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VOL XXIII No 11
NOVEMBER 1969

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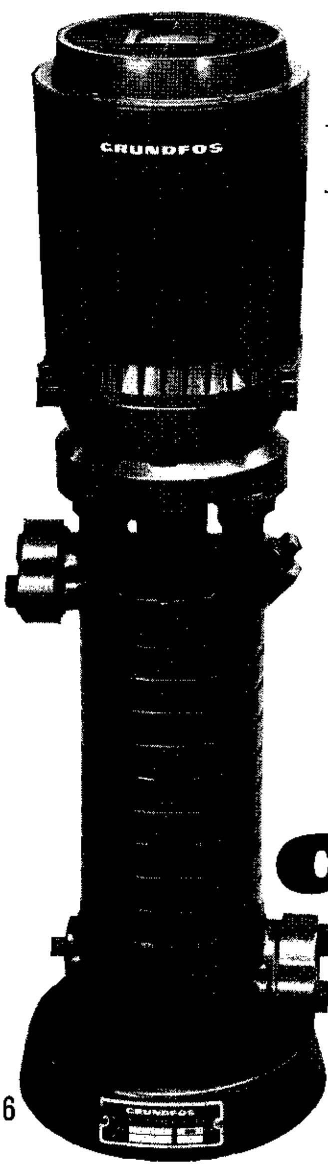

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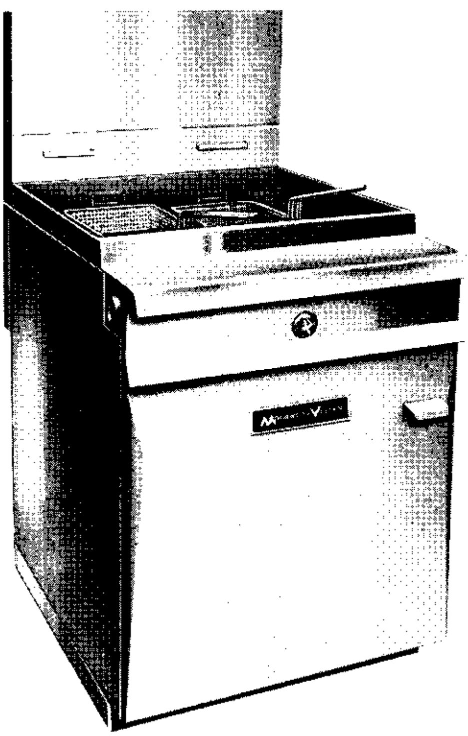

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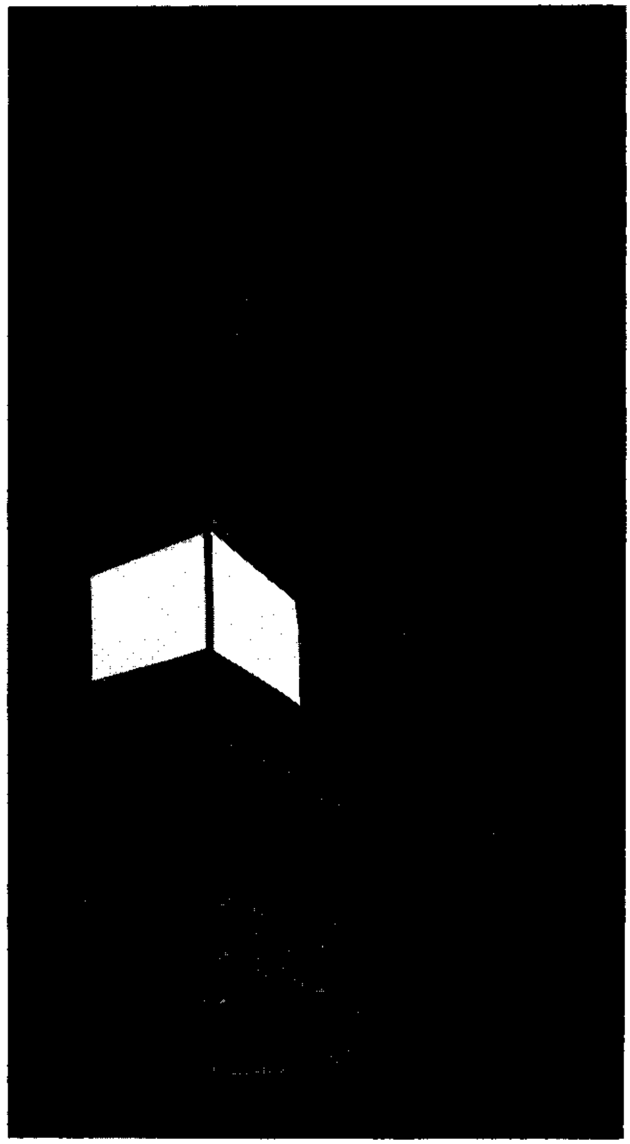

