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The Journal of the
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Vol. 24 April 1970

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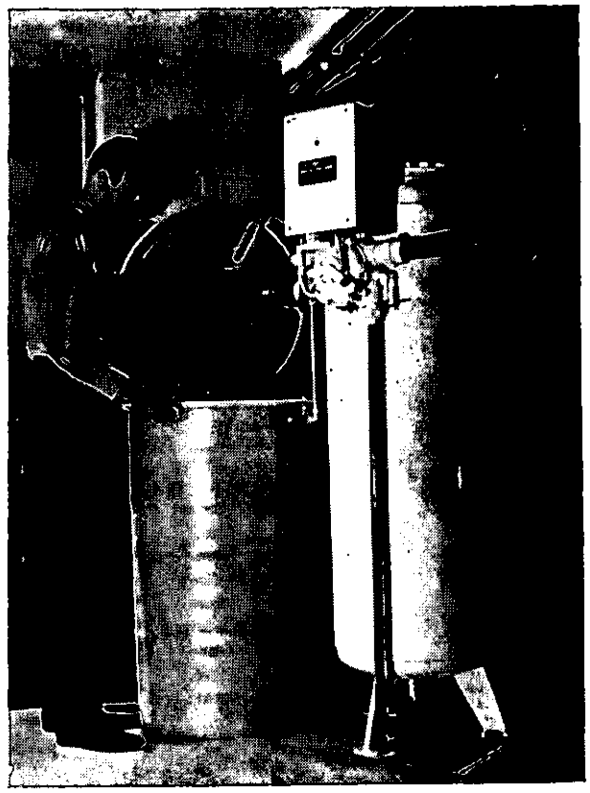

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Contents

Features

News

Departments

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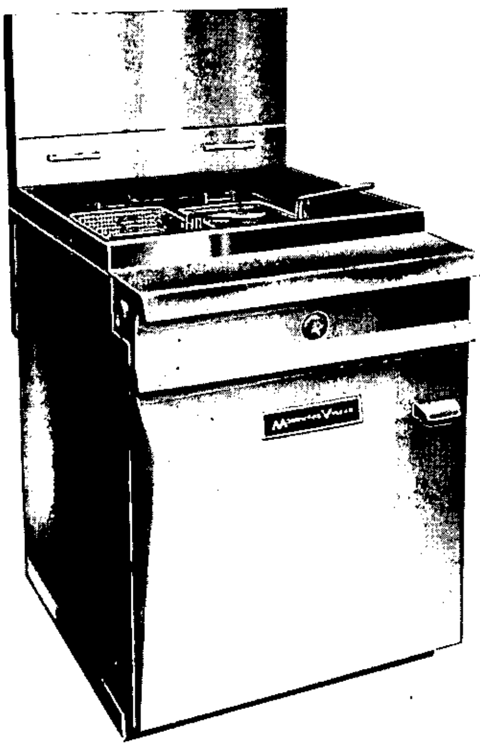

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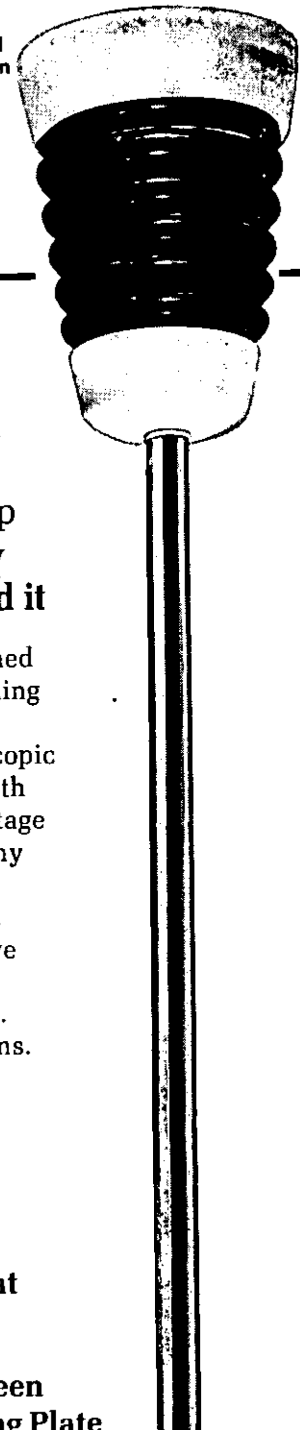

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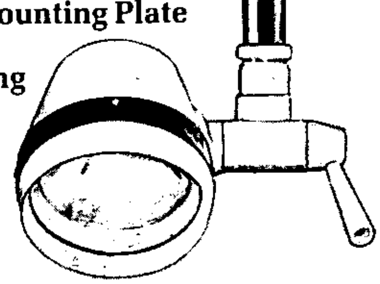

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Hospital Engineering

Vol. 24
April 1970
Pages 66-90

DESIGN CONCEPTS AND AIR-CONDITIONING REQUIREMENTS OF MULTIPLE OPERATING-THEATRE SUITES

by R. Rott, Design Consultant
and G. D. Conn, B.Sc., A.Inst.P., Market Sales Manager

Honeywell Ltd.

In considering the layout of the modern operating theatre suite, the main aim is efficiency.

True enough, the surgical, nursing and supporting staff deserve the highest credit for their therapeutic, sometimes life-saving, achievements. However, it is only right to aim at higher standards at which they can perform their tasks, the more so as surgical procedures making use of recent scientific and technical advances are potentially capable of so much. All the resources of modern technology, supported by advanced scientific research, should be used to create an organic working unit that can be used to best advantage to the benefit of both the surgical team and the patient undergoing surgery.

Paramount is the creation of a co-ordinated functional movement pattern within the operating suite, both to avoid confusing the staff, and to remove the stress and hazards which might deleteriously affect the outcome of the operation.

Opinions among theatre-planning committees regarding the form of the movement pattern diverge to a great extent, and hence the ideal operating-suite design has not yet been decided. Some are in favour of the clean-sterile dirty-disposal segregation pattern developed in the UK. This is based on separate clean and dirty corridors, or, in the case of multiple-theatre suites, a dirty central-island-type core system. In the latter, lifts or conveyors provide transport to a convenient handling area without interfering with the movement of surgical staff or patients, or of sterile supplies within the operating suite. This system allows for the servicing of theatre instruments from outside (which is a dirty area) without interfering with activities within the suite. Figures 1 and 3 show a typical layout of this type, designed for a north-European hospital of 1600 beds.

An alternative system is based on a central-island-type clean sterile core, where sterile supplies are handled, and the scrub-up facilities for the surgical team are located. Consequently, patients' movement, both before and after surgery, is shared with the disposal routes. This system is preferred in the US, where it was developed, and initially found some enthusiasm in the northern European countries as well. Figure 2 shows a layout designed on this principle.

In some cases a through-way system is adopted. The theatres and the supporting ancillary rooms are positioned between two corridors, one being defined as sterile and the other as clean. This follows the criteria that sterile supplies should follow the patient and surgical-team access route into the theatre, while the patients' exit after recovery is shared with the disposal route.

Obviously, in each of the systems described, both patient-transfer and staff-changing facilities must be incorporated in the design.

Air-conditioning requirements

Air conditioning which is specially developed for operating suites is essential to achieve a controlled environment. This is particularly important, as for some surgical interventions specific conditions have to be met in the operating theatre. The various layout systems require different approaches in the design of the air-conditioning system, to produce the required conditions for any specific case.

In the theatre illustrated in Figs. 1-3, the air-conditioning system is designed to maintain an ambient theatre temperature of 65±5°F, together with a relative humidity of not less than 55%. The plant is based on winter design conditions of 30°F and summer design conditions of dry bulb 80°F, wet bulb 68°F. The plant capability extends beyond the stated limits, but under certain conditions the relative humidity will rise above the nominal set point of 55%. The conditions in the ancillary rooms associated with each theatre are

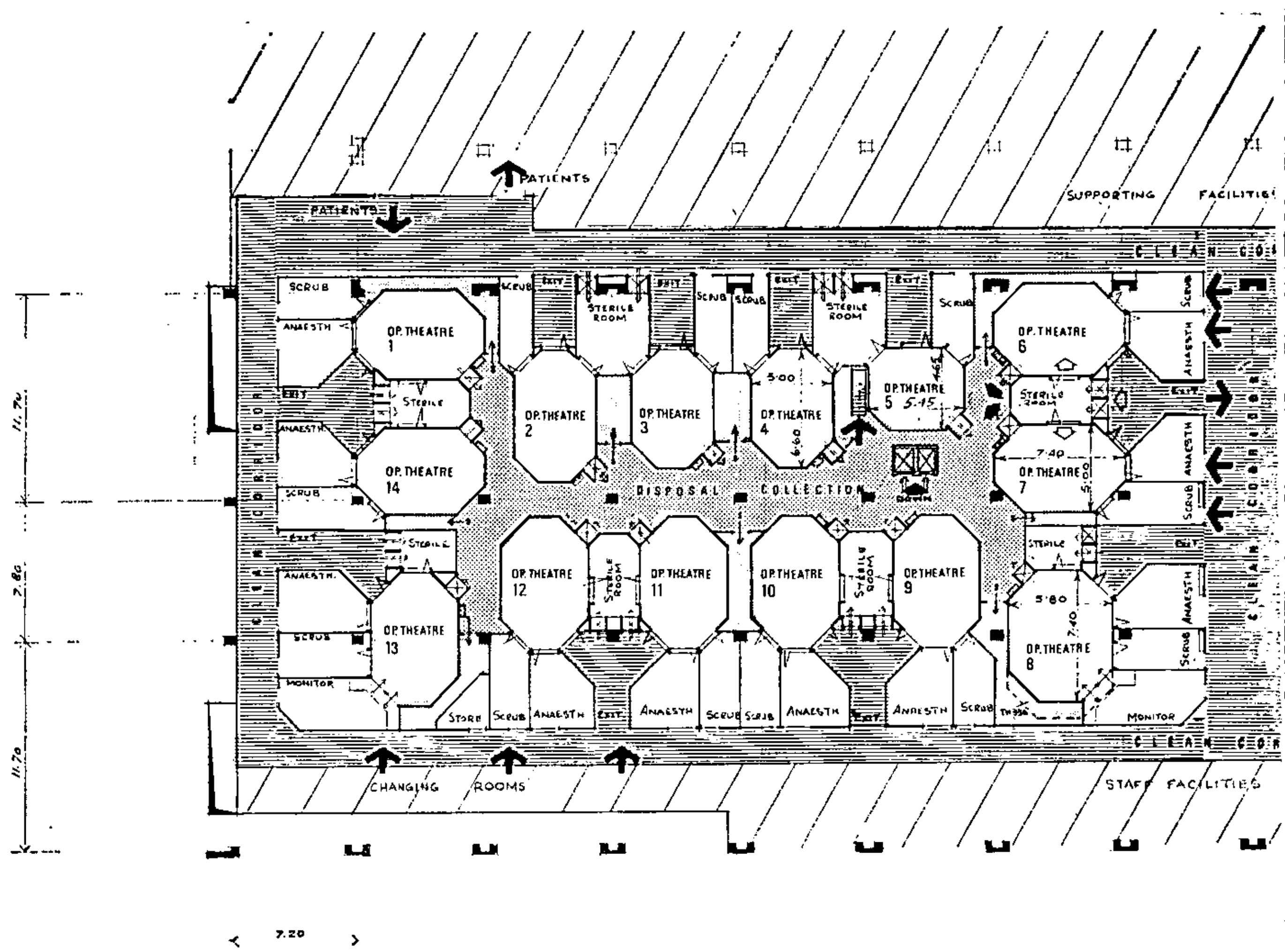


Fig. 1 Layout designed according to UK-developed system

controlled by the theatre-control system, and will vary in accordance with the conditions selected in the theatre. The efficiency of the filtration is generally better than 99·95%, measured against a sodium-chloride test cloud containing particles in the range 0·01–1·7 μm.

The air-conditioning-system controls would preferably be pneumatic for the reasons below.

(*a*) It provides a system free of explosion risk. However slight this might be it is always present in other equipment.

(*b*) Using linear-characteristic thermostats and humidistats, the controllers can show the variable being controlled remotely, as well as being capable of remote reset. In addition, pressure switches can easily be set up to indicate both high and low alarm conditions.

(*c*) Valves have an inherent spring-return facility in case of power failure.

(*d*) Components are compact.

(*e*) Equipment maintenance is made easier, and the spares inventory is reduced.

(*f*) The entire installation is under the control of the equipment manufacturer, and is not subject to any outside installation contractor.

The air-conditioning equipment required comprises:

(*a*) a prefilter constructed of plastic foam designed to remove the larger particles

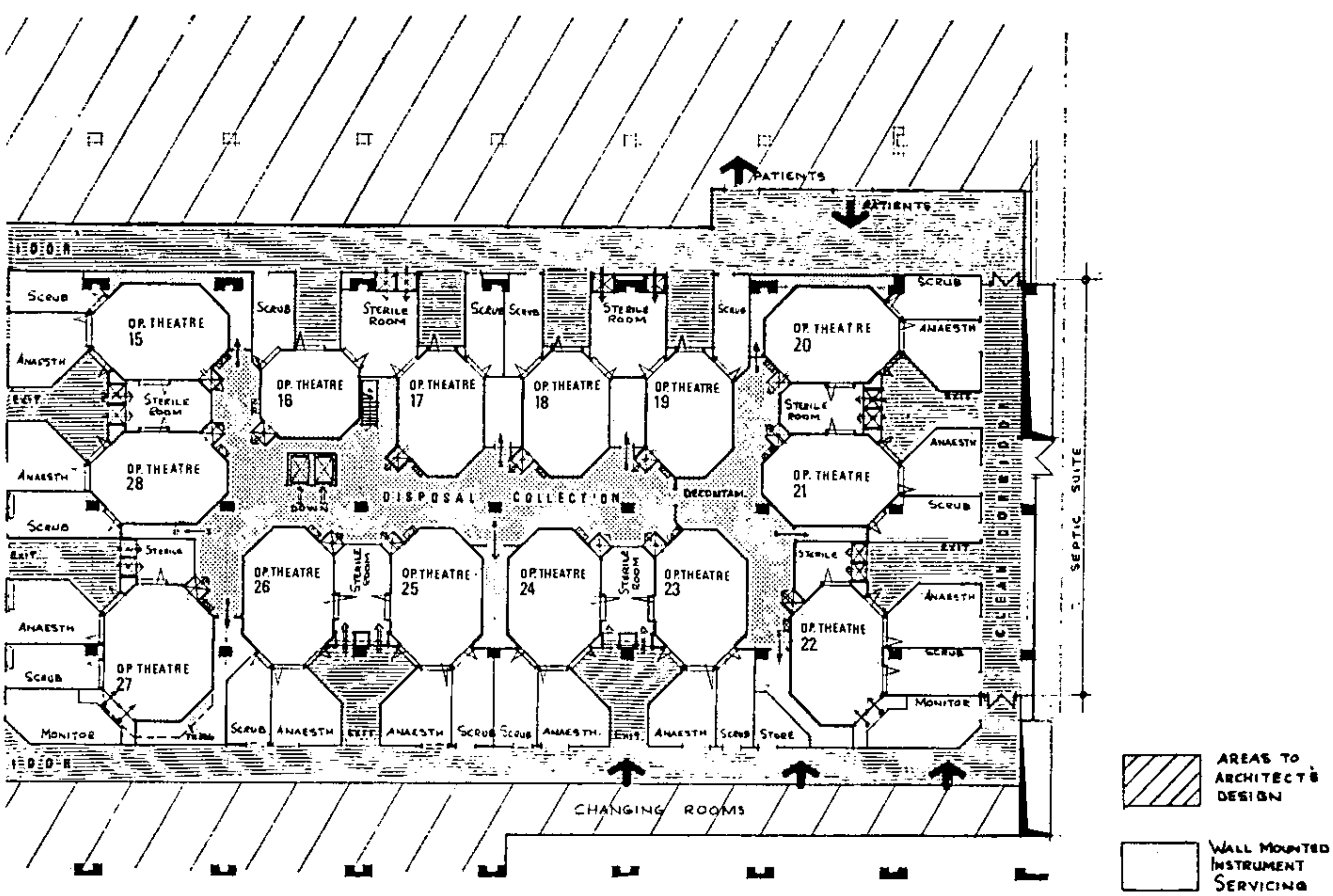
(*b*) a preheater, designed to raise the outside air temperature to 55°F when required. This is usually a single-row hot-water coil with steel fabricated headers. The heater is controlled by a pneumatic actuator; the valve and controller sensing is by two balancing themostats, one in the fresh-air inlet and the other immediately after the main fan unit

(*c*) an electrostatic precipitator, designed to work at an efficiency of not less than 90%. This will have a hot-water pump attached, to enable the filter to be washed without dismantling

(*d*) a fan unit, including a fan section and fan, direct-expansion cooling coil and drain pan. The fan will have a conventional 3 h.p. drip-proof motor

(*e*) an attenuater unit, designed to reduce the sound level, measured in the theatre, below that of curve n.c. 35

(*f*) a reheater designed to raise the air temperature from 55°F to that required in the theatre (65–75°F), according to the setting on the control thermostat. The reheater will be controlled by a pneumatic



thermostat capable of remote reset and located within the operating theatre

(*g*) a supplementary reheater for the ancillary rooms, controlled from a separate thermostat which may be located in the recovery room

(*h*) a humidifier, which may be of the spinning-disc type fed from the cold-water supply and including a mist and salt eliminator. If so, in the case of power or air-conditioning shutdown, the valve will return under its own spring to the closed position. Alternatively, a direct-steam-injection humidifier can be provided, in which the main steam valve is under the direct control of the humidistat, capable of remote reset, located next to the thermostat mentioned in (*f*)

(*j*) terminal filters, located at the theatre inlet. These are of a fine microbiological construction of 100% glass-fibre-paper, type GA, and will filter to an efficiency of 98% against a sodium-chloride cloud when tested separately

A control panel is also provided within each theatre. This is normally flush mounted (as shown in Fig. 4) and contains:

(i) temperature indicator

(ii) relative-humidity indicator

(iii) illuminated push buttons for the operation of the general lighting, the operating lamps, the air-conditioning plant and the 'theatre prepared' and

