING

A joint Meeting of the East Midlands, Lancashire, North Eastern and Yorkshire Branches was held at Middlewood Hospital, Sheffield on Saturday, 12th April, 1969, when W. C. Jeffries, C.Eng., F.I.Mech.E., M.I.H.V.E., M.I.Plant E., M.I.Hosp.E., Regional Engineer, Sheffield R.H.B., gave a talk to members entitled "The Engineer—Leader or Labourer". The subject matter was an introduction to the principles of management. The talk given by Mr. Jeffries was supported by slides and was of great interest to the large gathering of members from the branches. During the break for tea, members were joined by the Chairman of Sheffield No. 2 H.M.C., Alderman M. J. Sewell, A.I.P.S., J.P., and in a short address he said how important was the role of the Engineer—more than ever before—in our hospitals today, and how gratifying it was when so many gave up a Saturday afternoon and travelled considerable distances to hear a talk that was of common interest in their profession. The meeting was attended, also, by Mr. D. H. Mellows, Area Council Member for the Branches concerned.

FIRE PREVENTION CONFERENCE/ HOME SAFETY EXHIBITION

A Conference and Exhibition will be held at Leavesden Hospital, Abbots Langley, Watford on Monday and Tuesday, 11th/12th August, 1969.

The Exhibition, mounted in the main Conference hall, will be open from 9 a.m. to 9 p.m. There will be demonstrations of fire fighting appliances and tours of Hospital departments.

The Conference will comprise two lectures on the first day and one on the second, followed by a "Brains Trust" which will be Question session.

Further and fuller details will be announced later.

PURPOSE-MADE HOTCUPBOARD

Moorwood-Vulcan Ltd., of Sheffield (a member of the Brightside Group of companies) has received an order from Drake and Scull Engineering Company Ltd., for special purpose-made hospital ward hotcupboard units worth £7,500.

The hotcupboard units are to be installed at ward level and some of these incorporate water boilers and grills. The hotcupboard units will be installed at the New South Cheshire General Hospital.

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SITUATIONS VACANT

HOSPITAL ENGINEER

To be responsible to the Group Engineer for all engineering maintenance and co-ordinate building maintenance in Gulson and Whitley Hospitals, Coventry.

Salary £1,370 a year rising to £1,600 subject to qualification and experience.

Full details of the post and qualifications required will be sent on application to the Group Secretary, Coventry Hospital Management Committee, The Birches, Tamworth Road, Keresley, Coventry CV7 8JJ by 19th May, 1969.

WINCHESTER GROUP HOSPITAL MANAGEMENT COMMITTEE

HOSPITAL ENGINEER

Applications are invited for this new post in the sub-group comprising the Basing Road, Hackwood Road and the Shrubbery Maternity branches of the Basingstoke District Hospital. The first 150 beds of the District General Hospital (700 beds) open Autumn, 1969, and the successful candidate will be responsible to the Group Engineer for the engineering services in all these units, the commissioning of the new unit and the preparation and implementation of a planned maintenance programme.

Applicants should possess one of the following qualifications, or its approved equivalent, and have completed an apprenticeship in mechanical or electrical engineering or have otherwise acquired a thorough practical training appropriate to the post.

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

(ii) City and Guilds Certificate in Plant Engineering.

(iii) Ministry of Transport First Class Certificate of Competency if it includes an O.N.D. or O.N.C.

Salary £1,270-£1,500 (Unit allowance of £50 after opening of first phase of the District General Hospital. Possibility of accommodation).

Application forms from the Group Secretary, Royal Hampshire County Hospital, Winchester, to be returned as soon as possible. Previous applicants need not re-apply.

AIREDALE HOSPITAL MANAGEMENT COMMITTEE

DEPUTY GROUP ENGINEER required.

A new 650 bedded district general hospital will be completed in October 1969 and commissioned in 1970 and this post will provide excellent experience for an applicant interested in making a career in the hospital service.

The present salary scale for the post is £1,370 to £1,605 with a special responsibility allowance of £100, and applicants' qualifications etc. should comply with the following:—

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

Forms of application and job description obtainable from Group Secretary, Airedale Hospital Management Committee, St. John's Hospital, Fell Lane, Keighley, Yorkshire, to be returned as early as possible.

THE DAVID LEWIS EPILEPTIC COLONY

WARFORD, NEAR 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. Accommodation at nominal rent.

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

GREENWICH DISTRICT HOSPITAL

HOSPITAL ENGINEER

to be responsible, under the Group Engineer, for 460 bed hospital being replaced in phases by the new 800 bed District Hospital now being built, which is of advanced design, fully air-conditioned and incorporates large mechanical and electrical installations.

Applicants must have completed apprenticeship in mechanical and electrical engineering and hold one of the following:—

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

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

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

Salary £1,510 rising to £1,745 p.a. Furnished flat available at reasonable rent. Further information from Group Engineer at Hospital. Apply giving details of qualifications, experience and naming two referees to Group Secretary, Greenwich District Hospital, Vanbrugh Hill, S.E.10 by 13th May.

HACKNEY GROUP HOSPITAL MANAGEMENT COMMITTEE

Appointment of Group Laundry Manager,
Hackney Hospital, London, E.9.