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'The Hospital Engineer'
is published monthly by
Peter Peregrinus Limited,
PO Box 8, Southgate House,
Stevenage, Herts., England

Individual copies cost 5s. 10d.
(postage paid)

The annual subscription is
£3 10s.

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THE HOSPITAL ENGINEER

VOL. XXIII No. 11
NOVEMBER 1969

The Journal of The Institute of Hospital Engineering

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THE
HOSPITAL
ENGINEER
Vol. XXIII No. 11
November 1969
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Part 1

Evolution of the boiler and good boiler-house design

by S. B. Tyrer, M.I.Plant E., A.M.I.Hosp.E.*

Introduction

Every boiler house is essentially a place to house boiler plant, and, whilst the 'house' aspect is important in its own right, as will be described later, 'boiler' is the prime word. The boiler carries the responsiblity of being the centrepiece of an engineering system which may be humble in its extent or highly complex.

There are on the boiler market today a great number of boilers to choose from, and the design engineer has to weigh carefully the requirements of the system to be used, whatever its function, before choosing a type or size of boiler. The questions of numbers required, diversity or running factor, standby plant, fuel storage, ash disposal, water treatment, chimneys, flues etc. are all factors which go together to say 'boiler house', and are factors which will all be discussed in the following appreciation.

System design

Each boiler plant is the functioning heart of a circulation which should provide a measured output to its system in relation to its requirements and within its design capability, and should give maximum efficiency in running at all times. The boiler plant itself obviously has to be designed as an integral part of the system, and the design of the system has to suit the requirements of the client, whichever field that may be in.

We can assume here that the system will be one of two basic types, working on either steam or hot water. These can be subdivided into saturated low-pressure steam (200 lbf/in²), intermediate- and high-pressure steam 200–500–2 000 lbf/in²), and low-pressure hot water (open systems), medium-pressure and high-pressure hot water (closed systems).

The system design will determine the medium to be used and at what temperature and pressure. Knowing this, the designer will then proceed with the final design and selection of the boiler plant. In selecting the boiler, it is important to appreciate why a particular type of boiler is correct for the application to be considered; the following section gives an indication of basic boiler designs.

Basic boiler designs

Steam boilers

The medium of steam, with the types of boiler required for its generation, is considered first.

Earlier types of steam-raising plant relied simply on a drum type of boiler, with the fire source below and the water in the boiler drum generating steam, which was tapped off at the top—like a kettle.

These are shell boilers, and many types are still available today which use this principle of generating saturated steam up to pressures of 250 lbf/in². More sophistication has, of course, been applied over the years, such as feeding the combustion gases through the boiler drum in the form of a fire tube; the simple but reliable Cornish and Lancashire boilers are good examples of this design. By incorporating drum boilers on brick settings the heat in the flue gases was utilised further by passing it back on the outside of the drum, and so the basic idea of flue-pass boilers was established.

The installation of brick-set boilers still goes on today where large steady steam loads are required 24 hours a day without shutdown or large variations in loads. Although these plants are not quite as efficient in fuel input and steam output as their more modern counter-

*Technical Assistant, South-Western Regional Hospital Board parts, they give very long life with the minimum of maintenance requirements.

The Cornish and Lancashire type fire-tube brick-set boilers evolved to the economic brick-set boiler, which packed more fire tubes into the boiler in two and three-pass designs incorporating a smoke-box door on the front for turning the gases back to a 'dry-back' combustion space in the brickwork settings at the rear of the boiler. Because of the increasing number of fire tubes in the boiler shell itself, all the useful heat from the flue gases was utilised in the shell, and the brick setting eventually disappeared along the length of the boiler, though a 'dry-back' brick combustion space, for turning the gases back through the shell fire tubes, remained.

Eventually the brickwork disappeared altogether, and a steel combustion space was added in the boiler shell itself, giving us the 'wet-back' shell economical boiler we have today. These generally are 'three-pass' boilers, but some already have four-pass flue systems extracting every useful unit of heat from the combustion gases.