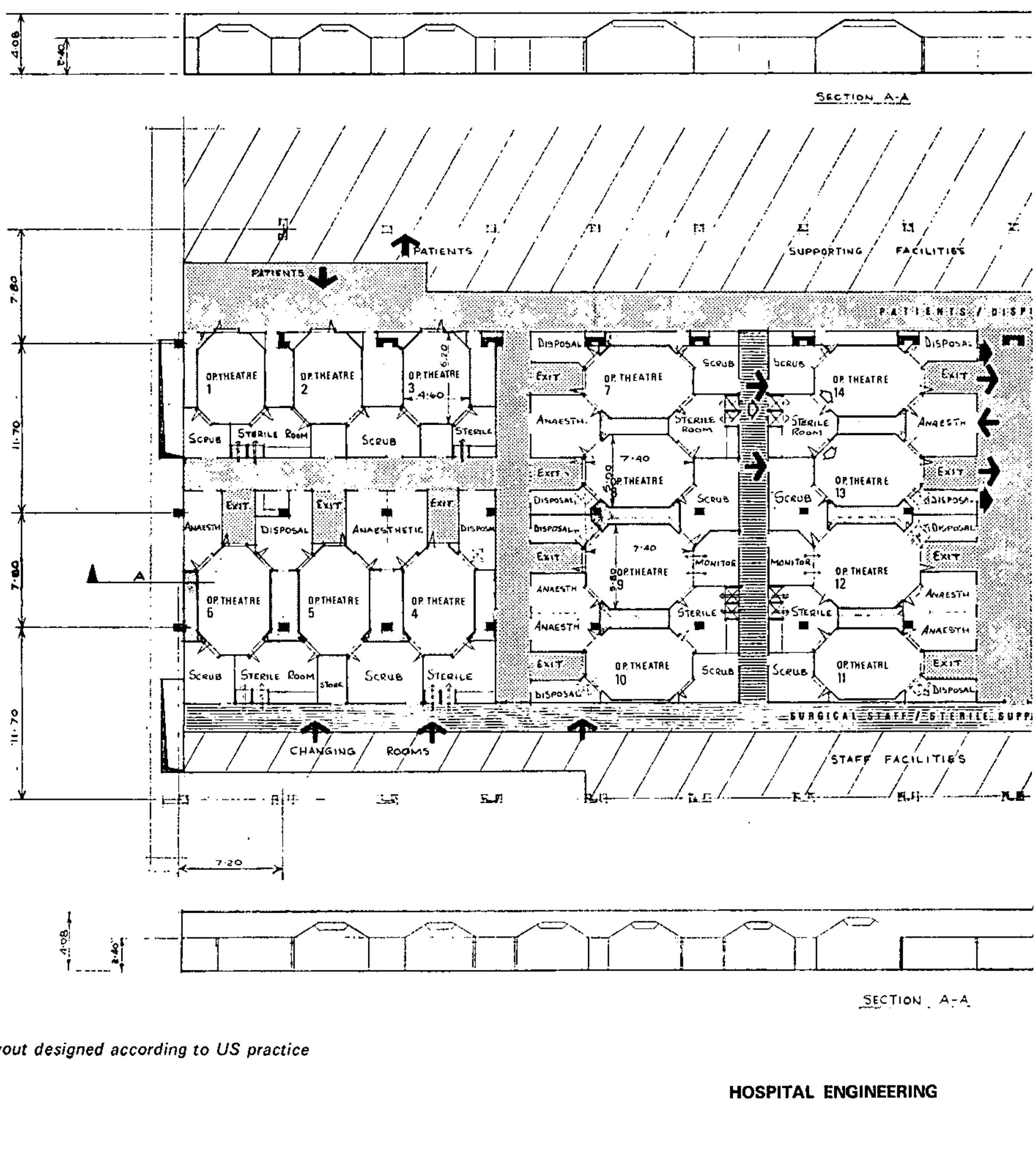


Fig. 2 Layout designed according to US practice

'theatre in use' signs

(iv) manual control for adjustment of the theatre temperature

(v) manual variable-intensity control for the general lighting

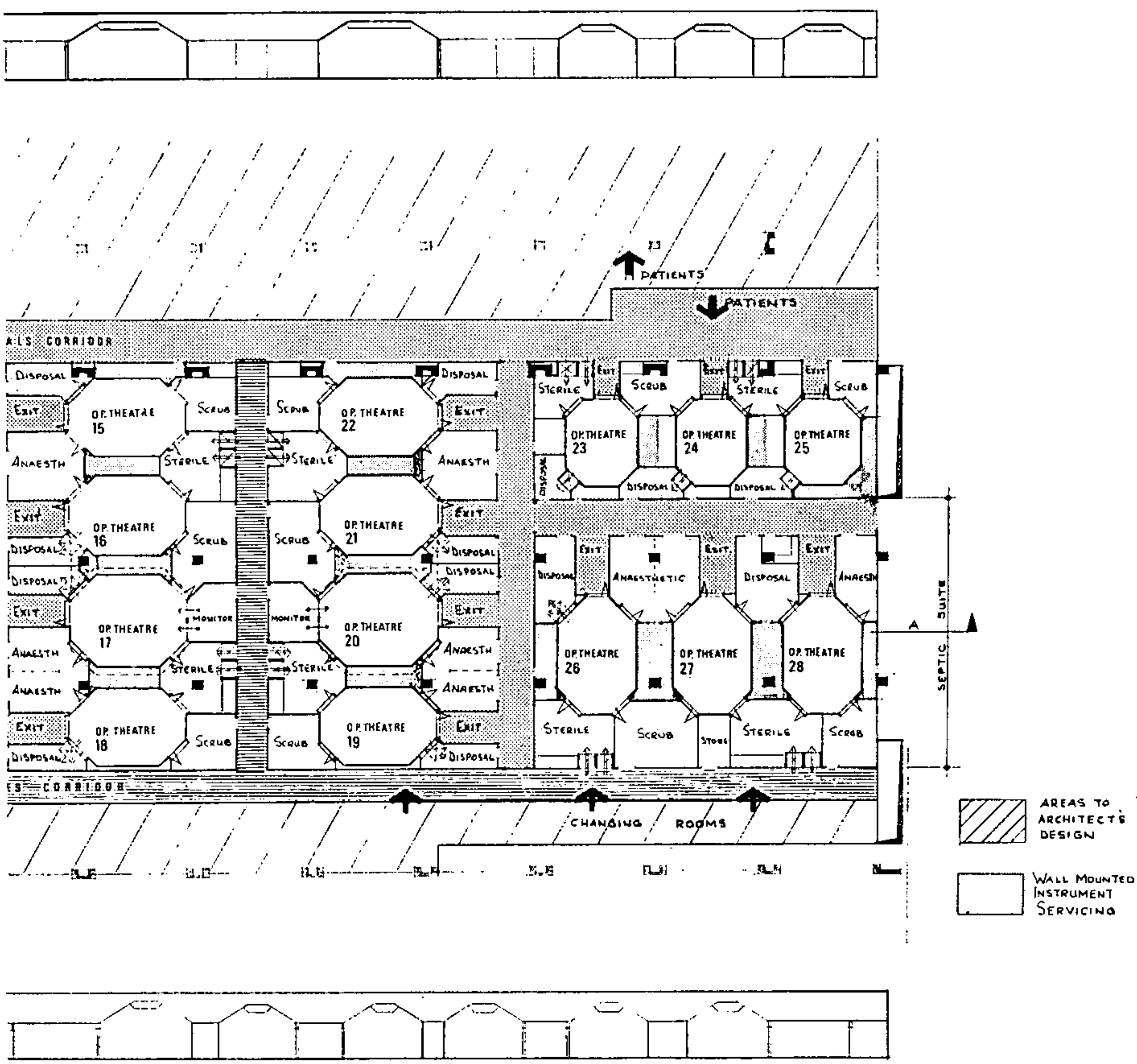
(vi) manual variable-intensity control for the operating lamps

(vii) all necessary fuses and circuit breakers for the electrical equipment, including separate wall-mounted 13/15 A and 25/30 A socket outlets

(viii) intercommunication station.

The air is supplied to the theatre through strip-line diffusers mounted close to the top of the inclined ceiling panels. Each diffuser has two slots and covers almost the total width of each panel, thus providing a ring of supply air above the perimeter of the surgical working area. The upper slot is adjusted to provide a stream of air directed at the operating table, while the lower slot provides air over the general area.

The extraction system is designed primarily as a gravity system through pressure-relief dampers mounted low in the wall panels. The dampers allow 75% of the air to pass when the theatre static pressure is 0·4 in w.g. (1·016 mm w.g.), the remainder being expelled to the ancillary rooms. The pressure-release flaps can be adapted, if required, for a forced-extraction system, to enable balancing of individual grilles. Experience has shown that there are few heat gains experienced within the theatre;



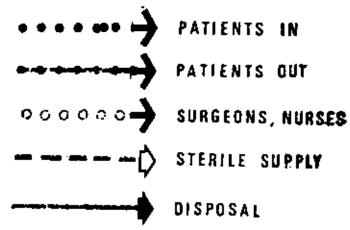
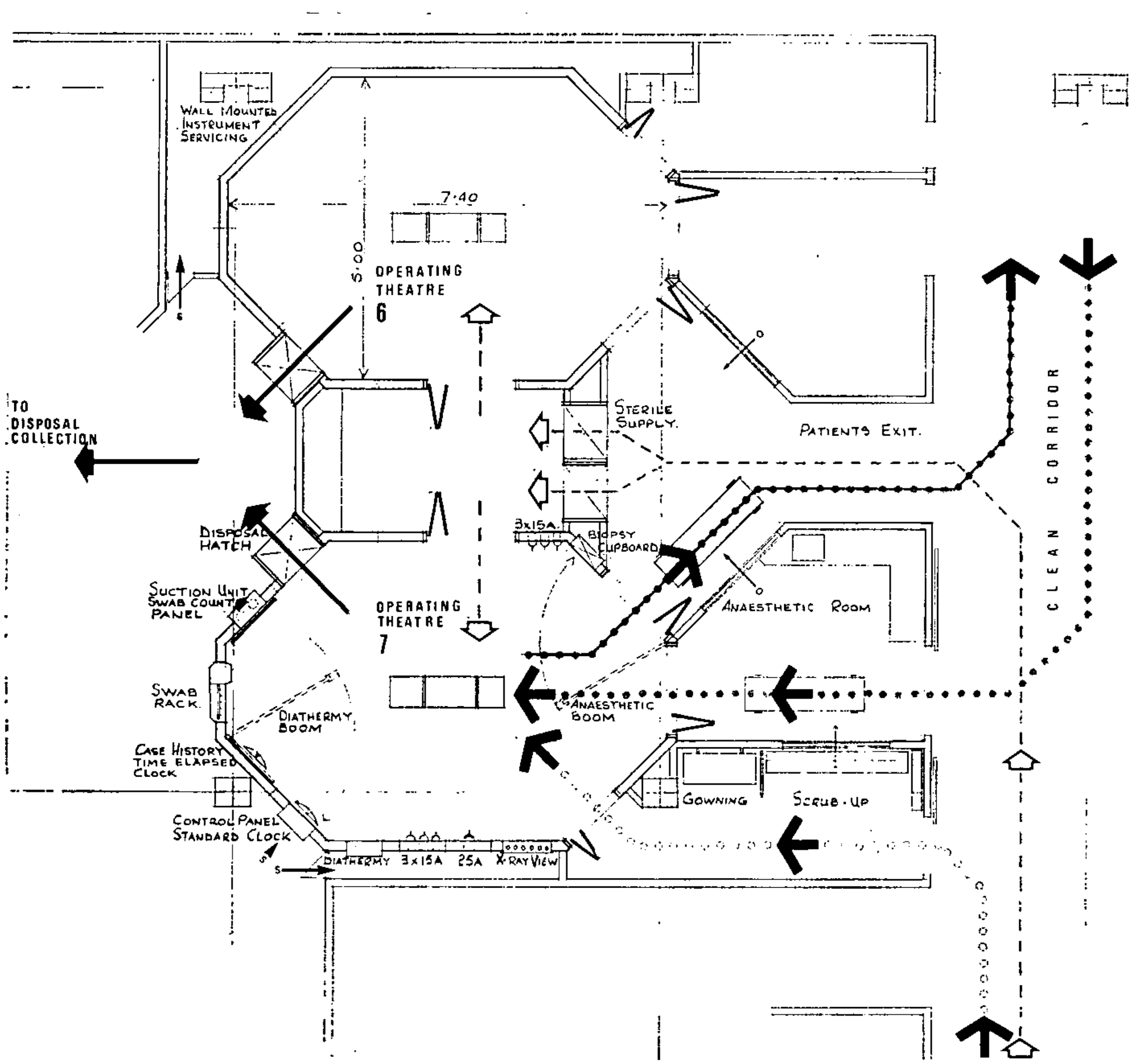


Fig. 3 Detail of Fig. 1, showing various routes



these are set out below.

operating lamps: 300 W = 1020 Btu/h
other equipment: 200 W = 672 Btu/h
surgical team (say eight persons):
234 W latent = 800 Btu/h latent
700 W sensible = 2400 Btu/h sensible

The above is merely an indication and varies from theatre to theatre.

The importance of correct filtration and air movement within the theatre and ancillary rooms cannot be over-emphasised. In recent years, an average of 10% of patients undergoing surgery are subject to postoperative wound infections. The bacteria causing these infections originate from

(*a*) the surgical team
(*b*) the air delivered to the theatres
(*c*) air from dirty areas finding its way into the theatres.

The risks of the above may be lessened by

(*a*) rapid air changes within the theatre (a table of recommended air changes is shown below)
(*b*) correct filtration of the air entering the theatre suite
(*c*) keeping a positive pressure within the theatre at all times, perhaps by running the fan at half speed when no operations are taking place to enable the pressure to be kept up in the rest of the operating suite.

The normal number of air changes per hour for various rooms within the operating suite should probably be as follows:

operating theatre	20 change/h with gravity extract
sterile lay-up rooms	25 change/h with gravity extract
anaesthetic rooms	10 change/h with forced extract
scrub-up rooms	10 change/h with gravity extract
clean corridor	6 change/h with gravity extract
recovery	6 change/h with gravity extract
sterilising	10 change/h with forced extract

Any changes in environmental conditions in the theatres which are needed for varying types of operation, or for the needs of different surgical teams, may be carried out from the control panel as described above, while constant monitoring (with instantaneous alarm) of these conditions takes place at the supervisory control console (see Fig. 5) manned by the engineering staff. This central console is also capable of supervising the complete range of mechanical and electrical installations within the hospital, including fire detection, intrusion security and lift alarms. If this facility is incorporated the efficiency of the entire hospital, not merely the operating suite, may be brought to the highest possible level.

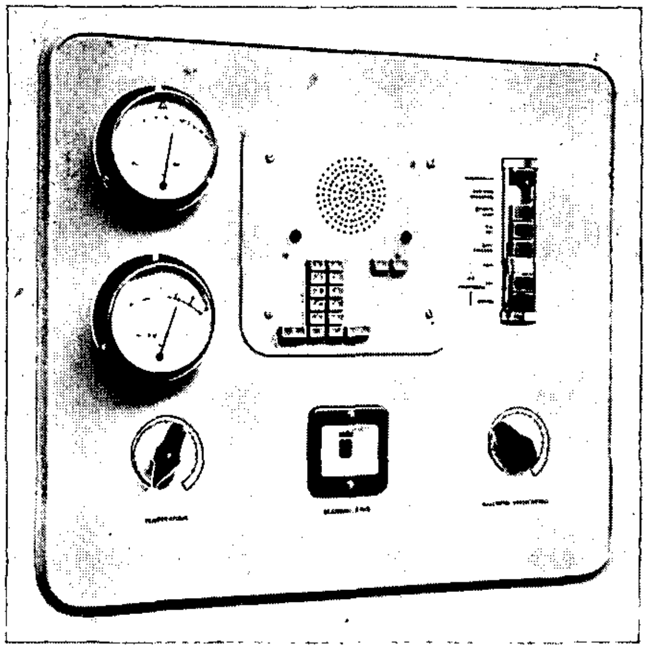


Fig. 4 Air-conditioning control panel

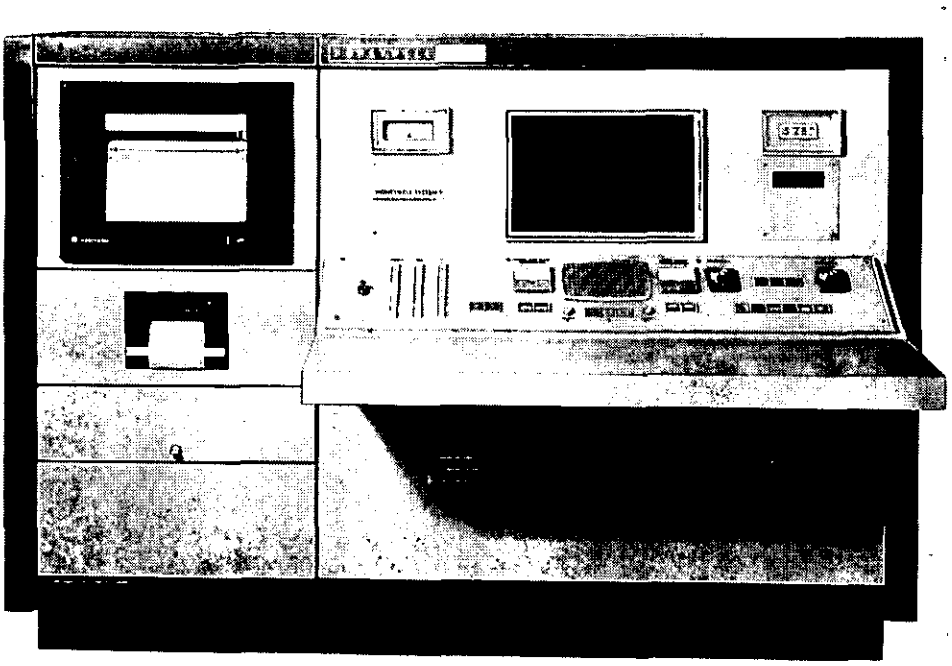
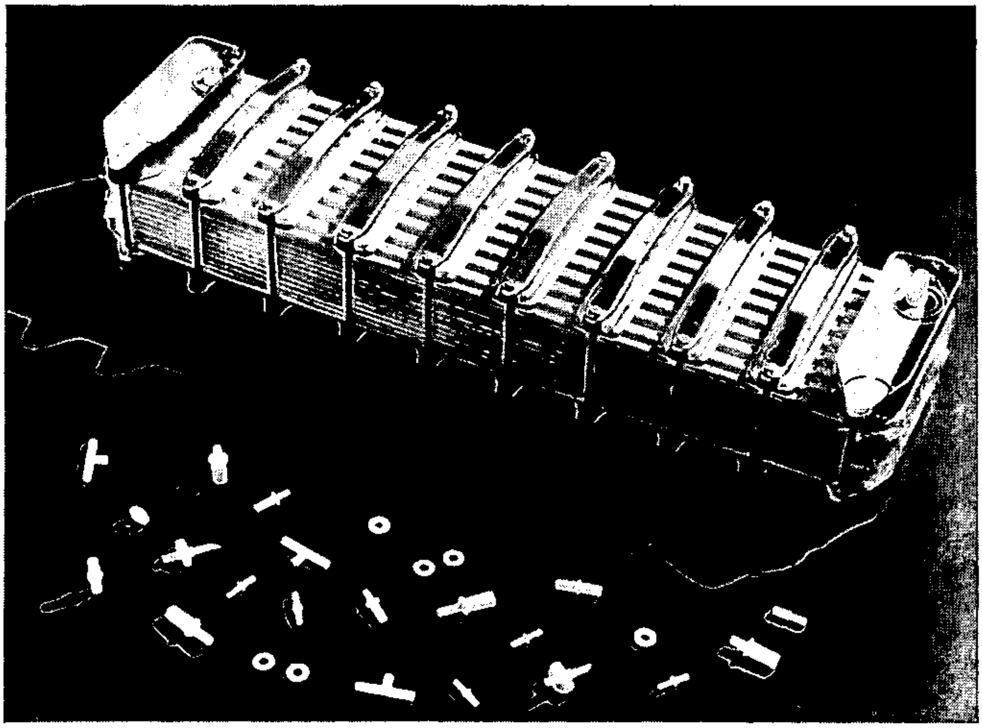


Fig. 5 Master control console



The disposable filter unit

Smaller artificial-kidney machine

Severe renal failure, a condition of the body where the kidneys are no longer able to filter impurities from the blood, confronts the medical profession with one of its most formidable organisational tasks.