Applications are invited for the above appointment which becomes vacant on 16th July 1969, for the laundries in the Group (90,000-115,000 pieces per week).

Applicants should have a good technical background experience in staff management and organisation of a large laundry (hospital or commercial) providing a high output with good quality.

Recognised qualifications and knowledge of laundry equipment technicalities an advantage. Salary scale £1,425-£1,675 per annum plus £90 per annum London Weighting allowance.

Applications with details of age, qualifications and experience, to the Group Secretary, Administrative Office, Hackney Hospital, London, E.9 by 21st May, 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 in May, 1969. 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 £987 per annum, rising by annual increments to a maximum of £1,270 per annum. Candidate 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.

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.

LISTER AND NORTH HERTS HOSPITALS, HITCHIN, HERTS

HOSPITAL ENGINEER responsible for the engineering services at the above hospitals. Candidates should possess one of the following qualifications or an equivalent approved qualification.

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

or City and Guilds Certificate in Plant Engineering;

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

Salary scale: £1,270-£1,500 p.a. plus special responsibility allowance of £50 p.a. Long hours gratuity also payable. Permanent and superannuable post.

Applications, naming two referees, to Hospital Secretary.

ENGINEERING TRAINING CENTRE FOR THE NATIONAL HEALTH SERVICE, EASTWOOD PARK, FALFIELD, GLOS.

Applications are invited for the post of PRINCIPAL at this newly acquired residential Centre situated between Bristol and Gloucester accommodating 60 trainees. The Centre will provide short course 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.

Applicants should be Chartered Mechanical or Electrical Engineers. Training experience would be an advantage. The post will carry overall responsibility for running the Centre and the training programme. Salary scale: £2,730-£3,255. National Health Service conditions of service will apply. Residential accommodation is available if required.

Further details and application forms from the Secretary, South Western Regional Hospital Board, 27, Tyndalls Park Road, Bristol BS8 1PJ.

Closing date 31st May, 1969.

PETERBOROUGH AND STAMFORD HOSPITAL MANAGEMENT COMMITTEE

GROUP ENGINEER

Applications are invited for the appointment of Group Engineer. Applicants should hold the Higher National Certificate in Mechanical Engineering and Principles of Electricity or Electro-Technology; or an equivalent qualification approved by the Department of Health.

In addition, applicants must have a thorough practical mechanical engineering training and a sound knowledge of the principles and practice of the efficient operation of steam boiler plants, and have had experience in both mechanical and electrical engineering services generally.

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 in May, 1969. A new Maternity hospital of 97 beds is now under construction, to be commissioned in June, 1970.

Salary Scale: £1,750-£2,055 per annum (36½ to 48 points).
Responsibility allowance of £175 per annum will be paid.

Applications, stating age, details of practical training and experience, together with qualifications and the names of two referees, to the Group Secretary, Peterborough and Stamford Hospital Management Committee, Peterborough District Hospital, Thorpe Road, Peterborough.

WATFORD GENERAL HOSPITAL

Applications are invited for the post of Hospital Engineer at Shrodells Wing of the Watford General Hospital. This hospital is at present undergoing a major redevelopment and will ultimately have a total of 800 beds. Salary range £1,270-£1,500, with a special responsibility allowance of £50 per annum. Qualifications required are Higher National Certificate in Mechanical or Electrical Engineering. Applicants without qualifications may be considered. Applications giving full particulars and the names of two referees should be addressed to The Group Secretary, West Herts Group Hospital Management Committee, 9 Rickmansworth Road, Watford, Herts., by 7th June, 1969.

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD

COMMISSIONING ENGINEER required for electrical and mechanical engineering services. Applicants should have had a sound training in electrical or mechanical engineering services and a number of years of experience on the installation or the operation of service installations. The Commissioning Engineer will be expected to check final installation and ensure that all plant and equipment is functioning correctly prior to hand-over to the operating staff.

Salary scale: £2,122—£2,484 inclusive of London Weighting.

Application form from Secretary, North West Metropolitan Regional Hospital Board, 40 Eastbourne Terrace, W.2. quoting reference 21, returnable by 4th June.

WILLESBOROUGH HOSPITAL, NR. ASHFORD, KENT

HOSPITAL ENGINEER required to be responsible to the Group Engineer for a sub-group of four hospitals. Applicants must have completed apprenticeship in mechanical or electrical engineering and have had a wide experience in the maintenance of mechanical and electrical engineering plant, and should possess one of the following qualifications:—

(i) C. & G. Mechanical Engineering Technicians Certificate (Part II) to include Plant Maintenance and Works Service.

(ii) C. & G. Certificate in Plant Engineering.

(iii) M.O.T. First Class Certificate of Competency which includes an Ordinary National Diploma or Ordinary National Certificate.

(iv) Higher National Certificate or Higher National Diploma in Mechanical Engineering.

(v) Higher National Certificate or Higher National Diploma in Electrical Engineering.

Salary: £1,270 rising to £1,500 p.a. plus a special responsibility allowance of £25 p.a.

Applications with details of training, qualifications and experience, naming two referees, to Group Secretary, South-East Kent Hospital Management Committee, "Ash-Eton", Radnor Park West, Folkestone, by May 30th, 1969.

MISCELLANEOUS