It can be appreciated that from the large open grates of the early coal-fired boilers, with a single fire tube and large brick-flue passageways, the resistance of the gas passage was very small, and, with the lower efficiency of these early boilers, the full useful heat in the gas was not used. Consequently very hot flue gases escaped up the chimneys. Flue-gas economisers were used to save some of this heat, but even so, the high temperatures assisted chimney draughts which were more than adequate for the low resistance through the boilers. The air supply required for combustion was therefore always excessive, giving poor combustion and high grit carry-over on open-fire boilers. However, as coal and labour were cheap, the thick black smoke pouring from the chimney stacks was never interpreted as a sign of inefficient combustion.

As designs progressed, however, and fire tubes increased in the boiler shells, the resistance of the gas ways increased. In addition, as more heat was extracted, the leaving-gas temperatures decreased until the natural-draught chimney could no longer provide enough draught to overcome the boiler 'pull' and provide enough air for good fuel combustion. This led to the introduction of the induced-draught system on open-grate coal-fired boilers and, later, forced-draught systems on oil- and gas-fired boilers.

The main use of the steam generated from boilers in the earlier years of power-steam generation was as motive power for reciprocating engines, in mines, ships, mills, locomotives or winches, and the generation of electrical power on a small scale. The saturated steam resulting from the standard type of drum boiler was ideally suited for this work inasmuch as the wet steam acted as its own lubricant in the piston parts, minimising wear. As engineering techniques on boiler construction were still at the riveting stage, and engine designs were limited to cast- and wrought-iron metals with pressure limits of around 100 lbf/in², no further advances in boiler design were encouraged for some years.

The introduction of the steam turbine was probably the biggest factor in the emergence of modern high-output boiler design. After the initial years of using saturated steam on reaction-blade turbines, which basically used the energy given up by the steam as it expanded through the blades and were therefore not embarrassed by the wetness of the steam (in fact this tended to superheat and dry the steam as it expanded through the blades, so assisting the motion principle), impulse-blade turbines, using the kinetic energy of the steam directly injected from fixed nozzles onto moving blades, came into use. This system gives a much higher efficiency of the turbine output, with much higher rotor speeds than was ever possible with the reaction type of turbine. The one big problem was that the wet steam caused a high wear rate on the blades, particularly when the early metals used were nothing more than the higher-carbon steels of the day. It was soon realised that, by superheating the steam leaving the boiler and increasing its pressure to obtain higher energy, a big step forward in power generation was available.

Boiler manufacturers soon realised that the drum type of fire-tube boiler could never meet this requirement, since shell designs for large diameters were limited to intermediate pressures. Their answer was the water-tube boiler which overcame the shell boiler-pressure restriction.

This boiler is basically a reversal of the shell fire-tube boiler; the water occupies the inside of small-diameter tubes, with the fire or heating surface on the outside of the tubes. This way, by pressurising the tube internally, far greater pressures were possible with consequent higher temperatures. Designers often differed from maker to maker, but essentially there were one or two small-diameter water drums at low level holding the bulk of the water, with a large number of interconnecting water tubes forming a nest around the combustion space and rising to a single or double steam drum, again of a small diameter, at a higher level. By directing the steam back from the steam drum through pipes into the combustion area to be heated further, very dry superheated steam was obtained. Boiler designs today for all power-station applications use this type of water-tube boiler, and with modern manufacturing techniques such as solid forged drums, extruded pipework and new welding techniques for high-quality steels, boiler pressure of 1500-2000 lbf/in² are now commonplace, with steam pressures approaching the critical pressure of 3 209 lbf/in². Fuels for water-tube boilers have generally been pulverised coal, which is blown into the furnace space under pressure. Now oil is being used more and more, which obviates the need for expensive grit- and ash-disposal systems and, of course, coal-pulverisation plant.

Water boilers

The other medium to be considered is water, which, until recent years in the UK, has been used in open or low-pressure hot-water systems for general central heating and domestic hot water. These types of system usually produce water temperatures not exceeding 180°F, in boilers at pressures usually well below 50 lbf/in²—the pressure being determined by the head of the system's feed tank.