Both for acute and chronic cases of this illness, a complex apparatus is needed which will take over the function of the kidneys and purify the patient's blood.

Purification of the bloodstream by the use of an artificial kidney is known as haemodialysis, and, until recently, has involved the use of equipment requiring much space and labour. The time required for the complete dialysis has been of the order of 12 to 15 h, the high volumetric capacity of dialysis machines has involved the use of additional ('priming') blood, and a blood pump has usually been necessary.

Since 1961, Nils Alwall, a pioneer in the field of haemodialysis, and professor of medicine at the Lund University, Sweden, has been working with AB Gambro of Lund on the problem. The result is a system which reduces the size and cost of the apparatus, cuts the dialysis time to about eight hours, eliminates the need for priming blood, and, in most instances, enables the machine to operate without a blood pump.

Basically the machine comprises an automatic monitoring system and a compact, disposable, parallel-flow dialyser. With this type of filter a small blood volume and low resistance to blood flow are achieved, and after dialysis, virtually all the blood is returned to the patient. In addition, the dialyser is destroyed, radically reducing the risks of infection.

The filter incorporates a number of 'plates', each comprising a pair of thin membranes which together form a channel through which the patient's blood flows. Dialysing fluid, heated to 37°C, suffuses the outer surfaces of the membranes, and with the machine connected to the patient's arterial and venous systems, the waste substances of the blood, together with part of the water content, pass through the membranes into the continuously renewed dialysate. Negative pressure in the dialysing fluid controls the amount of water removed from the blood so that the patient's normal weight is sustained.

Apart from the membranes, which are made from cellulose, the blood comes into contact with only one material during its passage through the filter. This is Kematal, ICI's acetal copolymer, which is used for the connections and multiple-distribution stacks at each corner of the pack. This is particularly suitable as a structural material for clinical apparatus, as it is strong and dimensionally stable, can be moulded with an excellent surface finish, will not corrode and can readily be sterilised.

Since the Gambro machine is designed for home as well as for hospital dialysis, it was essential to keep the weight and bulk of the filter to a minimum. In fact, the filter pack weighs only 7·5 kg, and its overall dimensions are 590 x 170 x 130 mm.

Careful testing of this equipment in laboratories, hospital departments and the renal clinic at the University of Lund has demonstrated that its use enables three patients to be treated in 24 h for each dialysis bed. The work load on hospital staff has decreased, saving three man hours per treatment, and less distress is caused to the patient than with the equipment previously used.

AB Gambro is now engaged in large-scale production of the haemodialysis machines, and in fact the renal unit of the Royal Postgraduate Medical School, Hammersmith Hospital is the first unit outside Scandinavia to use the system.

Plastics for the hospital engineer

by
A. Watson, M.I.C.E., M.I.Mech.E., M.I.Plant.E

1 Introduction

When one talks to people about plastics, one often gets the impression that they think you are referring to an inferior substitute, rather than to an engineering material in its own right. Perhaps this arises from the war-time use of other synthetic products, and it was indeed the last war that brought about the revolution in the chemistry of plastics. This was largely because of the territorial loss of certain sources of natural materials; when we lost our sources of rubber in the Far East a substitute had to be found for use in tyres etc., and this is when synthetic materials started to come into their own. Buna-S rubber and Neoprene arrived—the latter being, of course, still very much with us today. Neoprene surpasses natural rubber in its resistance to oils, chemicals and oxidation, and so became an engineering material in its own right. Perspex for aircraft canopies, and nylon for glider tow ropes, surgical sutures etc., followed, and the age of plastics had arrived.

The first purely synthetic plastic was Bakelite. This is a phenol–formaldehyde resin, the manufacturing process for which was patented by Baekeland in 1909. Its applications are many, and we have all used it in one form or another: in gear wheels, fuse boxes and light fittings, and even as a constituent of paint.

2 Types of plastic

The plastics in which we, as engineers, are mainly interested, can be divided into two families:

(*a*) thermoplastics, such as celluloid, which can be rendered plastic by the application of heat

(*b*) thermosetting plastics, such as Bakelite, which do not soften by the application of heat after they have initially set.

These two definitions are important because they dictate the most important limitation in the use of plastics; i.e. that of use only within certain temperatures.

It seems that new plastics materials are arriving every day, and it is impossible to deal with such a wide subject here, so I have taken the three most common that are most likely to be used by the hospital engineer in the form of piping. These are:

(i) polyvinylchloride (p.v.c.)
(ii) polyethylene (polythene)
(iii) acrylonite-butadiene-styrene (a.b.s.)

These materials are in general use for cold-water, sewage and drainage purposes at temperatures of up to 60°C, or in the case of a.b.s., 80°C.

3 Polyvinylchloride

The raw materials from which p.v.c. may be derived at present are coal and petroleum. No doubt, as the output increases, the coal-tar demand will become too high, and petroleum will become the main source of raw material.

P.V.C. is one of the largest, if not the largest, tonnage plastic, and has literally thousands of uses. Its mechanical characteristics can be varied over a range extending from soft and rubbery to hard and stiff by the addition of plasticisers. To appreciate fully its characteristics one has to take a brief look at the chemistry of plastics.

All thermoplastic materials, including p.v.c., are of the family known as polymers; this word comes from two Greek words: *poly*, meaning many, and *meros*, meaning part. Thus polymer means 'many parts'—which is indeed a perfect description of the repeating chain of molecules which forms a polymer. In thermoplastic materials, these long chains of molecules, once formed, remain separate; which is why such materials soften on the application of heat. In thermosetting plastics the chains of molecules interlock in a 3-dimensional network while the plastic is being moulded under heat. Since the chains can then no longer move with respect to one another, these materials do not soften or deform significantly on the further application of heat.

The function of plasticisers is to separate these long-chain molecules and give them flexibility. The plasticiser does not chemically react with the p.v.c. molecules—indeed, if it is wrongly chosen it can migrate to the surface and be wiped off, so the plasticiser must be compatible with the material.

There are at present, in common use, two types of

Assistant Regional Engineer, Manchester Regional Hospital Board

p.v.c. pipe covered by British Standards:

BS 3505: 1962 Unplasticised p.v.c. pipe (type 1420) for cold-water supply

BS 3506: 1962 Unplasticised p.v.c. pipe for industrial uses.

(Plasticised p.v.c., i.e. flexible piping, is not generally used by the hospital engineer in great quantities: so I shall deal only with the rigid material.)

3.1 Conditions of use for p.v.c.

P.V.C., along with most thermoplastic materials, has a high coefficient of expansion, so great care must be taken when fitting to compensate for this characteristic. The pipe must be supported at the recommended intervals, but the clips must only hold the pipe firmly, leaving it free to expand or contract. At temperatures approaching 60°C continuous support is recommended.

When p.v.c. piping is erected in conditions of high ambient temperature—say in a duct or subway—the pipe is in a state of expansion, and as soon as it is filled with cold water it contracts. Unless it is free to move within its clips, and adequate provision has been made by an expansion bellows, or similar device, to compensate for this movement, the pipe will end up in a stressed state, and is likely to fail by the pulling of a joint. When the pipe is initially filled, it should be done slowly, allowing the pipe to cool gradually and the pressure to build up slowly.

P.V.C. pipe should never be allowed to impinge on sharp or pointed surfaces such as heavy aggregate in a trench, or the edges of rolled-steel sections. In a trench the pipe should be bedded in fine granular material, and 'snaked' when laying, so that on contraction it straightens and relieves the stress on the joints. Any impingement of a sharp point or edge on the pipe sets up an area of high local stress, which could be a point of failure because the hoop strength of p.v.c. pipe, i.e. its resistance to hoop stresses, is low compared with steel, copper, aluminium and their alloys. High local areas of stress, coupled with this low hoop strength, can easily form weak points in the pipe.

All heavy pieces of pipe-line equipment, such as valves or water meters, should be supported independently, even if themselves made of plastics material.

The making of mechanical joints in pipe-work runs needs no comment from me, as the subject is covered by manufacturers, but I could say a little on making solvent joints. This is essentially a chemical process, so various primary rules must be followed:

(i) cleanliness is essential; oil or dirt on the surfaces to be welded must be avoided at all costs

(ii) use the manufacturer's recommended solvent, and do not mix manufacturers' materials; they may not be chemically compatible and the joint may fail as a consequence

(iii) there is a setting time for solvent joints which depends on the conditions and temperatures under which the joint is made. As a general rule the joint does not reach its full strength for 24 h, but if this length of time is unacceptable, consult the manufacturer before you go ahead, as it may be possible to bring the pipe up to working pressure within this period.

P.V.C. pipe does, of course, have several disadvantages:

(i) the maximum operating temperature is 60°C, which limits its use to cold-water service, drainage etc. As its working temperature increases its operating pressure decreases (see the British Standards for more information)

(ii) the possibility of damage by subjection to temperatures above its softening point (around 80°C) by, for example, steam leaks, limits the positions in which it can be run; for example, not adjacent to steam or condensate lines, or in ducts or subways of high ambient temperature

(iii) ultraviolet light deteriorates p.v.c. (coloured pigments are introduced into the material to cut down this deterioration)

(iv) greater care in erection and supporting is required than with the conventional materials with which tradesmen are familiar

(v) rodent attack is possible on pipes below about 1 in o.d.

(vi) p.v.c. is an electrical nonconductor.

Bacteriological attack can occur with plasticised p.v.c., but this has not been the material under discussion.

4 Polyethylene (polythene)

The raw material from which polythene is derived is petroleum, and it is produced in large quantitites. It is a thermoplastic material, and since the war years, when its excellent electrical characteristics were utilised, this family of plastics has been put to all manner of domestic and industrial uses.

The characteristics of this material depend upon its density. As the density increases so do its rigidity and melting point, and, in general, the high-density materials have better mechanical characteristics than those of low density.

In polythene the molecular chains carry side chains which branch off at regular intervals; thus it is impossible to pack these molecular chains tightly together. As a result the material is flexible, but by controlling the basic polymerisation reaction the structure of the molecules can be modified to give different branching patterns. This affects the extent of packing, which gives the range of densities, and the corresponding range of characteristics.

There are four British Standards covering polythene pipe:

low-density polythene

BS 1972:1961 Polythene pipe (type 425) for cold-water service. This specification covers the black polythene pipe

BS 1973:1964 Polythene pipe (type 425) for general purposes, including chemical and food-industry uses. This specification covers the pure material without the addition of carbon black or antioxidants.

high-density polythene

BS 3284:1963 Polythene pipe (type 710) for cold-water services

BS 3796:1964 Polythene pipe (Type 710) for general purposes. (This is suitable for potable water, corrosive fluids, sewage and certain gases.)

Regarding erection, the points covered for p.v.c. apply equally here. Both types of polythene are easily bent by immersion in hot water. Large-bore pipes can be joined by butt welding or by welding on flanges or oversized sleeves. If in doubt, consult the manufacturer about the particular job in mind.

The manufacturers' literature covers the details of the advantages, such as its being of light weight, unaffected by aggressive waters, nontoxic, and resistant to frost damage, that it can be mole-ploughed in, and reduces water hammer and sound transmission etc.

Its main disadvantages are:

(i) maximum operating temperature 60°C

(ii mechanical properties affected by high temperatures (high expansion rate etc.). Here again, great care in erection, and limitations as to the positions in which this material can be installed, should be observed

(iii) unpigmented polythene is attacked by ultraviolet light, so that black-pigmented material must always be used for outdoor or exposed indoor applications

(iv) polythene is slightly permeable to some gases, including coal gas, so if there is a gas main in the vicinity the manufacturer's advice should be sought

(v) it is a nonconductor.

5 Acrylonite-butadiene-styrene (a.b.s.)

A.B.S. is a thermoplastic material formed, as would be expected, from the copolymerisation of acrylonite, butadiene and styrene. By varying the proportions of the three monomers, and by changing the conditions of polymerisation, the final product can be produced with mechanical characteristics within a wide range.

It is essentially an engineering material combining toughness, hardness and rigidity with a good balance of other properties. In general its maximum operating temperature is 80°C, and the remarks about erection referred to under p.v.c. also apply. It can be bent, preferably by the application of radiated heat, but care has to be taken not to overheat. A British Standard is in the course of preparation.

Joints are usually made by solvents and the remarks for p.v.c. again apply. If thick-walled tube is threaded and the threads sealed with p.t.f.e. tape, a satisfactory joint can be made, but the rated working pressure for such a joint is 50% of the equivalent solvent joint.

A.B.S. has obvious advantages, higher working temperature being one, but its disadvantages are:

(i) more costly than the other two materials mentioned

(ii) unpigmented a.b.s. is attacked by ultraviolet light, so that, again, pigmented materials should be used for outdoor and exposed indoor installations.

(iii) it is a nonconductor.

6 Conclusion

Plastics are constantly being developed to give better engineering characteristics. Properly specified and fitted pipe runs should give excellent service, and will give financial advantages over conventional materials. The one golden rule when using these materials is to consult the manufacturer whenever in any doubt—he should be only too happy to advise.

* Postbox *

Dear Sir,

I would like to compliment B.A.H. on the editorial, 'Reflections and forecasts', in the February issue of *Hospital Engineering.*

I agree that the Institute has changed quite considerably for the better in the last few years, but we still have a long way to go. Our main aim must be to improve the status of the Institute and hence the status of the hospital engineer.

To the outside world *Hospital Engineering* represents the Institute, and as such must reflect the improving image of the engineer. During the last six months *Hospital Engineering* has indeed improved its outward appearance, but the articles are still uninteresting and lacking in technical merit, and they far from cover the whole range of interests of the hospital engineer.

The responsibility must lie with us—the members. We must express an interest, we must write to the journal if we are dissatisfied and we must submit intelligent, interesting material for publication. If we do not, we can expect our status to either decline or, at best, remain at its present mediocre level.

Yours faithfully,

W.M.B.

Flat 12,
Southall Close,
Ware, Herts.

Dear Sir,

I write as an Honorary Member of the Institute of Hospital Engineering and therefore having no voice in its affairs, but, having had a close connection for some years with the former Institution of Hospital Engineers, perhaps I may be permitted to offer one or two observations on the article 'Reflections and forecasts' appearing in the February issue of *Hospital Engineering.*

Referring to the penultimate paragraph of that article, it should perhaps be remembered that the word 'engineering' is regarded by the Courts as a 'term of art' and engineers, as such, have no standing, as is the case with the clergy, lawyers and doctors. The State has, however, agreed to regard Chartered Engineers as acceptable persons for sponsoring applications for passports.

It occurs to me that possibly the Institute might usefully (and perhaps to its own prestige) take steps to coordinate the Incorporated bodies concerned with engineering with a view to forming a Council of Incorporated Engineers. Just as there are, I believe, both Chartered and Incorporated Accountants, there could then be both Chartered and Incorporated Engineers—something which, I think, would be of value to the profession as a whole.

Yours faithfully,

H. A. Sandford

Benham Grange,
Newbury, Berks.

NEW SITE FOR CHARING CROSS

by
F. Hart, D.P.A., F.H.A., J.P.

On the 15th April, phase one of the new Charing Cross Hospital will be 'topped out'. The largest teaching hospital to be built in the UK since the war has an interesting history—and a promising future.

Secretary, Charing Cross Hospital Board of Governors

A little over 150 years ago Charing Cross Hospital was founded in the Strand in the heart of London. It owed its origin to the humanity and foresight of a newly qualified doctor, Benjamin Golding, barely 21 years of age, who was greatly distressed by the poverty and wretchedness of the poor of London—a London of dreadful hovels and tenements, rubbish and litter of every sort.

Incredibly, the hospital was started against public agitation fostered by a national paper, *The Morning Herald*, which objected to its foundation as being 'monstrous and uncalled for'. Nevertheless, as soon as the doors were opened the beds were filled, a circumstance which has been perpetuated ever since.

Within a few years a medical school was established, where many famous medical men, including Thomas Huxley, the great physiologist, and David Livingstone, the explorer, received their training.

Always the site, measuring under an acre, was too small. As long ago as 1935 a search was made for a new and larger base upon which to build a bigger and better hospital and school. But setback followed setback—lack of money, the war, the changed policy on hospital building after the war, a new constitution imposed by the University authorities—and it was not until 1959 that a new hospital was approved on the site of the present Fulham Hospital in south-west London.

Preliminary work started in 1963, the foundation stone was laid by the hospital president in 1968, and work began in earnest that year.

Building will be roughly in two phases. The first major phase, comprising a ward and laboratory block, with some 650 beds, operating theatres, and a major part of the outpatient and X ray blocks, is now well on its way up. The cost will be some £12 million, exclusive of fees and equipment.

The design is on the cruciform principle. Entrance to the building will be over a bridge spanning an ornamental pond, and visitors will then find themselves in a vast concourse, not at first sight suggesting a hospital. Shops selling flowers, gifts and books will be in evidence, and there will be a bank and hairdressing salons. The receptionist will be on hand to direct patients and visitors to their destinations—access to the floors above will be by lift (of which there are nineteen) and escalator.

Each ward will be a unit of 26 beds, and there will be three units to each floor. A unit will have beds in single and six-bed rooms. A link will connect the ward to the laboratories associated with its activities. There will be accommodation for patients' visitors having to stay the night.

Patients and nurses will be in contact with each other through a special 2-way centralised communication system, which includes doctor call and location, crash call, nurse call and location, the fire alarm and bed-state information.

The importance of the aesthetic consideration has been a major aim of the architect, Mr. Ralph Tubbs, who has, in spite of the demands of the site, allowed for small gardens and courtyard areas.

It has been calculated that in this first phase of building there will be 3000 miles of steel reinforcement, four acres of glass, 250 miles of electrical wiring and 100 miles of heating pipes. Work is on schedule, and the first phase is expected to be occupied during 1972, when the present Charing Cross Hospital will close its doors for the first time since 1818. The preparation of operational policies based on up-to-date principles is now at an advanced stage.