For most systems over the years up to the 1920s the conventional cast-iron boiler, which is usually sectional in design, has been used, with larger schemes being served from multiple boilers. Before the advent of pumped heating circuits, systems were worked by gravity, and consequently it was inevitable that boiler houses would be accommodated in cellars below the buildings to be served. Thus the sectional boiler probably evolved for the purpose of setting up large units in areas of poor access such as underground boiler houses. So good was the design of this boiler that in its range it is today still the choice of many engineers for low-presure hot-water systems. It was designed, as most boilers were, for coal firing with hand stoking, but it has now been successfully used for many years with mechanical coal stoking, or gas or oil fired. Cast iron is generally much less liable to corrosion from water than is steel, and because of this many boiler manufacturers still consider it the best material for boilers to give long life and trouble-free service.

With the advent of pumped and accelerated hot-water systems, and the call for larger boiler outputs, the requirement of installing boiler plant in cellars became redundant, and steel-shell boilers, assembled at works and primarily designed for steam, as described earlier, were used. This, however, created problems; not, as was probably expected, on the water side, but through acid and water corrosion on the gas side of the boilers. The fire-tube boiler was so designed that the steam extracted the maximum heat from the flue gases, so much so that when used with the lower water temperatures of the water boiler (120-140°F) the exit fire-tubes' gas temperatures became so low that the acid and water dew-point temperatures were reached, causing the formation of sulphuric acid in the flue ways. This attacked the tubes and tube plates causing serious corrosion and short boiler life. This was partially overcome by injecting some of the higher-temperature flow water back into the low-temperature return to give a higher return temperature to the boiler, but the problem was still inherent.

Smaller steel boilers came onto the market to compete with the cast-iron range, but their design was similar being essentially rectangular with flat baffle flueways. This design caused 'dead' spots in the gas flow, and corrosion pockets often occurred.

In the UK there was a tendency to persist with low-pressure hot-water systems for most small and medium-sized heating systems, using steam either directly for larger systems, or as steam distribution with calorifier heat exchangers for low-pressure hot-water systems. However, in Europe the design engineers were quick to see that when using a shell boiler in larger water-heating systems they were not restricted to low pressures, as is the case with cast-iron and rectangular steel boilers. They found that by closing the water system, generating steam in the boiler, and recirculating the water in the boiler under pressure, it was possible to move water at temperatures above the normal boiling point of 212°F without flashing off to steam. This enabled a very large system to be run at steam terperatures without steaming problems such as water treatment, sludging, condensation trapping and collecting, level controls, feed pumps etc. Because of their earlier changeover to medium- and high-pressure systems European boiler makers have produced boilers specifically designed for pressurisation, and their experience is now being felt so much that British firms now generally adopt their designs.

The particular earlier method of using the steam in the boiler to pressurise the system is now not widely used; an external nitrogen-pressurisation unit is universally the most popular way of pressurising medium- and high-pressure hot-water systems. Boilers for this range are now designed with a three- or four-pass system of annular steel flue and water ways, which enables the lower-temperature water return to come in contact with the hottest gas surfaces so as to overcome acid and water dew-point corrosion problems.

Boiler-plant diversity and selection

As the boiler plant is usually the last part of a scheme to be designed, many of the factors affecting the design —such as the medium to be used (steam or water) and at what pressure and temperature, will have already been established. The plant running load will be known, and an assessment of the nature of the scheme will show what diversity of load and margin of standby plant is required. This can be particularly relevant in the sizing of the boiler plant, when in some cases full standby can require a boiler house of twice the size of a single power unit.

For instance, a modern block of multistorey flats taking its heating and hot-water systems from one roof-top boiler plant would probably not have any standby plant at all, since the capital cost of providing extra plant would be too high for it to be installed to stand idle waiting for a breakdown to occur, when possibly a service engineer would be on call locally to look after any breakdowns which might happen. On the other hand, a larger power station generating electricity for a whole town or region would probably have a high diversity factor on several large boiler plants, so that if any one plant gave trouble there would always be another one to bring online immediately. Likewise, hospitals need a high standby factor to ensure continuity of power supply to all services such as heating, hot water, air conditioning, steam sterilising etc., where any length of shutdown could not be tolerated.

The actual selection of the boiler is made by the design engineer and is based on his assessment of the system requirements, taking into account the important factors of diversity of load, boiler-life expectancy and the type of fuel to be used.

Selection of boiler fuels and firing appliances

The choice of boiler fuels often depends on more than the actual comparative costs per therm of heat produced. Availability of supply, maintenance costs, running costs, storage and handling problems and efficiencies all affect the choice of fuel, as does client preference. The engineer must do a careful cost comparison taking these factors into account before recommending a type of fuel.