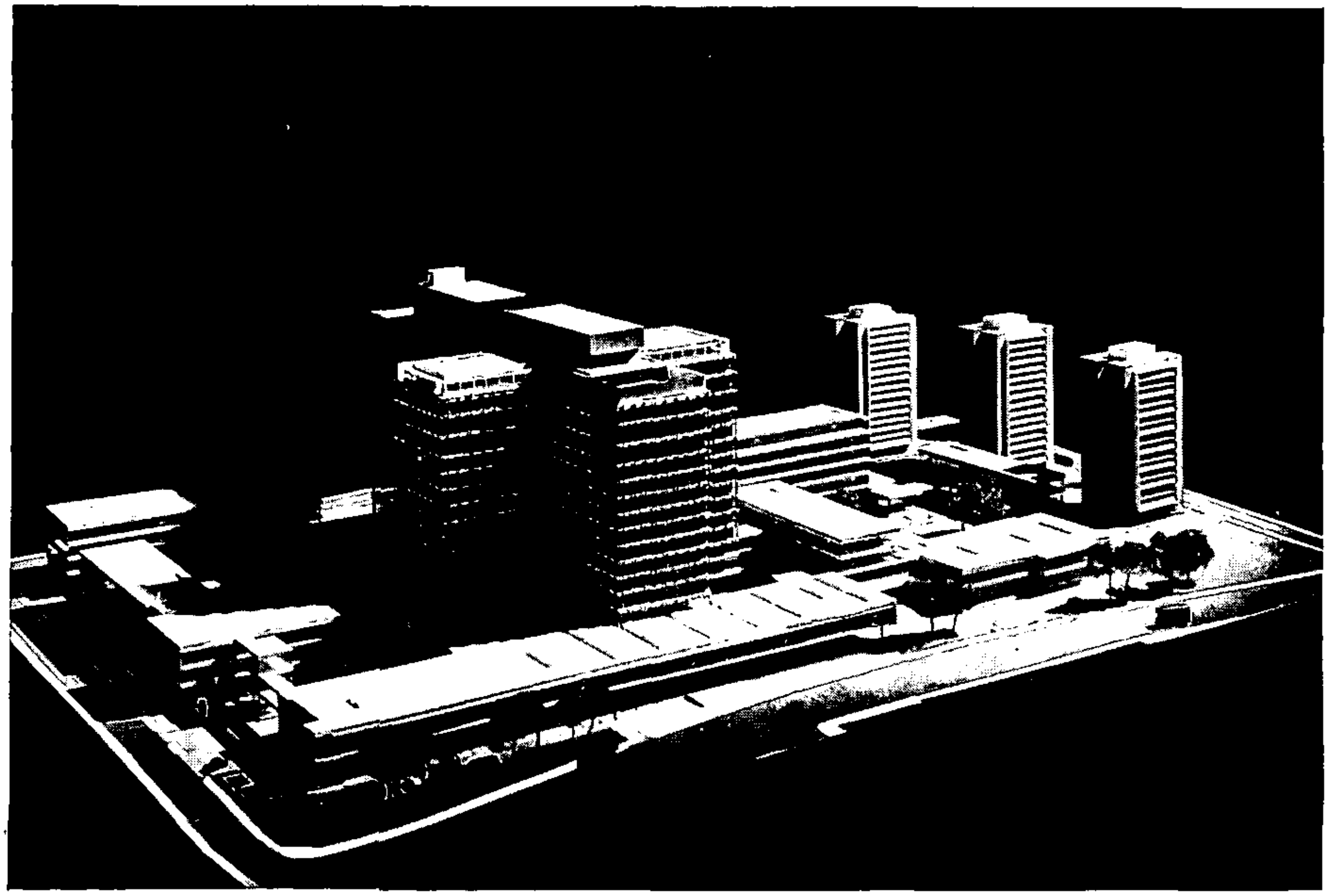
The remainder of the new hospital, including maternity and children's units, geriatric wards and the radiotherapy department, and the completion of partially erected departments such as X ray, catering, physiotherapy and residencies, will be started as soon as the first phase is finished. This will allow the demolition of the present Fulham Hospital, whose patients, like those from Charing Cross, will move into the new building. The medical school, which will be enlarged to probably nearly three times its present size, will also be constructed during this period.

The needs of the staff are not being neglected. A large assembly hall, capable of housing some 500 people and available for dances, theatricals, conferences and symposia, and a swimming bath and squash courts, are shortly to be started. The cost of these—£400 000—will be covered by a special appeal, and this has already received nearly £250 000.

Two of the three residential blocks, containing flats of various sizes to be rented by staff, are now complete and almost ready for occupation. An impressive new School of Nursing is also almost finished, and will be in use before the year is out.

The new Charing Cross Hospital has been built with a view to being ready to meet the demands of the future. General practitioners will be catered for by the inclusion of facilities for postgraduate education and access to hospital service departments. Every attempt will be made to keep the patient out of the hospital bed by the hospital taking some responsibility for community health education, and resting beds will be attached to the comprehensive outpatients' department.

The needs of patients have been carefully studied, and there will be generous provision of toilets and day rooms, and opportunities for ambulant patients to get away from the ward environment, even to using the hospital restaurant.



So Charing Cross Hospital moves towards the 21st century with confidence in its new hospital, planned with much care and foresight by a team which started work in 1959 and has remained intact, with confidence in its ability to obtain staff to work in the accommodation provided, and confident of meeting the wide responsibilities of a district hospital for the London Boroughs of Hammersmith, Chelsea and Kensington. And with this confidence goes pride in the past, in the great work done by generations of doctors, nurses and supporting staffs, and in the example they set.

Taking off the heat

A range of packaged heat-recovery units of revolutionary design has been introduced by Improvair Ltd., well known for their water coolers. The new units, called 'Rotary-X-Changers', will recover up to 80% of the heat or cold normally wasted in the exhaust of an air-conditioning system, which means that the running costs of the heating and cooling equipment could be reduced substantially. They are equally effective in recovering waste heat from industrial processes; the heat saved may be used to supply other processes.

The Rotary-X-Changer is basically a heat exchanger of regenerative type. It has a rotor of knitted wire mesh which revolves slowly while exhaust air passes through one half and inlet air passes through the other. If the exhaust is hotter than the inlet, the mesh is heated in the exhaust stream and gives up the heat gained when it enters the inlet stream. Conversely, if the exhaust is cooler than the inlet (as it might be in an air-conditioned building on a hot day), then heat is transferred from inlet to exhaust.

A bonus feature of this method of heat transfer in air-conditioning applications is that moisture is extracted by condensation from warm moist air, and given up by evaporation to cool dry air. Thus, in winter the incoming air is heated and humidified while in summer it is cooled and dehumidified. The process is largely self regulating, since excess moisture condenses and falls to the base of the unit where it is drained off.

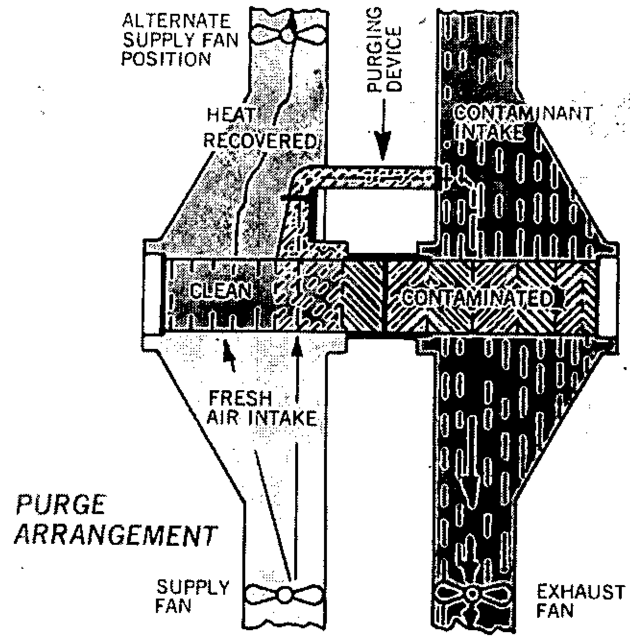


Fig. 2 The exchanger installed in the inlet/exhaust ducting of an air-conditioning system

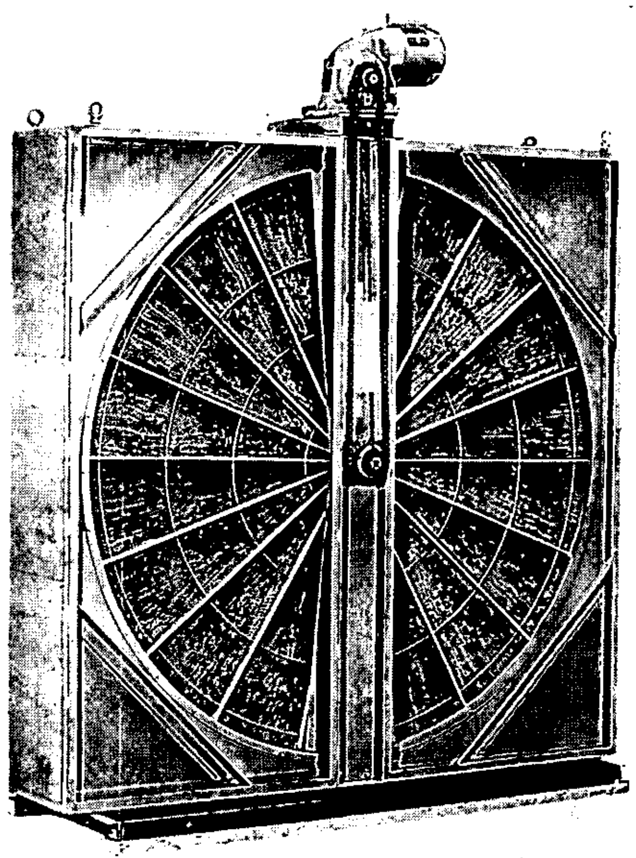


Fig. 1 The rotor of the exchanger is driven at 18–24 rev/min by a geared f.h.p. motor and chain drive. A constant air-inlet temperature can be maintained by using a variable-speed motor with a control system incorporating temperature sensors

To prevent 'short circuiting' through the wire mesh between the exhaust and inlet sides, the rotor is divided into a number of sectors by radial partitions fitted with wiper seals. Similar seals are fitted to the perimeter of the rotor.

Air which would be transferred in the mesh from exhaust to inlet is blown back to exhaust by a small quantity of inlet air in the purge section situated between the exhaust and inlet ducts. Since forced draught is used for the inlet and induced draught for the exhaust, the pressure of the inlet is up to 2 in w.g. above that of the exhaust. The effective sealing, the pressure difference and the purging arrangements together ensure that contamination of the inlet air by exhaust carryover is less than 1% by volume. This figure is acceptable for all known applications, and the equipment is approved for use in hospitals and laboratories.

In addition to the obvious long-term economies to be derived from heat recovery, the manufacturers claim savings in the first cost of a system when a Rotary-X-Changer is incorporated. Smaller heating and refrigerating units are needed, and the saving from this alone is normally sufficient to cover the cost of the Rotary-X-Changer and the additional ducting needed. The unit itself presents no installation problems; it is extremely compact for its capacity, and its low weight allows it to be installed on a roof with little or no structural alteration.

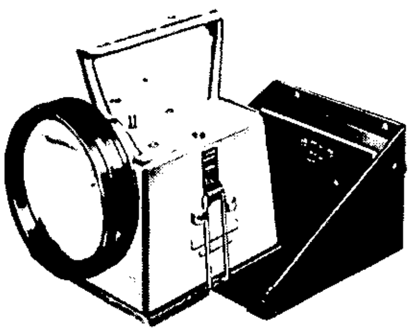
These new units are available in a wide range of sizes, including double-rotor models, to cover all process or air-conditioning applications. A choice of aluminium or stainless-steel mesh allows it to be used in corrosive atmospheres if necessary.

* Market News *

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

Emergency handlamp

A new emergency handlamp, the Bardic HL 50, rests on a bracket fixed to the wall, and is locked in position by a patent solenoid action which prevents the lamp from being removed. However, on mains failure, the lamp is automatically illuminated and freed from the bracket ready for use.



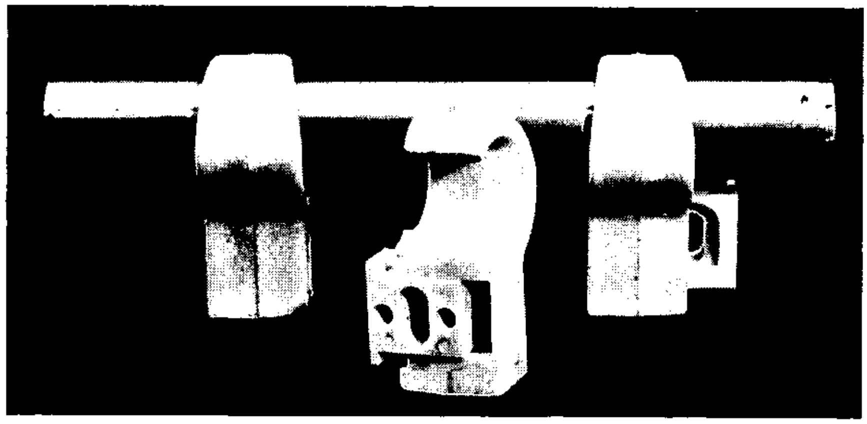
The unit contains a sealed nickel–cadmium battery, which requires no maintenance, and will provide two hours light on mains failure, The battery is automatically recharged when the lamp is returned to the bracket.

This handlamp will be particularly useful to maintenance engineers who may need to carry out essential repairs in areas such as substations and generator houses. It can be ideally sited alongside a mains fuse box, near a generator or at a fire point.

Bardic Systems Ltd., William Street, Southampton **HE 70**

Pipe clips

Two new small-bore halfsaddle pipe clips, specially developed to reduce pipe-fixing time onsite, and to provide a firm, corrosion-resistant support for small-bore pipe installations, have been introduced by Dom Products.



The first of the 'Uni-klip' pipe-clip ranges is injection moulded in high-heat-endurance white polypropylene. Designed for internal use, it is suitable for fixing hot-water pipes in central-heating and air-conditioning installations, as well as other supply pipes, and is available in 0·5, 0·75 and 1·0 in diameters. The second range is in grey p.v.c. in the same sizes, and is suitable for interior or exterior use, particularly for cold-water and gas pipes.

To fix the clip, the half-saddle section is first clipped round the pipe at the required position, and an integral slide-in base is then fixed to the wall with a single screw. The half-saddle is then simply pushed over the base section. Because of their simple application, the clips are also ideal for replacing old or damaged supports on existing pipe runs.

Dom Products (Royston) Ltd., Roysia House, Royston, Herts.

HE 71

Airduct thermostat

A new thermostat, type RT 140, being marketed by Danfoss Ltd., is specially designed for the on/off control of air temperatures in air ducts and plenum chambers. The unit operates through a duct sensor and a capillary tube of 6·5 ft (2 m), enabling the housing to be mounted in any position for easy maintenance and adjustment. The sensor, which may be inserted directly into the air duct or plenum chamber, is of the spirally wound type, providing a large surface area for rapid and accurate air-temperature control.

The thermostat has a temperature range of 59–113°F (15–45°C), an adjustable differential range of 2·7–20°F (1·5–11°C), and a maximum permissible sensor temperature of 212°F (100°C).

Danfoss (London) Ltd., 6 Wadsworth Road, Perivale, Middx.

HE 72

Corrosion-free boiler

A new boiler, designed to overcome the corrosion problems presented by low-temperature return water, has just been introduced by Parca Heating Products. Employing a new technique for mixing the return water, the design removes all limitations on return-water temperature.

Known as the Parca 70, the units are intended basically for either oil or gas firing, but can also be supplied for solid fuel. There are ten models in the range, with capacities from 2 to 16 Btu/h, and are suitable for full district-heating applications and roof-top boilerhouse installation, as well as more conventional uses.

The boiler incorporates a water-cooled firebox, to which is welded a convection unit consisting of vertical flue tubes in a housing.

The temperature of the water in the convection unit can be adjusted by means of an automatically operated by-pass valve, in order to obtain the optimum outside temperature of the flue tubes. For example, if the plant is operated at 43 lbf/in^2, the surface temperature of the tubes can be kept above 275°C—higher than the temperature below which the risk of sulphuric-acid corrosion becomes significant — under all operating conditions.

An integral water-mixing unit is fitted, in which the return water is blended with hot boiler water. No by-pass valve pump is required.

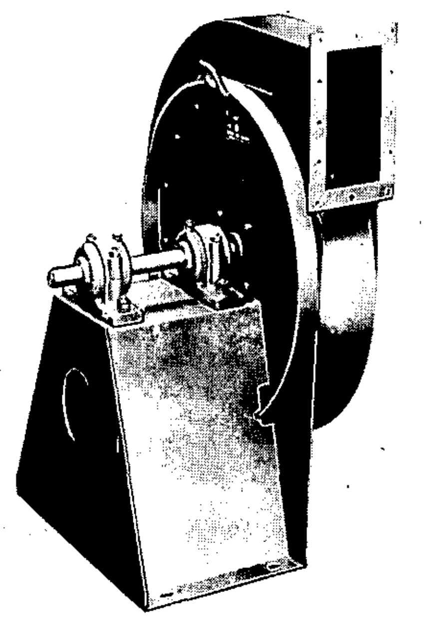
HE 73

Parca Heating Products Ltd., 90 Staines Road, Hounslow, Middx.

High-pressure fans

A comprehensive range of high-pressure units has been added to the metric series of centrifugal and axial-flow fans by Davidson & Co. Ltd.

Known as the Sirocco MHP, the new range caters for all applications involving low or medium volumes against high pressure. It provides 132 different fan configurations — including direct-coupled and belt-driven arrangements — and offers a choice of three types of impeller to meet various operating conditions. Applications for which the MHP range is suitable include combustion



air, gas boosting, air curtaining, waste-gas disposal and fume exhausting.

The fans provide outputs of up to 14 500 m^3/h (8500 ft^3/min) and pressures from 150 to 1500 mm (6 in to 60 in) w.g. The direct-coupled arrangement is suitable for temperatures up to 200°C (390°F), while the belt-driven arrangement can be used at up to 320°C (600°F).

A 24-page catalogue is available.

Davidson & Co. Ltd., Sirocco Engineering Works, Belfast **HE 74**

Pressure switch

Actuated Controls has announced the introduction of a new range of pressure switches, model C. These switches have been designed for direct mounting in control cabinets, consoles or equipment; the omission of the instrument case offers a space saving and flexibility of mounting arrangements.

The switch is produced in five pressure ranges covering up to 150 lbf/in^2. The pressure-responsive element is a precision capsule available in phosphor bronze or as a complete stainless-steel assembly.

The switches can be operated in the temperature range −20°to 60°C, and the variation in operational accuracy over the range is less than 1%. As an alternative to the bare-mechanism assembly, the models are available in industrial, weatherproof or flameproof enclosures.

Actuated Controls Ltd., Vale Lane, Hartcliffe Way, Bristol **HE 75**

Deioniser

A new Elgastat, designed to bring ultrapure water to the laboratory instantly, without chemical regeneration or maintenance, centres around a throw-away ion-exchange can, the 'Elgacan'.

The Mark II is portable and self-contained, requiring no external services. The purifying action is instant and the flow rate up to 15 l/h.

In operation the storage tank is filled with raw water, and deionised water may then be drawn instantly. The purified water passes through a conductivity line cell, and the water quality is checked on a purity meter. When the ion exchangers are exhausted, the Elgacan is removed and replaced with a new one.

The capacity of an Elgacan depends on the total dissolved solids of the influent water. Thus, in London a single can produces 25 l, and in Glasgow, where the raw water is exceptionally good, some 130 l may be produced.

Elga Products Ltd., Lane End, Bucks. **HE 76**

Instrument and equipment washer

A new instrument and equipment washer for hospitals has been introduced by A. Johnson & Co. (London) Ltd. It automatically washes, cleans and dries soiled instruments in wire-mesh baskets by guiding them through five special processes within the 12 ft long machine.

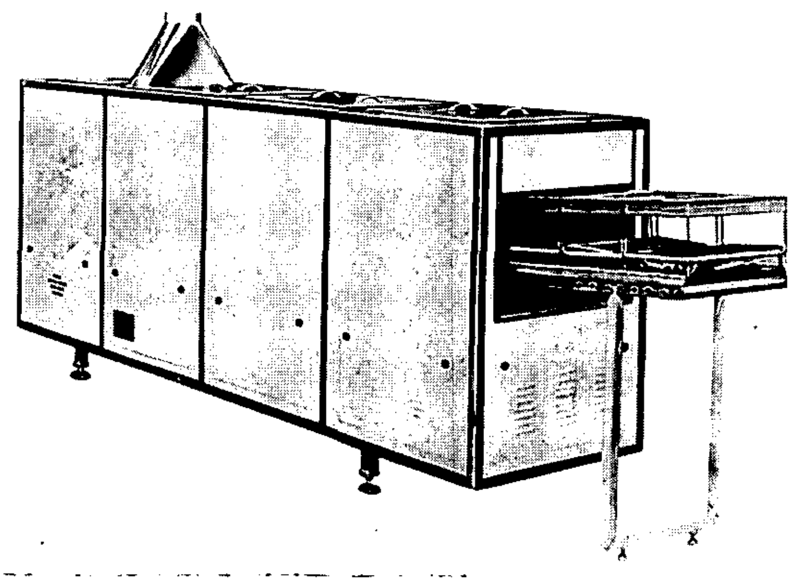
The Mark VIII is designed for incorporation in a flow-line cleaning and sterilising system.

An inclined gravity-feed roller conveyor carries baskets of contaminated instruments into the machine, where a selector system synchronised with the main conveyor drive prevents the entry of more than one basket at a time.

Four cleaning tanks provide a sequence of cold-water power pre-wash, ultrasonic cleaning with water and detergent, cold-water power wash and hot-water rinse. Hot air is then applied in large volumes to ensure adequate drying.

The first basket in a batch takes 25 min to clear the machine, and baskets are subsequently emitted at 3 min intervals.

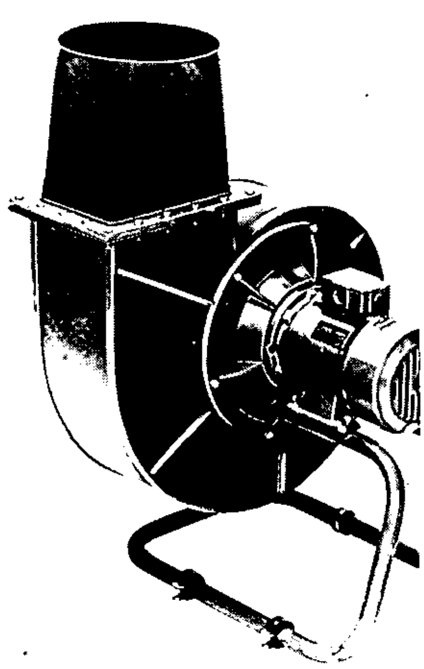
A. Johnson & Co. (London) Ltd., Molly Millars Lane, Wokingham, Berks. **HE 77**



NEW at HEVAC

The International Heating, Ventilating and Air Conditioning Exhibition opens at Olympia on the 20th April and runs for six days. As many of the exhibiting companies number the hospitals among their most demanding customers, there should be plenty on view of interest to the hospital engineer. Many new developments will be on show for the first time.

The big guns will almost undoubtedly be the boiler manufacturers. For example, **John Thompson Cochran Ltd.** (Stand C215) will have five fully automatic package-boiler units on their stand, and a sixth on that of the **National Coal Board** (Stand B155). Making its debut will be the Calpac—the first British-designed hot-water unit to accept flow and return temperature differentials in excess of 100°F, while



Lambert Bros.

offering a 5-year guarantee against gas-side corrosion, tube leakage and thermal shock. It is designed to provide primary heating and also instant domestic hot water when required, and as such the fully automatic unit is probably the most compact of its kind ever produced. The boiler to be exhibited has a primary rating of 2·3 MBtu/h and a secondary rating of 237 kBtu/h.

Going one better, at least as far as numbers are concerned, will be English Electric, exhibiting for the first time as **English Electric Diesels, Boiler Division** (Stand E301), which will have, in addition to six examples from its established Golcalor and Clayton ranges, a new member of the Paxman series of steam boilers. The Paxman H120 is claimed to be one of the lightest and smallest conventional boilers manufactured. Of British design, it comes complete with burner equipment which can handle oil of 3500 s viscosity, and has an output of 1200 lb/h at 150 lbf/in^2. English Electric claim a particularly high efficiency for this new boiler, and also recommend only annual tube cleaning. Incidentally, a further interesting feature of the display will be a cutaway RO33 Clayton boiler, clearly showing the feed-water recirculation principle.

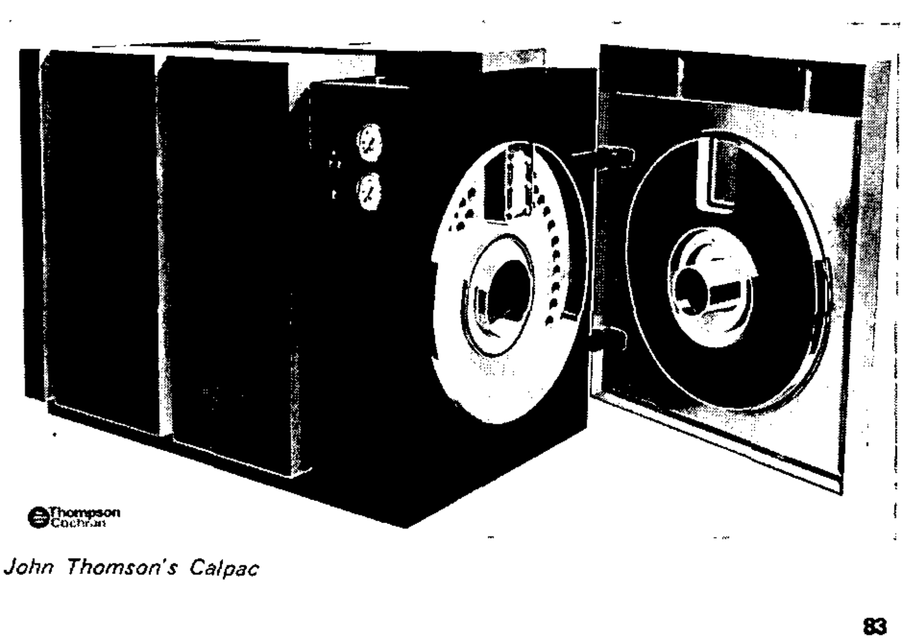
The oldest-established British firm of small packaged air-conditioning equipment manufacturers, **Stewart King Industries Limited**, is keeping its new HL ('High-Low') unit very much in the dark. The unit will produce from 7500 Btu/h upwards, and several novel design features are claimed for it, but details will not be available until the exhibition opens.

Considerably more specific is the description given by **Lambert Bros. (Walsall) Ltd.** (Stand G424) of the new range of lightweight centrifugal fans for the extraction of corrosive fumes from laboratories. The fans are manufactured in West Germany, where they are already widely used, and HEVAC will be the jumping-off point for the distributor's sales effort in the UK. There are 15 sizes of fan in the range, covering 6½ in to 49 in diameters. The five sizes from 6½ in to 16 in are assembled from moulded parts, and three types of direct or V-belt drive motor are available for them. The ten larger sizes, made from fabricated parts, are V-belt driven. The maximum operating pressure is 8 in w.g. Being introduced simultaneously by Lambert are complementary fitments, such as moulded extractor ventilators and adjustable roof plates.

An important field allied to both heating and air conditioning is that of water treatment; so **Houseman & Thompson Ltd.** (Stand H509) will certainly be feeling at home. The stand's *tour de force* will be the largest standard model in the Houseman-Duro duplex automatic water-softening plant range, the ACM 450, on show for the first time. Supplied as a packaged unit, comprising two steel-plate softening tanks, a regenerant tank and 30 ft^3 of ion-exchange resin, and mounted, if required, on a steel base, the ACM 450 will deliver up to 100 gal/min of purified water. Resin regeneration may be initiated by push button, or automatically by calendar clock, water meter or residual-hardness meter.

Satchwell Domestic Heating Division (Stand B160) is a newly formed sales company with the responsibility of promoting control devices manufactured by Satchwell and by Black Automatic Controls. New from the Black range will be a combined governor and solenoid gas valve, solenoid gas/oil valves and low-cost pressure switches. A new development in the domestic-heating field is also to be unveiled.

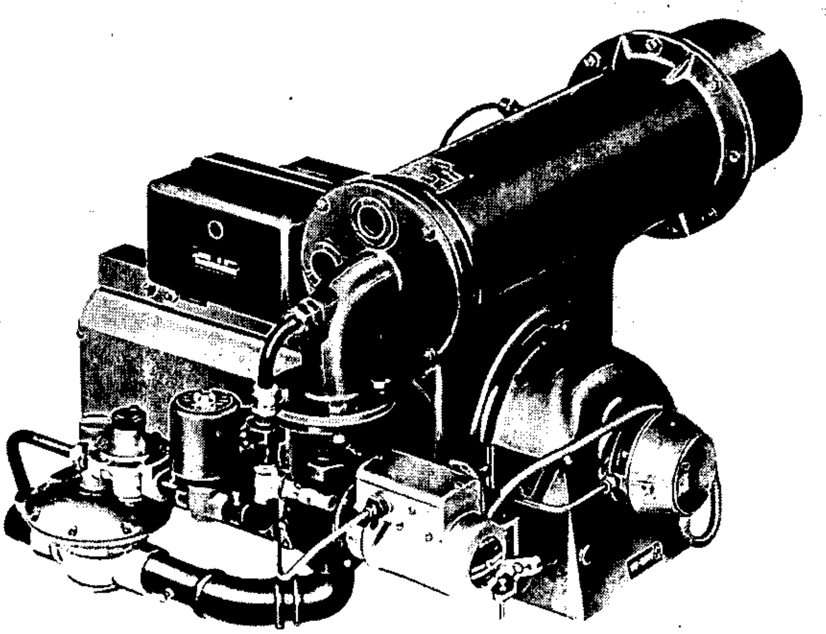
Back to the boilers, or at least to



John Thomson's Calpac

the ancillary equipment. **Nu-way Heating Plants Ltd.** (Stand B167), in addition to its established 'P-Pac' burner, will be exhibiting three new burners. Series A comprises fully automatic oil-fired burners of monoblock construction, suitable for firing light, medium or heavy fuel oils. Series AG burners are nozzle-mix gas-fired units, operating on towns, natural or liquified-petroleum gas. Of particular interest, however, will be the new Dual Fuel range, which can operate on either natural gas or a light distillate oil. As the fuel can be selected by a simple two-position manual switch, these units are capable of providing the dual features of the economy of natural gas combined with the standby capacity of a reserve oil supply.

This year's HEVAC, the sixth, has a total of 320 exhibitors, more than ever before, and will show developments from twelve countries. It should be worth the 5s. admission fee.

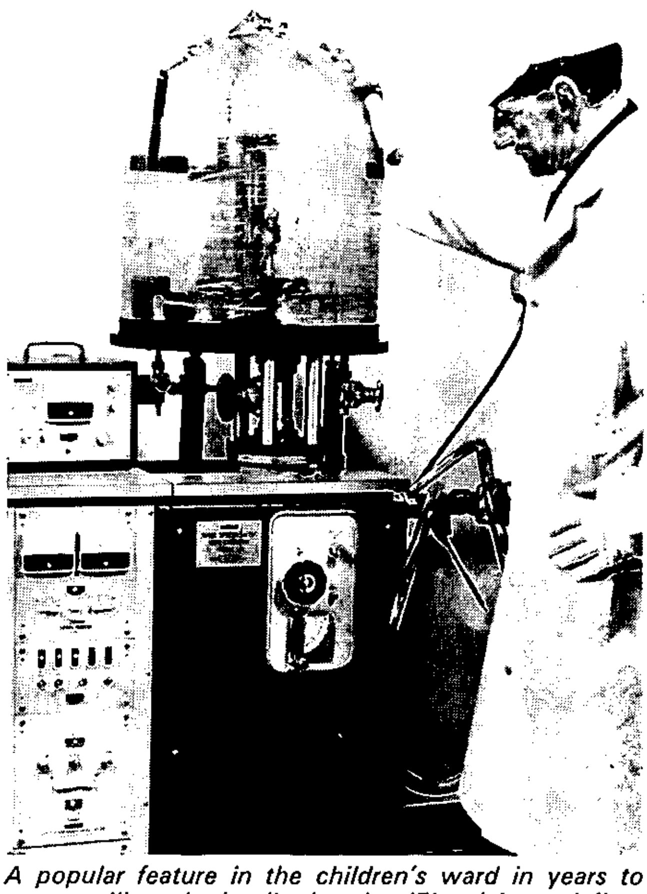


Series AG burner

Clippings

One exhibit at the recent Physics Exhibition illustrated the use of Marconi closed-circuit television in blood- and tissue-screening work. The sample is placed in front of a high-powered microscope or X ray viewer and is viewed with a Marconi black-and-white V321 camera. The image is displayed on a colour receiver, and the system is such that seven levels of sample density are displayed as seven different colours on the receiver screen. The resulting display can be processed electronically to provide an automatic count of the number of cells of each density.

Artificial limbs employing control devices which are operated directly by myoelectric signals in remaining muscles have been under investigation for some time, but the dual problems of replacing the power source of the detector and overcoming the inconvenience and discomfort of having wires coming out through the skin have so far proved to be considerable barriers. Both are removed, however, by a new experimental device, the Emgor, which requires no physical contact with the outside of the skin. It comprises a ceramic cylinder, about 0·75 in long, capped at each end with a platinum alloy. Inside is a passive device, energised inductively by the electronic circuitry of the prosthesis itself. The capsule is implanted inside a muscle, and the presence of a myoelectric signal causes its resonant frequency to change. This change is used to control the movement of a particular actuator in the prosthesis. As the capsule detects only the signal from one muscle, the eventual use of multiple implants to provide more degrees of freedom for, for example, an artificial hand, seems a definite possibility.



A popular feature in the children's ward in years to come will undoubtedly be the 'Floosie' candyfloss generator, demonstrated here by 'Captain' Tim Tallboy, late of Southend pier. Devised especially for hospital service, the machine features fail-safe control and instrumentation, enabling the manufacturers to guarantee a product entirely free of extraneous matter and totally sterile.

Part 2

Electrical-installation testing

by A. Egley

2.2 Earth-continuity test

2.2.1 Object

To ensure that the earth path formed by earth conductors, conduits, sheaths, armouring etc. is continuous, and of sufficiently low resistance to carry the current which would flow as a result of an earth fault.

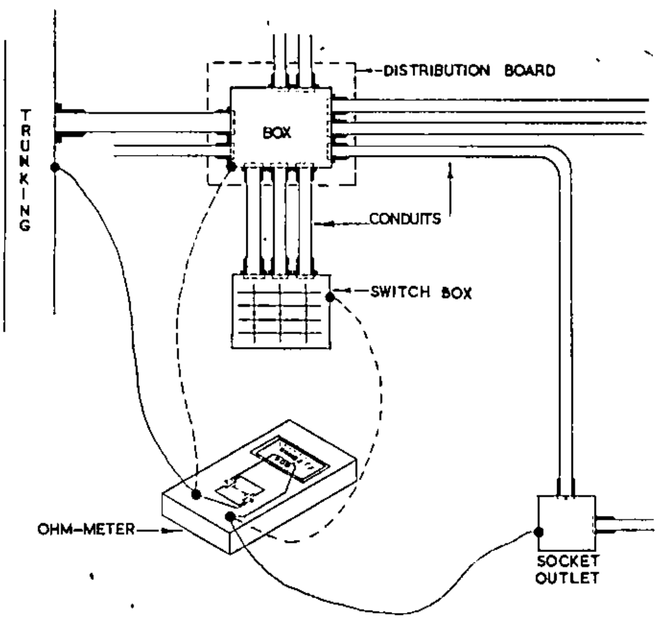


Fig. 3 Earth-continuity test

It is complementary to the earth-loop impedance test, and it is carried out in sections as the installation proceeds, with the supply disconnected.

2.2.2 Instruments

An ohmeter, or a similar tester, is the instrument commonly used. The instrument scale is in ohms, or fractions of an ohm. The instrument is powered either by a hand-driven generator or by batteries, and has auxiliary leads. These leads must be of sufficent section to have a resistance much lower than the conduit or sheath under test, and may have to be of considerable length to span the whole section under test. Their resistance must be known.

2.2.3 Method (see Fig. 3)

The ohmeter is placed near the centre of the run to be tested, and the leads are connected by crocodile or similar clips to each end of the conduit. When the test set is connected, the current that flows is equal to the voltage divided by the resistance of the circuit. The meter reading is in ohms, and is the total resistance, including that of the leads. If the leads are not of negligible resistance, their resistance must be deducted from the meter reading.

With some instruments it is possible to carry out an initial instrument test. In this, the leads are short-circuited, and the instrument pointer then set to read zero. Thus, when the actual test is carried out, the instrument gives the resistance of the conduit alone.

If an installation is too large to be covered by a single test, and a series of tests is taken from the extreme end of the installation back to the supply, then the total resistance is

$R_1 + R_2 + R_3 + \ldots = R_t$, the total resistance

2.2.4 Theory

Whenever alternating current is used, magnetic and electric fields are present. These induce voltages, and hence currents, in conduits, armouring, trunking, sheathing etc. If these are not dissipated they can create problems quite apart from the normal ones of shock and fire. They cause interference with radio, television and electromedical equipment, and with communications in general.

In addition, if a live conductor comes into contact with, or has an arcing fault to, a conduit, it is essential that a protective device, which may be a fuse or a circuit breaker, operates. It cannot do this unless the conduit system is continuous and capable of carrying the fault current. Hence the resistance of the earth path must be low enough to carry the current without producing a large voltage drop.

It is also essential that it be bonded at some point to the general mass of earth. In exceptional cases the earth point will not be the normal solid earth termination, and the fault current will flow through the trip coil of an earth-leakage circuit breaker. These are rare, and are confined to locations where the soil resistivity is high and the supply is provided by overhead cables at medium voltage without an earth conductor. In this event, the current will be small, less than 1 A.

Note

(i) There is a growing tendency towards the use of protective multiple earthing (p.m.e.). In such systems the sheathing of m.i.c.c. and similar cables is the neutral *and* earth-continuity conductor, and conditions are different from those described above. This will not be discussed at this stage, but should it become used in hospitals it should be thoroughly understood.

(ii) Discrepancies will arise if the conduit system being tested is not isolated from the rest, as there may be parallel earth paths. The result will be a lower reading than the actual resistance of the conduit.

(iii) Where lead- or aluminium-sheathed cables are installed with steel-wire or steel-tape armouring, both sheathing and armouring form the earth-continuity conductor. They must be properly bonded and clamped before testing for continuity etc.

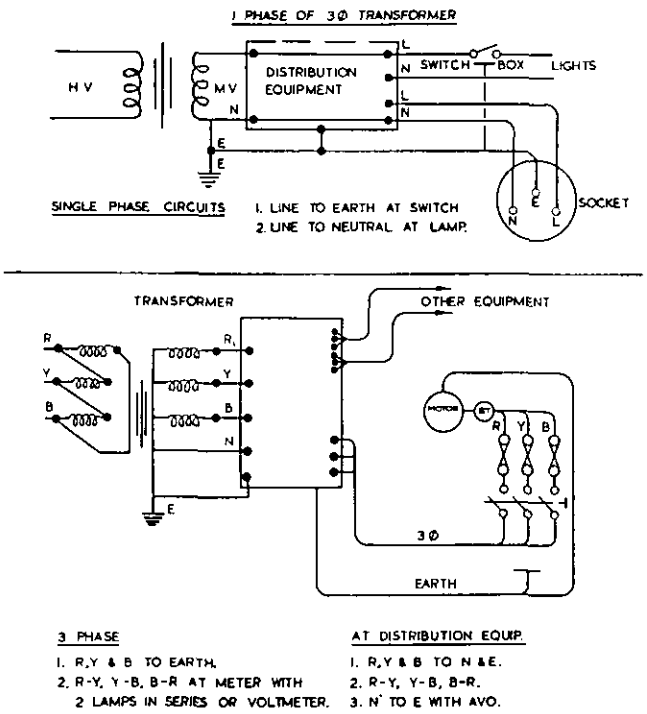


Fig. 4 Polarity test

2.3 Polarity tests

2.3.1 Object

To check that:

(i) all switches on single-phase circuits are in the live (unearthed) line

(ii) the fuses etc. and protective devices are in the live line

(iii) socket outlets, spurs, clock connectors etc. are correctly connected

(iv) all live conductors in 3-phase boards, switches, switch fuses, circuit breakers etc. are connected to a separate live line.