The following is a typical report showing how an oil fuel was chosen for a hospital redevelopment, not because it was cheaper, but because building costs and the availability of skilled labour were more important factors in the overall assessment.

Dilke Memorial Hospital, New Geriatric Unit

Comparison of capital and running costs between solid and oil fuel for the new boiler plant

Introduction

The existing plant at the hospital comprises two hand-fired cast-iron sectional boilers, using coke, which serve the heating and hot-water supply. The boilers are situated in a basement boiler room, the entrance to which is adjacent to the proposed kitchen extension. Neither the plant nor the boiler room itself is large enough to contain the proposed geriatric unit, and owing to its position the boiler room cannot be enlarged.

It is proposed, therefore, to provide a new central boiler house to serve both the existing hospital and the new extension. This will be in the form of either adaptations to existing outbuildings or a completely new building, depending on which method of firing is adopted. The present boiler room will in either case be used as a cylinder room.

Types of fuel

The report considers four different types of fuel: 35 s and 950 s fuel oil, anthracite and bituminous singles.

The solid fuels are the types quoted for by the National Coal Board, who have been fully consulted in the preparation of this report with regard to the solid-fuel analysis.

Boiler efficiencies

The boiler efficiencies used in the calculations are 70% for fuel oil, 75% for anthracite and 65% for bituminous singles. These figures are based on experience throughout the region on various types of boiler plant.

In the NCB's original quotation and report a recommendation was made that if using bituminous singles the boiler should be a high-efficiency cast-iron sectional boiler. This is a unit of foreign manufacture which has not yet been used in this region, and, to my knowledge, is only in a limited number of installations generally. I would not, therefore, recommend that this boiler should be considered. In any event a boiler of the type proposed could also be used with oil firing showing a similar higher efficiency.

Automatic operation

It is considered that the plant should be as automatic in operation as possible. With fuel oil this could, of course, be fully achieved. With solid fuel it could not; the plant would incorporate automatic delivery by conveyor/elevator from the lorry to fully enclosed fuel bunkers capable of storing three weeks' supply. From these bunkers the fuel would be automatically fed to the boilers so that there would be no manual handling of the fuel. However, in a plant of this size, automatic ash removal could not be justified, so that this would need to be carried out manually and arrangements would have to be made for ash disposal.

Though a plant of this nature would obviously not be as clean or as fully automatic as if oil-fired, it is considered that it could form a satisfactory alternative, depending on costs.

Estimated loads

Heating

The heat load, based on the known size of the existing boiler plant and the expected heat losses of the new unit, is 1 200 000 Btu/h. For running-cost calculations continuous heating has been allowed for, with a 39-week heating season and a weather factor of 0·46.

Hot-water supply

The estimated consumption of hot water is 3 225 gal/day throughout the year to be raised through 100°F.

The four types of plant considered are listed below.

(a) Using fuel oil of 35 s or 950 s viscosity
With this type of fuel the boilers proposed would be conventional cast-iron sectional boilers, housed in the existing laundry buildings which would be adapted as necessary. A new chimney would be required. The oil-storage tanks would be housed in a compound adjacent to the new kitchen.

(b) Using anthracite
The boilers would be of cast-iron sectional type fitted with gravity-feed automatic stokers. Elevator-conveyors would be required to feed the anthracite from the bunkers to the hoppers on the stokers. In order to allow access to the mortuary and to provide fuel bunkerage in a satisfactory position, a new boiler house would be required complete with new chimney.

(c) Using bituminous singles
Conventional cast-iron sectional boilers would be used with automatic underfeed stokers. Again, a completely new boiler house and chimney would be required.

Capital and running costs

These are given on the schedules below. It should be particularly noted, with regard to capital costs, that the figures quoted are not the complete capital cost for the plant; items common to all methods have not been included. The figures should only be used for comparison purposes.

It is considered that the electrical cost of running the plant would be similar for all the proposed plants, with the exception of 950 s fuel oil, for which the preheating costs have been added. Maintenance costs on all plants would be similar, with the possible exception of 35 s oil (which would be lower than the other types). This cost has therefore not been included. A cost for ash removal, general cleaning etc., has, however, been indicated.

Schedules

Heat loads

Maximum hourly heating load		
Existing load	=	511 000 Btu/h
New load	=	615 000 Btu/h
Total, including mains losses		1 200 000 Btu/h

H.W.S. daily load (from IHVE guide)
3 225 gal/day = 32 250 lb/day × 100 deg rise = 3 225 000 Btu/day

Capital and running costs

	Oil firing		Coal firing	
	35s (19 700 Btu/lb)	950s (18 700 Btu/lb)	Anthracite (14 000 Btu/lb)	*Bituminous singles* (11 650 Btu/lb)
Maximum weekly heating load (lb of fuel)	$= \frac{1\,200\,000 \times 168}{19\,700 \times 0{\cdot}7} = 14\,600$ lb	$\frac{1\,200\,000 \times 168}{18\,700 \times 0{\cdot}7} = 15\,400$ lb	$\frac{1\,200\,000 \times 168}{14\,000 \times 0{\cdot}75} = 19\,200$ lb	$\frac{1\,200\,000 \times 168}{11\,650 \times 0{\cdot}65} = 26\,500$ lb
Heating average weekly load (degree-day factor)	= 14 600 × 0·46 = 6 720 lb	15 400 × 0·46 = 7 100 lb	19 200 × 0·46 = 8 750 lb	26 500 × 0·46 = 12 200 lb
Average yearly heating load (39-week season)	6 720 × 39 = 262 000 lb	7 100 × 39 = 275 000 lb	8 750 × 39 = 341 000 lb	12 200 × 39 = 475 000 lb
H.W.S. yearly load	$\frac{3\,225\,000 \times 7 \times 52}{19\,700 \times 0{\cdot}7} = 85\,000$ lb	$\frac{3\,225\,000 \times 7 \times 52}{18\,700 \times 0{\cdot}7} = 89\,800$ lb	$\frac{3\,225\,000 \times 7 \times 52}{14\,000 \times 0{\cdot}75} = 112\,000$ lb	$\frac{3\,225\,000 \times 7 \times 52}{11\,650 \times 65} = 155\,000$ lb
Total yearly load	347 000 lb	364 800 lb	453 000 lb	630 000 lb
Total	$\frac{347\,000}{10 \times 0{\cdot}835} = 41\,500$ gal/yr	$\frac{364\,800}{10 \times 0{\cdot}96} = 38\,000$ gal/yr	$\frac{453\,000}{2\,240} = 202$ ton	$\frac{630\,000}{2\,240} = 280$ ton
Total fuel cost	41 500 gal @ 10·25 d/gal = £1 770	38 000 gal @ 8·25 d/gal = £1 325	202 tons @ 167s 6d per ton = £1 690	280 tons @ 116s 6d per ton = **£1 630**

Summary of capital and running costs

Oil firing—950 s oil (18 700 Btu/lb)

		£
Capital cost		
(*a*) *Engineering*		
3 boilers (Britannia 310 KO)	=	1 250
3 burner units (Nuway) ZL7, installed with controls etc.	=	900
2 oil tanks (3 500 gal each) with gauge and valves etc. 2 × £500	=	1 000
2 out-flow heaters electrically heated 2 × £100	=	200
Differences in external pipework runs	=	250
Total		£3 600
(*b*) *Builders' work*		
New oil compound, building-alteration differences etc.	=	4 000
Total capital cost		£7 600
Annual running costs		
Electricity cost for heating oil: $= \frac{364\,800 \times 0{\cdot}465 \times (220 - 45)}{3412}$ = 8 700 units × 1·64d	=	60
fuel costs: 38 000 gals @ 8·25d/gal	=	1 325
Allow 2 h/week for cleaning labour = 2 × 6s. 0d. × 52	=	32
Capital servicing costs		
Plant £3 600 @ 8%	=	288
Buildings £4 000 @ 6%	=	240
Total annual cost		£1 945

Oil firing—35 s oil (19 700 Btu/lb)

		£
Capital cost		
(*a*) *Engineering*		
3 boilers (Britannia 310 KO)	=	1 250
3 burner units (Nuway) ZL7 installed	=	400
2 oil-storage tanks (3 500 gal each) with gauge, valves etc. 2 × £500	=	1 000
Difference in external pipework runs	=	250
Total		£2 900
(*b*) *Builders' work*		
New oil compound, building-alteration differences etc.		4 000
Total capital cost		£6 900
Annual running costs		
Fuel costs: 41 500 gal @ 10·25d/gal	=	1 770
Boiler cleaning etc.: 50 h/year @ 6s 0d	=	15
Capital servicing costs		
Plant £2 900 @ 8%	=	232
Buildings £4 000 @ 6%	=	240
Total annual cost		£2 257