The tests are carried out with the supply live.

2.3.2 Instruments

Two 240 V pygmy lamps in separate lamp holders connected in series, and two flexible leads with prods, crocodile-clip attachment or Avometer. The lamps should preferably be enclosed in an insulated case with either a vision panel or a series of holes in line with the lamp filaments.

Otherwise any commercial instrument used by electricity boards.

2.3.3 Method (see Fig. 4)

(i) Check at the mains switchgear that all phase conductors are connected to separate live leads from the busbar chamber, transformer or electricity board cut-out. (The two lamps in series are safe for 415 – 440 V, which is the normal range at medium-voltage busbars). Bright lamps indicate about 415 – 440 V, *and this should exist between any two line conductors.* Dull lamps indicate about 240 V, which should exist between any line and neutral and between any line and earth. (Note: on small installations where the main supply is controlled by an earth-leakage circuit breaker, the operating coil should be bypassed while the tests are conducted. Otherwise, it may operate every time the test between live and earth is carried out.)

(ii) Repeat at all distribution and switchboard sections. During the tests observe that cable ends are correctly marked: red, yellow and blue phase conductors, black neutral and green earth.

(iii) In each department remove switch covers and check that switches are connected in the live lead. This is done as follows: connect one lead of the test lamp to earth, and, with the light fittings complete with lamp, put the other lead onto one of the switch terminals. Then switch the light (or lights) on. If the test lamps stay alight the switches are correctly connected. If they go out, the switch is in the neutral conductor and should be altered AT ONCE.

(iv) Socket outlets should be tested with a plug specially drilled to accept the probes of the test lamp. The tests should be:

(*a*) line to neutral

(*b*) line to earth

(*c*) the neutral connection at the distribution board should be disconnected and a check made to see that no voltage exists between line and neutral. If it does, the neutral and earth conductors are crossed. However, if the insulation-resistance test has been fully carried out, this fault will have shown up then.

(Note: a neon screwdriver-type test lamp is NOT a proper instrument.)

2.3.4 Theory

All single-pole switches on single-phase circuits should be in the live line. When a person puts the switch in the 'off' position, to change a lamp or fitting, he expects (quite rightly) that the circuit is dead.

However, if the neutral conductor is broken at the *switch, then one peg, either the centre cap, or one side* of gas-discharge lamps, is alive even when the switch is off. This is dangerous and can cost a man his life.

The same applies to a socket outlet or any other single-phase unit. Apparatus which is earthed is lethal when the live conductor is intact and only the neutral is broken at a switch or switched socket.

Remember that a declared supply voltage of 240 V single phase has a peak value of about 1·4 × 240 = 340 V. Also its polarity reverses 100 times each second at the supply frequency of 50 Hz. It is the peak value that does the damage when a person receives an electric shock.

Causes of metal fatigue

Reprinted from 'Vigilance', the journal of the National and Vulcan Engineering Insurance Group.

Introduction

Fatigue, the term originally applied to the well known type of crack mechanism, implied that the metal concerned had become tired. This attitude was taken because it was appreciated that the stress generally involved was theoretically incapable of causing a direct fracture in the accepted sense, and so the theory of the metal gradually weakening through fatigue was proposed as an explanation of the mechanics of failure.

Such an approach was somewhat naive, although it was known then that the necessary prerequisite for failure was the repeated application of stresses over a long period.

Much more is known now, of course, of the fundamental causes, but in spite of this knowledge, the incidence of failure does not seem to diminish, and experience has shown that this particular mechanism is the most prolific in causing breakdown of plant of all descriptions, giving rise to the loss of thousands of production hours each year.

Governing factors

The factors which govern the initiation and propagation of fatigue cracks are well known; the principal

Fig. 1 Photograph of rivet head showing a fatigue fracture which has travelled across the stem owing to alternating bending or shear stresses

ones can be summarised as follows, neglecting the rather obvious one of underdesigning the particular item concerned:

(a) an abrupt change in section or too small a shoulder radius
(b) the presence of other sharp notch effects such as surface scoring, pre-existing defects and coarse machining marks
(c) a sudden change in tensile strength or ductility, such as the edge of a non-stress-relieved weld in a susceptible position
(d) the presence of a high stress at an interface, such as in a keyway or in an interference fit of a wheel on a shaft.

All of these aggravate the situation by building up a concentration of applied stresses, both service and, possibly, residual, to an extent greater than the metal section is capable of withstanding.

The surface condition of the item is of extreme importance, as on a so-called smooth surface, the fatigue will start at any discontinuity—even one of microproportions—which may be present.

Mode of stressing

Fatigue failures can be caused by all the normal stress configurations except possibly by that of direct compression, although the latter has a significant effect if it alternates with a tensile one.

In addition, the stressing must vary over a short period between an upper and a lower limit, whether in tension, bending, torsion or shear. It is not necessary for the stress variations to be rhythmic or equal. In fact, the application of a stress above some maximum permissible value, even for a very short period, may start the crack, and a much lower mean stress will continue to propagate it.

The maximum value used in any design basis is termed the fatigue limit. Such a value can be obtained by doing a number of tests at successively reducing loads and plotting the time on a logarithmic scale, the curve gradually flattening out to a fairly constant value between 10^6 and 10^8.

There are some alloys, however, which, when under corrosion environments, do not display this form of 'safe' stress. With these, it is merely a matter of time before failure occurs. The order of the stressing may be fluctuating, or alternating between compressive and tensile loading, the first mentioned being particularly conducive to fatigue failures if associated with a residual stress.

The results, however, are only really applicable to the set of conditions under which the test itself was carried out, and it is no easy matter to attempt to design any structure on the basis of such fundamental tests. To illustrate some of the factors which may introduce fatigue failures, a number of the more unusual incidents are described below.

Failure of rivet

The rivet had been used for fixing a gusset in a Lancashire boiler to provide a strengthening support between the front plate and the shell. There had been a number of failures of rivets reported at various times, particularly after a change in the firing system from solid to oil fuel.

The fracture face is illustrated in Fig. 1, which shows clearly the type of zonal markings found on a fatigue crack. The point of origin is arrowed, and the pattern displayed indicates that the stress was one of a fluctuating nature; i.e. rising to a maximum and falling back to the initial value.

These stresses would be of a shear or bending nature, or possibly a combination of the two, and applied from one side only. The variation in the texture of the succeeding zones indicates a similar variation in the intensity of the stressing during a propagation period. The dark crescent-shaped crack in the region of the initiation area was covered with a hard iron-oxide scale, probably formed at a high temperature, and a number of surface

Fig. 2 Small fatigue cracks and longitudinal inclusions justbehind the manufactured face. Magnification 100

cracks parallel to this were found when a section, longitudinal to the rivet stem, was taken, and examined microscopically (Fig. 2).

These defects were associated with slag inclusions running just under the surface, and it is probable that the latter had assisted in causing the surface cracks when the riveting was being carried out.

In this case, therefore, while the rivet size was adequate according to the manufacturing code, other factors had been introduced in the assembling and/or during the service life of the boiler, which invalidated the design concept. The predominant factors of the failure mechanism are rather difficult to isolate precisely, but they would be among the following:

(i) high residual stresses caused by the riveting process, and possible misalignment of the rivet and the hole
(ii) the introduction of high strain effects during start up and shut down, due to some differential movement of the shell and the end plate, when the probability of temperature gradients would be at its highest
(iii) the presence of surface cracks similar to these illustrated, which, if present when the rivet was inserted, would act as a stress-concentration factor
(iv) any slight corrosive tendency of the steam, due, for example, to the presence of carbon dioxide, would assist in the initiation and propagation of the initial defects.

Failure of shaft from hoist motor

This motor was engaged in an application where fairly heavy loads were used, and the process involved a lot of 'inching', both during hoisting and lowering. It can be seen, therefore, that the conditions for repeated fluctuations of stress would apply to the various parts of the transmission system.

The part which failed, and which was sent to the laboratory for examination, was a splined shaft which actuated the braking mechanism; it can be appreciated that this would take the full brunt of the stress cycling involved in the inching movement.

Fig. 3 Photograph of splined shaft with coarse machining marks on the reduced section, from which a fatigue fracture was initiated

The fracture had occurred on a reduced section of the shaft, and it could be seen that the line of initiation followed the rather coarse machining marks on the shoulder (Fig. 3). From the contour and zonal markings on the crack face, it was evident that the fatigue stresses were principally bending in the early stages, but had changed into part-torsional after the crack had developed a little way into the shaft.

During the sectioning of the shaft, it was discovered that cracks were present at the roots of other coarse machining marks behind the crack face, and also in the corners of the splined recesses. A transverse microspecimen was made, and one section of it is illustrated in Fig. 4, which shows the characteristics of the cracks found.

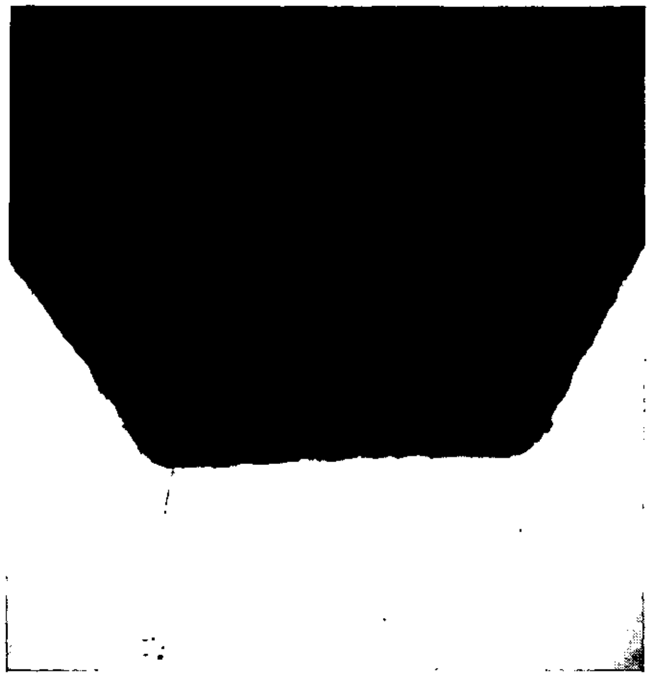


Fig. 4 Photomicrograph, unetched, showing small fatigue cracks starting on the base of the splines. Magnification 100

The situation was thus more complicated than was first thought, but a subsequent examination of the bearings on the machine showed that these had worn, giving rise to a degree of displacement, resulting in misalignment of the shaft and a very sudden braking action.

Here again, the design had been out of context with actual service conditions, the principal factor in the failure being the continual load fluctuation on the machine, which had reached well over 10 000 000 c.

During this period the misalignment would have given rise to a continuous rotating bending moment, which concentrated stresses at the machining marks in the reduced section of the shaft and set the transverse cracking mechanism in motion.

The timing of the onset of the longitudinal cracking in the splined section is difficult to assess, but it is considered to have been coincident with the torsional fatigue part of the transverse fracture.

* Members Diary *

INTERNATIONAL HOSPITAL EQUIPMENT, MEDICAL ENGINEERING AND SERVICES EXHIBITION

INSTITUTE CONFERENCE.

The Institute is to hold an additional one-day conference at Earl's Court, London, on the 17th June 1970, during this exhibition.

The morning session will comprise a paper entitled 'Use of natural gas in hospitals', which will embrace

(i) the national conversion programme for natural gas
(ii) tariff and contract gas-pricing policy
(iii) boiler changeover from other fuels to gas
(iv) standby fuels
(v) application of total energy in hospitals.

After the paper, there will be a discussion period, and questions will be answered by a panel of technical experts from the staff of the UK Gas Council.

The afternoon will be devoted to a session on 'Sterilisation—changes in organisation and techniques'. This will be lead by Doctor Cameron Weymes, T.D., M.Sc., M.R.C.P.(G), D.P.H., Medical Superintendent, Victoria Infirmary, Glasgow, and Doctor J. H. Bowie, M.B., Ch.B., F.R.C.P., of the Royal Infirmary, Edinburgh. This session will also develop into a general discussion when further contributions will be made by other specialists in the field.

Conference leaflets and exhibition tickets will be distributed in due course.

New Members

NEW MEMBERS

Applications for membership have resulted in the following elections:

Members

Dale, K. H.	Harrogate	*Leeds RHB*
Emery, R.	Liverpool	*Abbott and Partners*
Hackett, D.	Bristol	*Parsons, Brown and Partners*
Lowe, D.	Frimley	*Foramaflow Ltd.*
McLennan, J.	Bristol	*Hoare, Lea and Partners*
Purves, J.	Liverpool	*North Liverpool HMC*
Rochester, J.	Weybridge	*S.F. Air Treatment Ltd.*
Sandison, J. P.	Birmingham	*Pashler and Partners*

Associate Members

Brookes, J. R.	Birmingham	*East Birmingham HMC*
Cleminson, R. N.	Fulham	*Charing Cross Hospital Board*
Glasper, R. A.	Sunderland	*Sunderland Area HMC*
Hardy, J. W. E.	Wokingham	*Hamworthy Engineering Ltd.*
Hargreaves, D.	Doncaster	*Doncaster HMC*
Hayhurst, T.	Blackburn	*Blackburn and District HMC*
Hurst, M. H.	Aylesbury	*Royal Buckinghamshire and Associated Hospitals HMC*
James, J. L.	Bristol	*Abbott and Partners*
Lea, D.	Barnsley	*United Sheffield Hospitals*
Long, P. H.	Newport	*United Cardiff Hospitals*
Marchant, R.	Surbiton	*Kingston and Long Grove Group HMC*
Marshall, G.	Nelson	*Burnley and District HMC*
Mowbray, J. T.	London	*Central Middlesex HMC*
Muir, G. J.	Liverpool	*South Liverpool HMC*
Pitblado, G. M.	Darlington	*Darlington and District HMC*
Poland, E. I.	Liverpool	*East Liverpool HMC*
Powell, J. R.	Roehampton	*Westminster Hospital Board*
Shoebridge, D. J.	Bristol	*Cossham and Frenchay HMC*
Smurthwaite, P. J.	Clevedon	*Hoare, Lea and Partners*
Stamps, J. H.	Accra, Ghana	*Societé Commerciale de L'Ouest Africaine*
Taylor, H.	Horsham	*The Royal Earlswood Group HMC*
Tyrer, S. B.	Winterborne	*South Western RHB*
Washington, J. H.	Macclesfield	*Macclesfield and District HMC*
Watts, O. A.	Dorchester	*Dorset (Herrison, Dorchester) HMC*

Graduates

Charles, G.	Castleford	*Leeds Group (B) HMC*
Dunnett, J.	Aberdeen	*Aberdeen General Hospitals BOM*
French, J.	Warrington	*Warrington and District HMC*
Lea, W. F.	Chelmsford	*Chelmsford Group HMC*
Neill, R.	Grassington	*High Royds HMC*
Price, P. W.	Horsham	*The Royal Earlswood Group HMC*
Thomas, G. F.	London	*Royal Free Hospital Board*
Tunnicliffe, G. J.	Stoke-on-Trent	*North Staffordshire HMC*
Ward, S. G.	London	*King's College Hospital Board*

Student

Reid, J.	Murthly	*Murray Royal and Murthly Hospitals BOM*

Associates

Broom, R. A.	Chingford	*Fan Application & Engineering Ltd.*
Stringer, B.	Boston	*Sheffield RHB*

Affiliates

C. H. Blackburn & Co. Ltd.	Calne
Castan Ltd.	Portsmouth

Obituary

We record with regret the death of Mr. W. Ewing, Engineer at the Glen O'Dee Hospital, Banchory. Mr. Ewing was taken ill with influenza and, although admitted to the Aberdeen Royal Infirmary, failed to respond to treatment.

Willie Ewing was a staunch member of the Institute over many years. He had been Chairman of the Mid-Scotland Branch for the last four years, and his untimely death is a blow both to the Branch and to the Institute as a whole.

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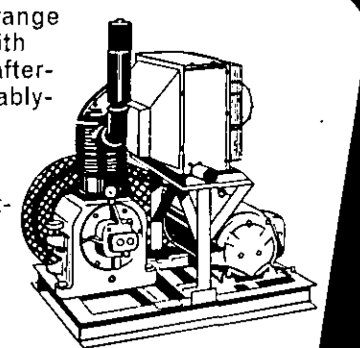

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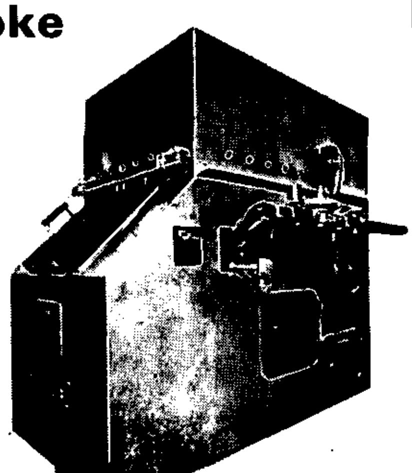

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ILFORD AND DISTRICT HOSPITAL MANAGEMENT COMMITTEE

GROUP WORKS ASSISTANT ENGINEER

(TWO POSTS)

One at GOODMAYES HOSPITAL, Barley Lane, Goodmayes Ilford, Essex, who will be required to assist the Hospital Engineer over the whole range of duties. House accommodation is available at a moderate rental.

One at DAGENHAM HOSPITAL, Rainham Road South, Dagenham, Essex, who will be directly responsible to the group engineer.

Applicants should possess the ONC, or equivalent qualification, but consideration will be given to an appointment on an abated salary scale which applies to applicants without the stipulated qualifications.

Terms and conditions are in accordance with the Professional and Technical 'B' Whitley Council. Salary scale £1077-£1403 per annum (unabated) plus £90 London weighting per annum. Posts are superannuated.

Applications giving full details, together with the names of two referees, to the Group Secretary, King George Hospital, Eastern Avenue, Newbury Park, Ilford, Essex, within 14 days of the appearance of this advertisement.

BOARD OF MANAGEMENT FOR GLASGOW SOUTH-WESTERN HOSPITALS DEPUTY GROUP ENGINEER

Applications are invited for the above new post. The successful candidate will be required to deputise for the group engineer for the operation and maintenance of all engineering services in this group of four hospitals of approximately 1500 beds. Experience in hospital or allied service engineering is desirable. Applicants must have completed an apprenticeship in mechanical or electrical engineering and must hold one of the following qualifications or an approved equivalent:

(i) HNC or HND in (a) mechanical engineering with endorsements in industrial organisation and management and principles of electricity or electro technooogy, or (b) in electrical engineering with endorsements in industrial organisation and management, and including (at S 111 or 02 level) endorsements in applied heat and applied mechanics

(ii) City & Guilds mechanical-technicians Full Technological Certificate (Part III) which must include plant maintenance and works service. Salary scale £1514 – £1774 per annum, plus £75 special responsibility allowance. Applications, stating age, qualifications and experience, with names and addresses of two referees, should be sent to the Secretary, Board of Management for Glasgow South-Western Hospitals, 1345 Govan Road, Glasgow SW not later than 20th April 1970

SENIOR SUPERINTENDENT (ELECTRICAL)

Required by the GOVERNMENT OF KENYA, Ministry of Works, on contract for one tour of 24 months in first instance. Salary according to experience in scale Kenya Shillings 29 880–33 420 (approx. £1743–£1949) plus an inducement allowance of £926–£956 a year paid direct to the officer's bank in the UK. Gratuity 25% of total salary drawn inclusive of generous leave or 45% without leave. Free passages. Education allowances. Quarters at reasonable rental. Contributory pension scheme available in certain circumstances.

Candidates, must possess City & Guilds Full Technological Certificate or equivalent, and must have had at least 12 years' experience (including a comprehensive engineering apprenticeship followed by at least seven years in a supervisory position) in (*a*) the maintenance of electrical and mechanical equipment and services and medical equipment in large modern hospitals, preferably a teaching hospital. (*b*) the operation and maintenance of diesel-engine-driven alternators and l.t. and 11kV distribution systems. Officer appointed will be responsible for the maintenance of building structure and finish, hospital grounds and roads, hospital vehicles, electrical and mechanical engineering, building services and medical equipment at the Kenyatta National Teaching Hospital, Nairobi.

Apply to CROWN AGENTS,'M' Division, 4 Millbank, London SW1, for application form and further particulars, stating name, age, brief details of qualifications and experience, and quoting reference number M2T/681110/HR

ST. JAMES' HOSPITAL MANAGEMENT COMMITTEE PORTSMOUTH

GROUP ENGINEER

required to be responsible for the organisation and control of engineering services in this single-hospital group. An incentive-bonus scheme has been prepared by management consultants, and is in operation. The successful candidate will be expected to assume a key role in maintaining and developing this scheme.

Insight into management problems is essential. Proven managerial ability is as important a qualification for the post as the appropriate technical expertise.

Applicants must hold an approved engineering qualification in accordance with PTB Circular 191.

Salary scale £1713–£1995 with special-responsibility allowance of £25 per annum.

An unfurnished house may be available.

Job description and application from from Group Secretary.

Re-advertisement

NORTH MONMOUTHSHIRE HOSPITAL MANAGEMENT COMMITTEE

NEVILL HALL HOSPITAL
Abergavenny, Mon.

HOSPITAL ENGINEER

required

The successful applicant will be responsible to the group engineer for the maintenance of all engineering services at this hospital and four smaller hospitals.

Nevill Hall is a newly opened general hospital, the first phase of which consists of 192 acute beds. The second phase, scheduled to commence in 1971, will increase the bed complement to 340. The present engineering services include semiautomatic steam-boiler plant and continuous site generation of electricity.

Applicants must have completed an apprenticeship in mechanical or electrical engineering and should possess one of the following qualifications, or equivalent qualification approved by the Secretary of State for Social Services:

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

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

(iii) MOT First Class Certificate of Competency, which includes an Ordinary National Diploma or Ordinary National Certificate; or

(iv) Higher National Certificate or Higher National Diploma in Mechanical Engineering with endorsement in industrial organisation and Management and Principles of Electricity or Electrotechnology, if this was not taken as a subject of the course; or

(v) Higher National Certificate or Higher National Diploma in Electrical Engineering, with endorsements in Industrial Organisation and Management and including (at SIII or 02 level, or with endorsements in) Applied Heat and Applied Mechanics, coupled with suitable practical experience in mechanical engineering.

Salary scale: £1403 rising to £1658 per annum plus a special-responsibility allowance of £100 per annum. Unqualified candidates will be considered on an abated scale.

Application forms and further details are obtainable from the Acting Group Secretary, North Monmouthshire Hospital Management Committee, Nevill Hall Hospital, Abergavenny, Monmouthshire, and must be returned by the 30th April 1970

ASSISTANT HOSPITAL ENGINEER

Ideal experience and training for young engineer seeking advancement. ONC (02) engineering desirable, and good practical training in the maintenance of mechanical and electrical services. Salary £1077, rising to £1403, plus London weighting. Consideration will be given to the appointment, on an abated scale, of persons without these qualifications.

Job descriptions are available from the hospital secretary. Applications, giving full details of training, qualifications and experience, naming two referees and quoting Reference P89, should be sent to the Hospital Secretary, Kings College Hospital, Denmark Hill, London SE5, by the 26th April 1970

MAPPERLEY HOSPITAL, NOTTINGHAM

ASSISTANT ENGINEER

required for the above psychiatric hospital. Applicants must have completed an apprenticeship in mechanical or electrical engineering and hold an Ordinary National Certificate in engineering or an approved qualification. The successful candidate will have the opportunity to gain experience over a wide range of hospital engineering, and will be encouraged to study for further qualifications.

Salary scale £1077-£1403

House available

Applications to the Group Engineer.

BURY & ROSSENDALE
HOSPITAL MANAGEMENT COMMITTEE

GROUP ENGINEER

Applications are invited for the post of group engineer for the above group which consists of 10 hospitals with a total bed complement of 1200.

Applicants:

(i) must have completed an apprenticeship in mechanical or electrical engineering or have otherwise acquired a thorough practical training as appropriate to the duties and responsibilities of the post. They should have wide experience in the management of mechanical and electrical engineering plant, in the control of maintenance and operation of staff and in the preparation of estimates and reports

(ii) must hold one of:

(a) HNC or HND in mechanical engineering with endorsements in industrial organisation and management and principles of electricity or electrotechnology, if this was not taken as a subject of the course
(b) HNC or HND in electrical engineering with endorsement in industrial organisation and management and including (at S111 or 02 level, or with endorsement in) applied heat and applied mechanics, provided he has suitable practical experience in mechanical engineering
(c) City & Guilds mechanical-engineering technicians Full Technological Certificate (Part III) which must include plant maintenance and works service.
The salary is in accordance with points range 48½—60; £2044 rising by 5 increments to £2409 plus a special-responsibility allowance of £100 per annum.

Applications, giving age, experience and qualifications, together with the names of the referees, should be sent to:

The Group Secretary, Bury and Rossendale Hospital Management Committee, Bury General Hospital, Walmersley Road, Bury, Lancs. BL9 6PG, not later than 25th April 1970

THE RETREAT YORK

Group Engineer

Applications are invited for the post of engineer at this independent psychiatric hospital of 275 beds.

A three-bedroomed house is available at a reasonable rent. Pension scheme transferable to and from National Health Service scheme. Free life assurance.

Applicants must have completed an apprenticeship in mechanical or electrical engineering, or have otherwise acquired a thorough practical training as appropriate to the duties and responsibilities of the post. They should have wide experience in the management of mechanical and electrical engineering plant, and the control and supervision of building and maintenance staff.

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

(i) Higher National Certificate or Higher National Diploma in mechanical engineering with endorsements in industrial organisation and management and principles of electricity or electrotechnology

(ii) Higher National Certificate or Diploma in electrical engineering with endorsements in industrial organisation and management and including (at SIII or 02 level, or with endorsement in) applied heat and applied mechanics, provided they have suitable practical experience in mechanical engineering

(iii) City & Guilds mechanical engineering technicians Full Technological Certificate (Part III), which must include plant maintenance and works service.

Salary £1608–£1856 plus special-responsibilities allowance of £50.

Application forms and job description obtainable from The Secretary, The Retreat, York

Bro Morgannwg Hospital Management Committee
Hospital Engineers

We require hospital engineers for (*a*) Neath General Hospital (covering hospitals in the Neath and Port Talbot areas) and (*b*) for Glanrhyd *Hospital (700 psychiatric beds)*, Bridgend.
Main work involved: These appointments entail responsibility to the Group Engineer for the mechanical and electrical maintenance services at these hospitals.
Applications: Applications are invited from persons who have completed an indentured apprenticeship in electrical or mechanical engineering or have acquired a thorough practical knowledge as distinct from a purely craft training. They should be familiar with planned maintenance procedures and have a sound knowledge of boiler plant, mechanical and electrical equipment and wide experience in their maintenance. Applicants should be in possession of one of the following qualifications or an equivalent qualification approved by the Department of Health and Social Security:
(i) HNC or HND in mechanical engineering with endorsements in industrial organisation and management and principles of electricity or electrotechnology
(ii) HNC or HND in electrical engineering with endorsements in industrial organisation and management and including (at SIII or 02 level) applied heat and applied mechanics, provided they have suitable practical experience in mechanical engineering
(iii) City & Guilds Mechanical Engineering Technician's Field Technological Certificate (*part III*), *to include plant* maintenance and works service.
Persons without these qualifications but with exceptional hospital experience and knowledge may also be considered.
Salary scale: Salary for post (*a*) is based on a pointage of over 24½ points; i.e. £1514-£1774 per annum, *plus a special responsibility* allowance of £50, and the salary for post (*b*) is based on a pointage of up to 24; i.e. £1403-£1658 per annum. A house is available at a reasonable rental at Glanrhyd Hospital, but no accommodation is provided at Neath Hospital.
Application forms are available from the Personnel Department, 'Garthmor', Old Road, Neath, Glam. (Telephone Neath 3606), and should be returned by 24th April 1970

WIGAN AND LEIGH HOSPITAL MANAGEMENT COMMITTEE

HOSPITAL ENGINEER required for BILLINGE HOSPITAL. *Progressive post in fast-developing hospital now in second phase of major development* and ultimately to have 650 beds. The successful applicant will be responsible to the group engineer for the mechanical and electrical services.

Applicants must have completed an apprenticeship in mechanical or electrical engineering and must possess one of the following qualifications or an approved equivalent:

City & Guilds mechanical-engineering technicians Certificate (Part II) which must include plant maintenance and works service

City & Guilds Certificate in plant engineering

MOT First-Class Certificate of Competency, if it includes an Ordinary National Diploma or ONC

Salary scale: £1403–£1658 plus £75 responsibility allowance.

Applications, with full details and names of two referees, to Secretary, Wigan and Leigh Hospital Management Committee, Royal Albert Edward Infirmary, Wigan, Lancs., within 10 days of the appearance of this advertisement.

COURSES

Current practice in FUEL EFFICIENCY

The 17th Annual Refresher Course for Managerial and Technical Staffs, at Southampton University during the week 13th–18th September 1970.

Fuel in the 70s – cost comparisons – instrumentation – maintenance – burners – additives – ancillaries – developments.

Organised by Portsmouth Polytechnic, supported by Southampton College of Technology and major local industries.

Fees: residential £35; non-residential £25.

Details from Dr. M. E. Horsley, Department of Mechanical Engineering, Portsmouth Polytechnic, Anglesea Road, Portsmouth Telephone: Portsmouth 21371, *extension* 19, *Locksheath* 2759

CLASSIFIED ADVERTISEMENTS

continued from previous page

APPOINTMENTS and SITUATIONS VACANT

GREENWICH AND DEPTFORD HOSPITAL MANAGEMENT COMMITTEE

GREENWICH DISTRICT HOSPITAL

DEPUTY GROUP ENGINEER for group of two hospitals to be replaced by new 800 bed hospital now being built and partly open which is of advanced design, fully air-conditioned and incorporates large mechanical and electrical installations.

Experience in planned preventive maintenance desirable. 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 electrotechnology, if this was not taken as a subject of the course.

(ii) Higher National Certificate or Higher National Diploma in electrical engineering including (at S111 or O2 level, or with endorsements in) applied heat and applied mechanics, provided he has suitable practical experience in mechanical engineering.

(iii) City & Guilds mechanical-engineering technicians Full Technological Certificate (Part III) which must include plant maintenance and works service.

Salary £1779 rising to £2039 per annum. Furnished flat available at reasonable rent. Further details about post from group engineer.

Applications, giving details of qualifications and experience and naming two referees, to Group Secretary, Greenwich District Hospital, Vanbrugh Hill, London SE10 by 24th April.

Lewisham Hospital
London SE13
HOSPITAL ENGINEER

Salary £1704–£1964 including £90 London weighting and £100 special-responsibility allowance. (Accommodation may be available to successful candidate.)

Applicants must have completed an apprenticeship in engineering, have good practical experience and be qualified in accordance with PTB Circulars 191 and 223 (or equivalent approved by Department of Health.)

Application form and job description available from Group Secretary, Lewisham Hospital (Telephone 01-690 4311; extension 111.) Closing date 17th April

MISCELLANEOUS

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

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HE5	HE25	HE45	HE65	HE85
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HE7	HE27	HE47	HE67	HE87
HE8	HE28	HE48	HE68	HE88
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HE10	HE30	HE50	HE70	HE90
HE11	HE31	HE51	HE71	HE91
HE12	HE32	HE52	HE72	HE92
HE13	HE33	HE53	HE73	HE93
HE14	HE34	HE54	HE74	HE94
HE15	HE35	HE55	HE75	HE95
HE16	HE36	HE56	HE76	HE96
HE17	HE37	HE57	HE77	HE97
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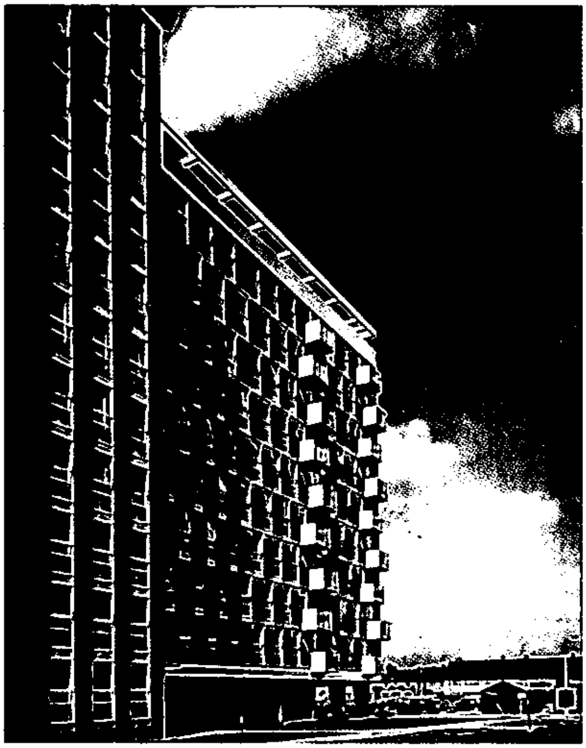


One of the blocks of flats in the Billingham (Teesside) district heating scheme

Associated Heat Services Limited

Associated Heat Services sell – not heating – but heat; that's the simplest way to sum up a service that really is a breakthrough for local authorities, estate developers, industrialists, and almost anybody who needs heat on any scale at all.

The customers of A.H.S. simply enter into a contract for heat. For a monthly or quarterly fixed payment (or if the customer prefers, on a tariff linked to actual consumption), A.H.S. supply it. Even this simple foreknowledge is a much appreciated benefit to those who have to deal with budgets. And there is no need for the customer to deal with any heating problems of any kind. Technical difficulties, replacement of parts or even complete boilers, staffing the boilerhouse, sending deputies if the regular man is sick (or even if *all* the regular men go down in an epidemic), proper maintenance, and all the rest of it – those become A.H.S. problems under the contract.

From factory premises and office blocks (both large and small) to complete industrial estates served by a central boilerhouse, all are eminently suitable for the A.H.S. deal. One of the most ambitious of the company's projects is at Billingham, Teesside where A.H.S. deal with a complete district heating scheme. This includes shops, flats, an hotel, nightclub, municipal offices, a theatre/cinema, and Europe's first Sports Forum (housing a wide range of sports facilities under one ultra modern roof) – all served by one central coal-fired boiler.

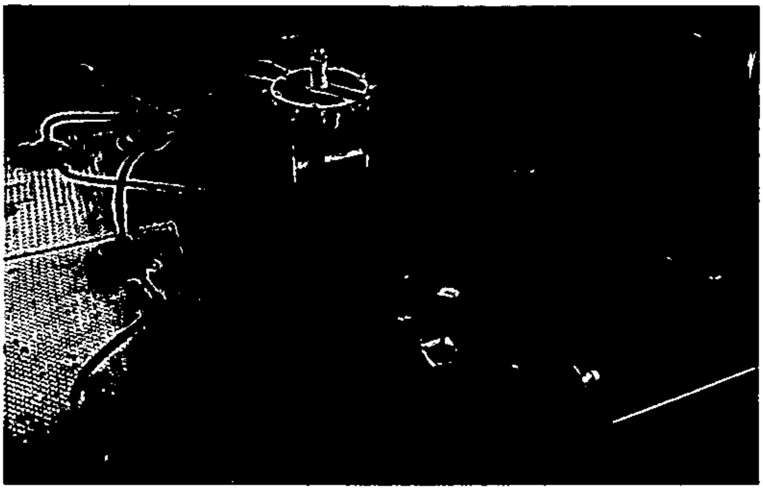
However big or small your boiler plant it makes good sense to give all your heating problems to A.H.S. Write or telephone their Head Office at 3, Hobart Place, London, S.W.1. (01-245 9161).

'Octopus' offers a new upswing in profitability to the brick industry.

Here's another breakthrough in solid-fuel utilisation – a dramatic improvement in kiln-firing techniques that has already proved itself in Britain's leading brickworks. Each of the tentacles of the 'Octopus' is a distributor-pipe which blows an air/coal mixture into the kiln. The coal burns in suspension inside the kiln, so that combustion is uniquely complete and uniform. The even distribution of heat makes control of temperature more exact, which is especially important where the firing cycle is fully automatic. Thermocouples inside the kiln can be linked to the feeders and control the temperature to within 10° at 1000°C.

In practice, it is found that the 'Octopus' gives better quality bricks, lowers wastage, minimises fuel costs – with *no* off-setting disadvantages. One brickworks, for example, hopes to double its annual output from 6,500,000 to 13,000,000 bricks with the installation of a new kiln and an 'Octopus' firing system. Another raised its output of first-quality bricks from 80% to 95%, with 4% of seconds and only 1% waste.

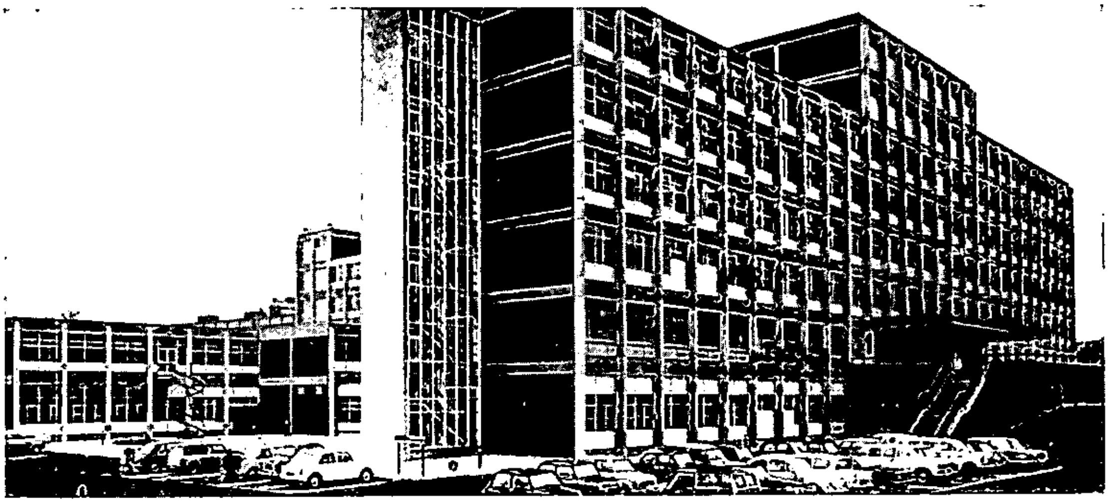
Another advantage is that production can be speeded when the 'Octopus' is installed. In one 16-chamber continuous kiln, it has proved possible to fire one more chamber a week, on average. Conversion is easy, too. 'Octopus' can be installed without interrupting production. This is only one example of the way in which solid-fuel technology is keeping pace with the needs of the 70s.