Solid fuel—Anthracite at 14 000 Btu/h

(*a*) *Engineering*		
3 boilers (Beeston Earleymil) complete with automatic controls, blower unit, hopper etc.	=	2 200
3 coal elevators	=	600
Total		£2 800

(*b*) ***Builders' work***		£
Building difference of new boiler house and store	=	6000
Total capital cost		£8800

Annual running costs		
Stoker cost:		
6s. 0d./h × 14 h/week × 52 week	=	208
Fuel running costs		
(75% efficiency) = 202 ton/year @ 167s. 6d. per ton	=	1620
Capital servicing costs		
Plant £2800 @ 8%	=	224
Building £6000 @ 6%	=	360
Total annual cost		£2412

Solid fuel—bituminous singles at 11 650 Btu/lb

Capital cost		
(*a*) *Engineering*		
3 boilers (cast-iron sectional with under-feed stokers)	=	2250
(*b*) *Builders' work*		
Building difference of new boiler house and fuel store	=	6000
Total capital cost		£8250

Annual running costs		
Stoker cost: = 21 h/week @ 6s. 0d. per hour		
6s. 0d./h × 21h/week × 52 week	=	327
Fuel running costs		
(65% efficiency) = 280 ton @ 116s. 6d. per ton	=	1630
Capital servicing costs		
Plant £2250 @ 8%	=	176
Buildings £6000 @ 6%	=	360
Total annual cost		£2493

Summary

Fuel	*Capital costs*	*Annual running costs*
35 s oil	£6900	£2257
950 s oil	£7600	£1945
Anthracite	£8800	£2412
Bituminous singles	£8250	£2493

Conclusion

From the above it will be seen that both 35 s and 950 s fuel oil have running costs considerably lower than solid fuel, and both involve a lower capital expenditure than a solid-fuel installation.

The installation of plant to burn 950 s fuel oil involves a capital expenditure of £700 more than for 35 s oil, but this would be recovered in approximately two years owing to reduced running costs. With this type of plant, however, weekly cleaning is necessary (this has been allowed for in the running costs), and maintenance is more costly than for 35 s (this has not been shown in the running costs). In view of the fact that this hospital is remote from the Group headquarters where engineering staff are based, I consider that plant suitable for burning 35 s fuel oil should be installed.

Part 2 of this paper will appear in the December issue

Assault on battery

Workers at the Bell Telephone Laboratories have taken the standard rectangular lead-acid battery—and claim to have doubled its estimated life by making it cylindrical. The parameters of the new battery, which is to be used as a standby power source, read as follows:

Weight	350 lb
Size	26·5in high, 14·4in diameter
Capacity	1680 Ah (at 290 A)
Float voltage	2·17V
Estimated life	30 years

Conventional batteries consist of rectangular lead-alloy grids immersed in dilute sulphuric acid. The spaces of the grids are filled with an electrolytic paste, which is the source of the potential to be generated. These batteries fail because the grids corrode and expand in the acid, so that electrical contact with the paste is lost. In the new battery the computer-designed grids are circular and slightly conical, so that each of the concentric rings that make up the grid expands at the same rate. The distance between rings then remains constant, and the grids cannot separate from the paste. In fact, since any corrosion effectively increases the amount of paste, the battery's original capacity is not only maintained but is actually enhanced with age.

Pure-lead circular grids are a major feature of the cylindrical battery

The longer lifetime is aided by the incorporation of physical strengthening factors which enable the grids to be made of pure lead, which corrodes more slowly than the more usual lead alloy. The cylindrical construction in itself increases the mechanical durability, and the battery casing is made of a new high-strength non-flammable p.v.c.-propylene plastics material. Even the paste has an interlocking crystal structure, which, in combination with the lead grids, provides battery plates of exceptional durability.

The battery is being manufactured in small quantities to determine the economics of production and supply.

Reprinted from Sulzer Technical Review

Computer-controlled network drafting

by A. M. Becker and H. Bantle

Network analysis is proving to be a useful tool in hospital planning and management. The NEC program allows networks whose logical interrelations are already fixed to be drawn up automatically. A large-capacity computer and a magnetic-tape-controlled plotter are employed.