The 'Octopus' in action at the Throckley Brick Factory of the Northern Brick Company, in Northumberland.

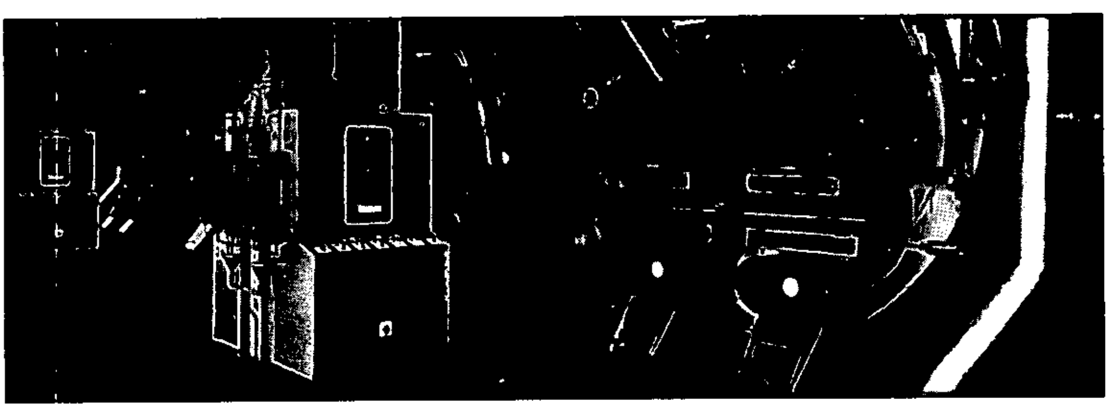
Rowntree Mackintosh

ney for Britain's Hospitals.



AT BIRMINGHAM: coal saves National Health Service money

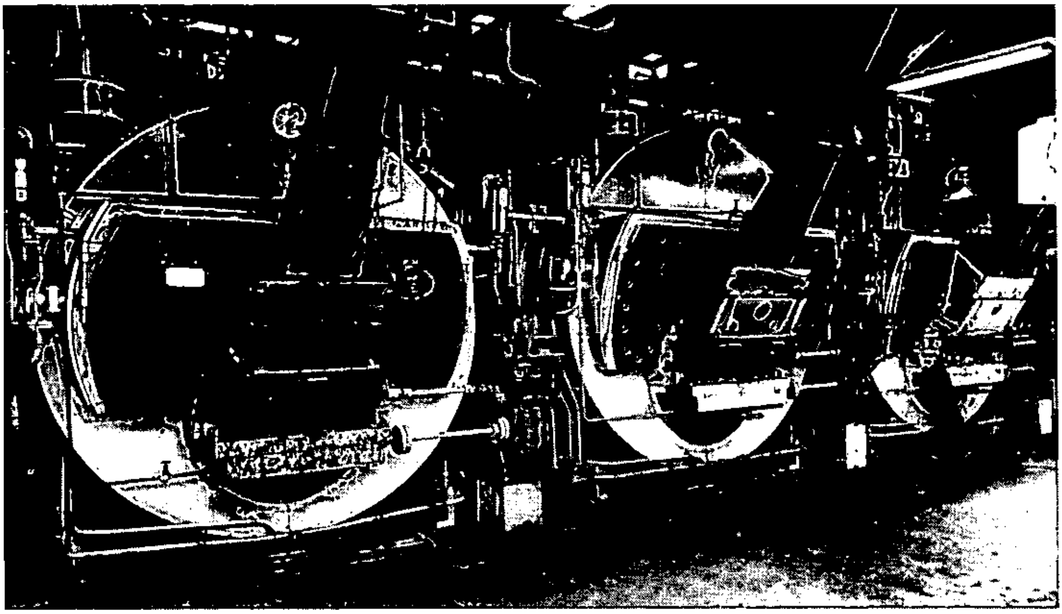
It is difficult to put an exact monetary figure on the economies produced by the new coal-fired boiler plant at Birmingham's Queen Elizabeth Medical Centre; it has been operating too short a time for accurate estimates to be made. But there is no doubt that the capital expenditure on this vast installation is producing large, continuous, and increasing economies in labour costs and the 'lb of steam per lb of coal' ratio.
The plant, consisting of six John Thompson wet back Economic boilers (each rated at 20,000 lb/hr) with John Thompson Triumph chain-grate stokers, serves the Queen Elizabeth Hospital, Maternity School, School of Nursing, School of Physiotherapy, the Medical School of the University of Birmingham and Birmingham Regional Hospital Board's Blood Transfusion Laboratories.
There is full Smith-Kelvin instrumentation, with an elaborate system of automated fuel feeding. John Thompson extractors feed the ash into a vacuum system by BVC Ltd., which delivers it into a storage bunker for periodic collection. This enables the labour force in the boilerhouse (six men in all) to remain at the same level as that which operated the old plant, which was one-third the size of the new plant.
The continuing development of the Queen Elizabeth Medical Centre will necessitate extending the boilerhouse, and this is already allowed for. The present consumption of 18,000 tons a year of Snibston Washed Singles will eventually be increased to 30,000 tons.
It is pleasant to think that every ton is offering greater efficiency to the hospital services at a lower cost to the taxpayer.



These facts prove it, Coal saves mo

AT SHEFFIELD: another hospital operates on coal

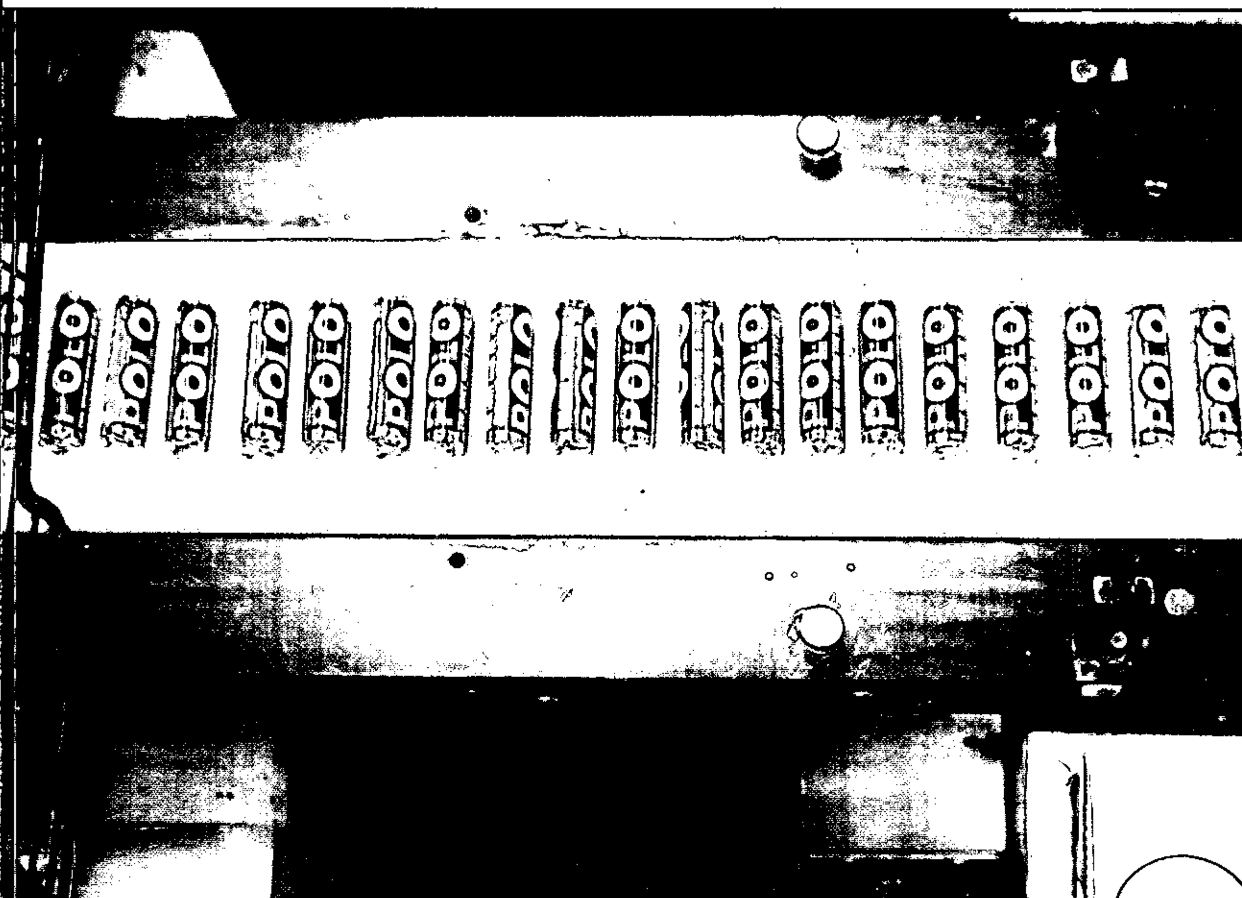
A great number of British hospitals choose solid fuel for the highly important task of maintaining suitable temperatures throughout a complex of buildings that – in many cases – has grown up haphazard and piecemeal over the years.
Nether Edge Hospital, at Sheffield, is no exception on any count. It was built over 125 years ago at a cost of £9,000. From time to time extensions have been made, new buildings added, old buildings adapted to new uses – until now it is efficiently modernised and able to take almost 200 maternity and gynaecological cases, and almost 400 medical cases.
The biggest improvements have been made during the last three years – at a cost of about £1,300,000. New lifts, new kitchens, new staff restaurant, new nurses' flats, new ante-natal ward, new maternity unit, new medical ward block have all been added.
And, as important as any of these, there is a new central boilerhouse. And, as in so many British hospitals, solid fuel provides the ideal combination of low cost and automatic control.



AT HULL: hospital chooses coal for high efficiency, low cost

Many hospitals prefer a solid fuel installation for its efficiency and low running costs. And the recently opened Hull Royal Infirmary also chose coal. The boiler plant consists of five Ruston Thermax boilers, each rated at 13,000 lb/hr equipped with coking type stokers. The coal is tipped from the lorry into a ground bunker and then taken on by bucket elevator to twin cross conveyors. These deliver the coal into overhead bunkers. Ashes are removed by Thompson plough-type ash extractors to a submerged conveyor, then to a skip hoist and overhead bunker for vehicle loading.
Hull Royal Infirmary are well pleased with their choice of a coal-fired system and its economical highly efficient results.

choose Coal for economy.

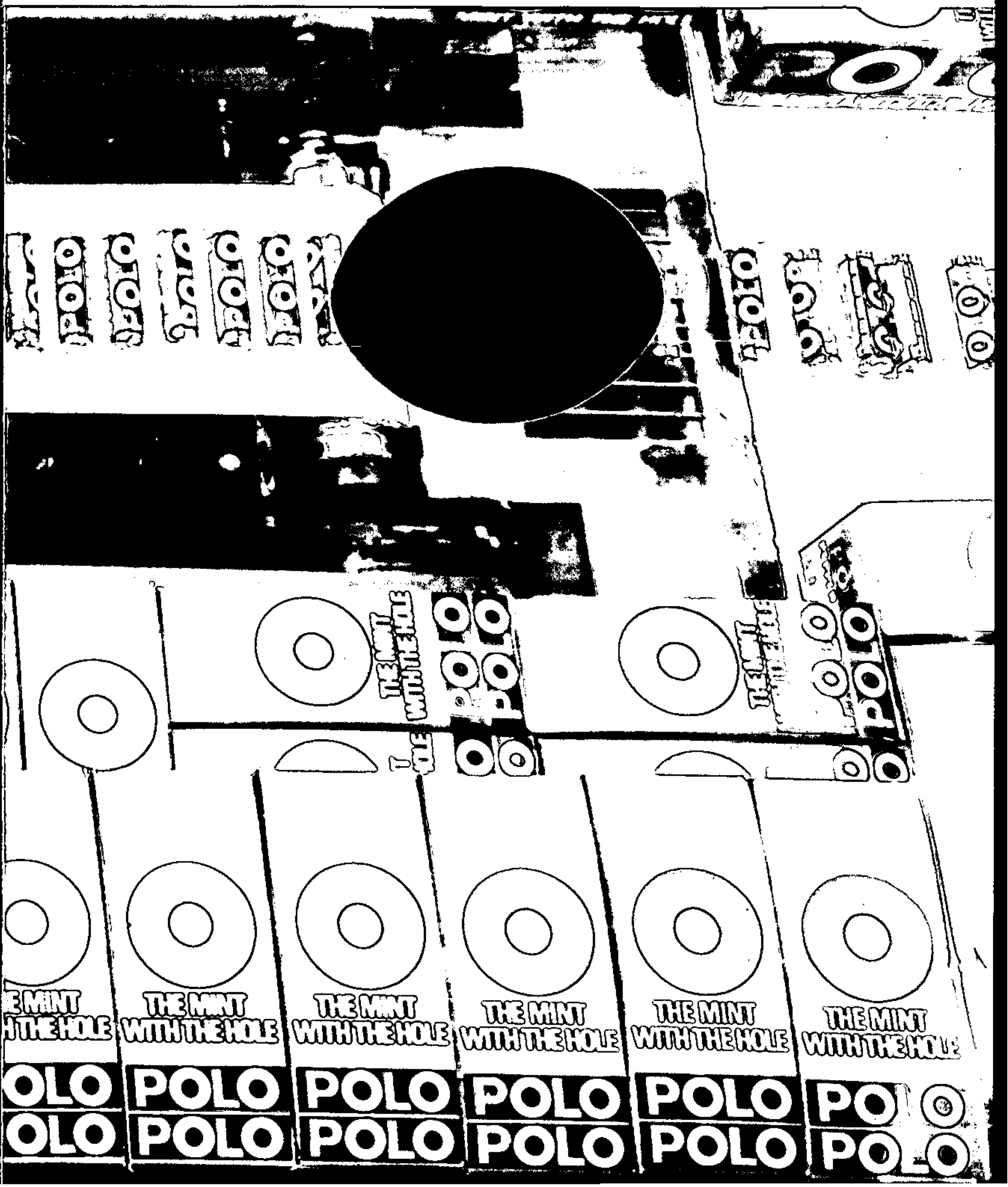


To the sweet-eaters, not only in Britain but in most parts of the world, Rowntree Mackintosh must be the two most mouth-watering words in the language, linked as they are to a diverse and successful range of confectionery products.

Behind the job of delighting the youngster in the sweet-shop (*and* everybody in his family as well) there is a long industrial history but one which has always kept pace with the very latest scientific and technological developments. This is well illustrated in the company's fidelity to coal – which is still the most economical fuel, just as it was all those years ago. Indeed, improved boiler efficiency has made solid fuel a better bargain than ever.

Technological improvement in the shape of sophisticated mechanical handling has also made coal unprecedentedly clean and convenient in use, as Rowntree Mackintosh could show you in their York factory.

There they have two new Edwin Danks Super Economic Boilers (20,000 lb/hr each), two John Thompson Water Tube Boilers (40,000 lb/hr each), and one 40,000 lb/hr Daniel Adamson Water Tube Boiler. The boiler house is fully manned round the clock – with only two men on most shifts!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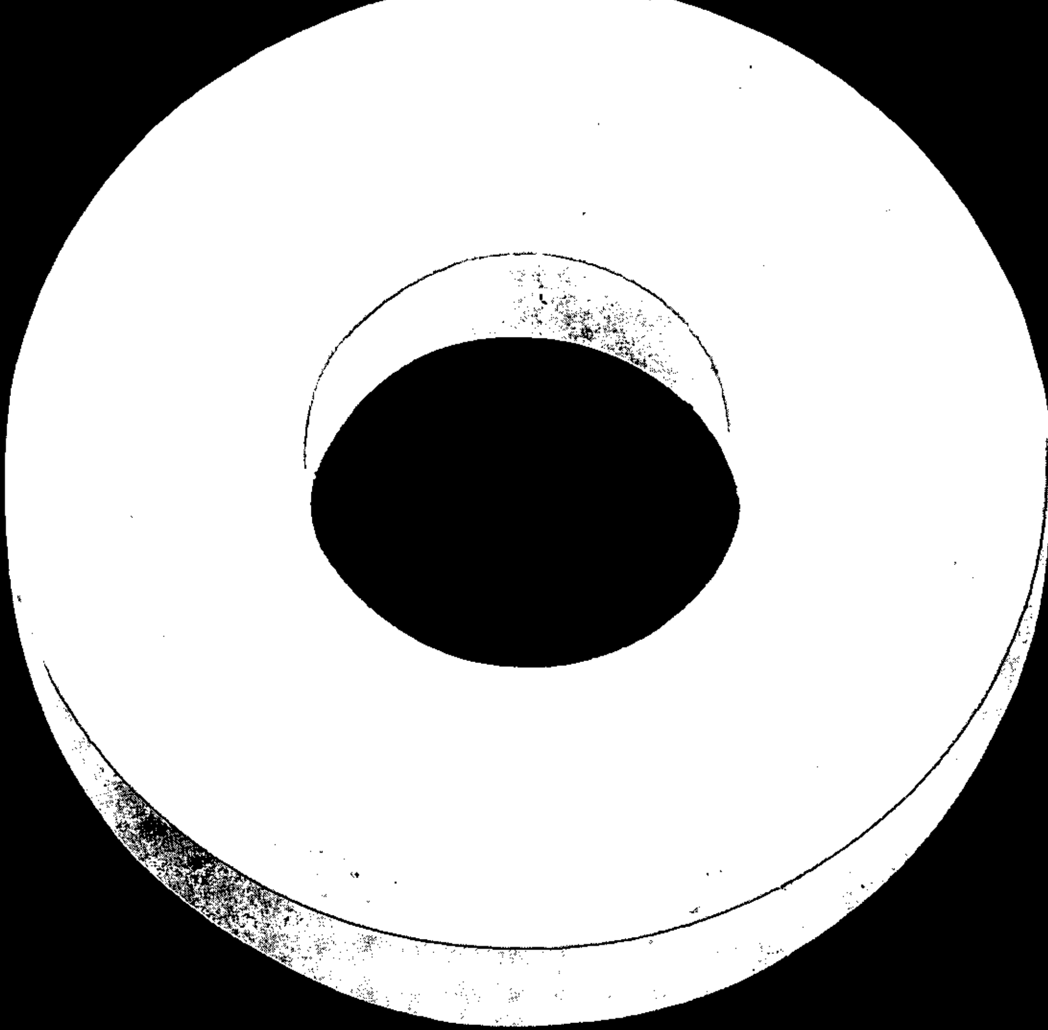

Rowntree Mackintosh are sweet on Coal