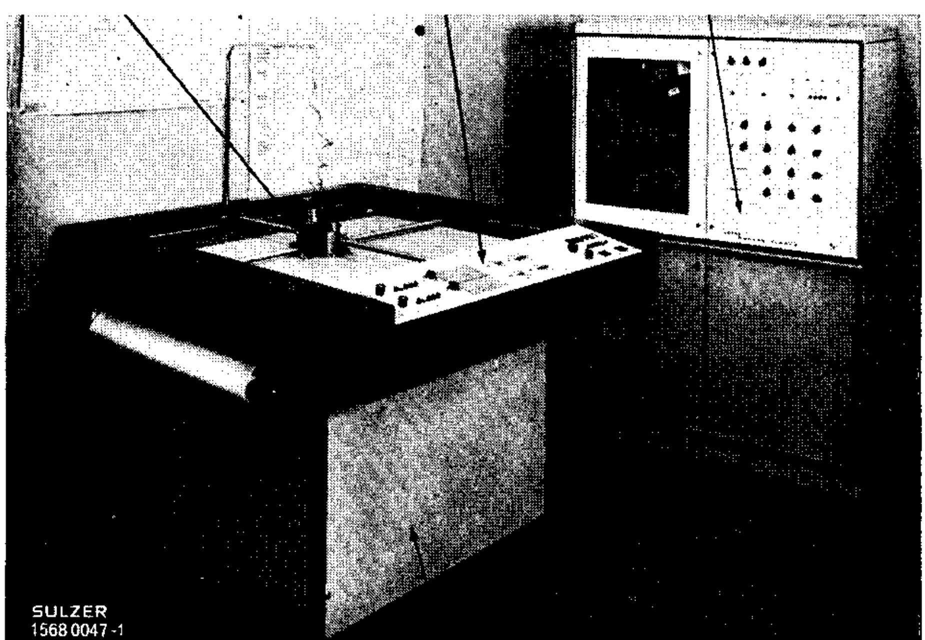
In the last ten years, network-planning techniques have been deployed on an increasing scale for the planning and supervision of projects. The various techniques (such as CPM, PERT, dynamic network technique etc.) are all based on the network, which is a graphic representation of the logical sequence of all operations (activities) in the execution of a project.

One of the basic requirements for successful project supervision is a network that is continually revised and brought up to date. But when major structural changes take place, the redrafting or correction of the network is troublesome and time-consuming. Now, with the aid of a specially developed computer program (NEC or *N*etzplan-*E*rstellung mit *C*omputer) and an automatically controlled drafting machine, networks whose logical interrelations have once been settled can be revised and redrawn in simple fashion at any time (Fig. 1).

Data acquisition

The title 'Computer-controlled network drafting' may be confusing. Of course, neither the computer nor the drafting machine is capable of conceiving the project systematically and in its entirety in such a way that the network does not have to be drafted by human agency. Nevertheless, once the interrelations between the activities have been finalised, a schedule of these activities can be drawn up with a view to automatic evaluation.

Drawing head Control desk Magnetic tape reading unit



Drawing table

Fig. 1 Plotter

For each activity the following data are stated:

starting event of the activity
final event of the activity
description of the activity
duration of the activity
code number of the person responsible for performing the activity.

Each activity is transferred onto a punched card, and the resultant set of cards provides the input for drafting the network with the computer. If, during the course of time, the structure or time schedule of the network is modified, the activity cards to be altered are removed from the punched-card deck and replaced by corrected cards. A new network can then be produced systematically. When supervising projects by means of the dynamic network technique [1,2], the latest position of the project is always kept on the master tape of this technique. The data are then obtained from this magnetic tape, and not from punched cards.

Procedure for automatic network drafting

Fig. 2 illustrates the two principal phases in computer-controlled network drafting. In phase 1 the input data of the activities deck, or the master tape of the dynamic network technique, are evaluated on a computer using the NEC program, which is composed of the software and the calculation program for drafting the network.

The software consists of standard programs containing the elementary commands for the plotter. For example: construct a point in the x-y co-ordinate system; join two points in the co-ordinate system by a straight line or curve of higher order; identify points with numbers or special symbols etc.

The actual calculation program evaluates the network, sorts its activities according to the earliest start, calculates the co-ordinates (x, y) on the drafting table and induces the necessary control commands from the software. All drafting data and commands are issued from the software onto a magnetic control tape. This marks the conclusion of phase 1.

In phase 2 the magnetic control tape is read by the tape reader of the plotter. Each term on this tape contains positioning information and control commands for the graphic representation of an activity by the drawing head of the machine. Drafting proceeds by the following stages:

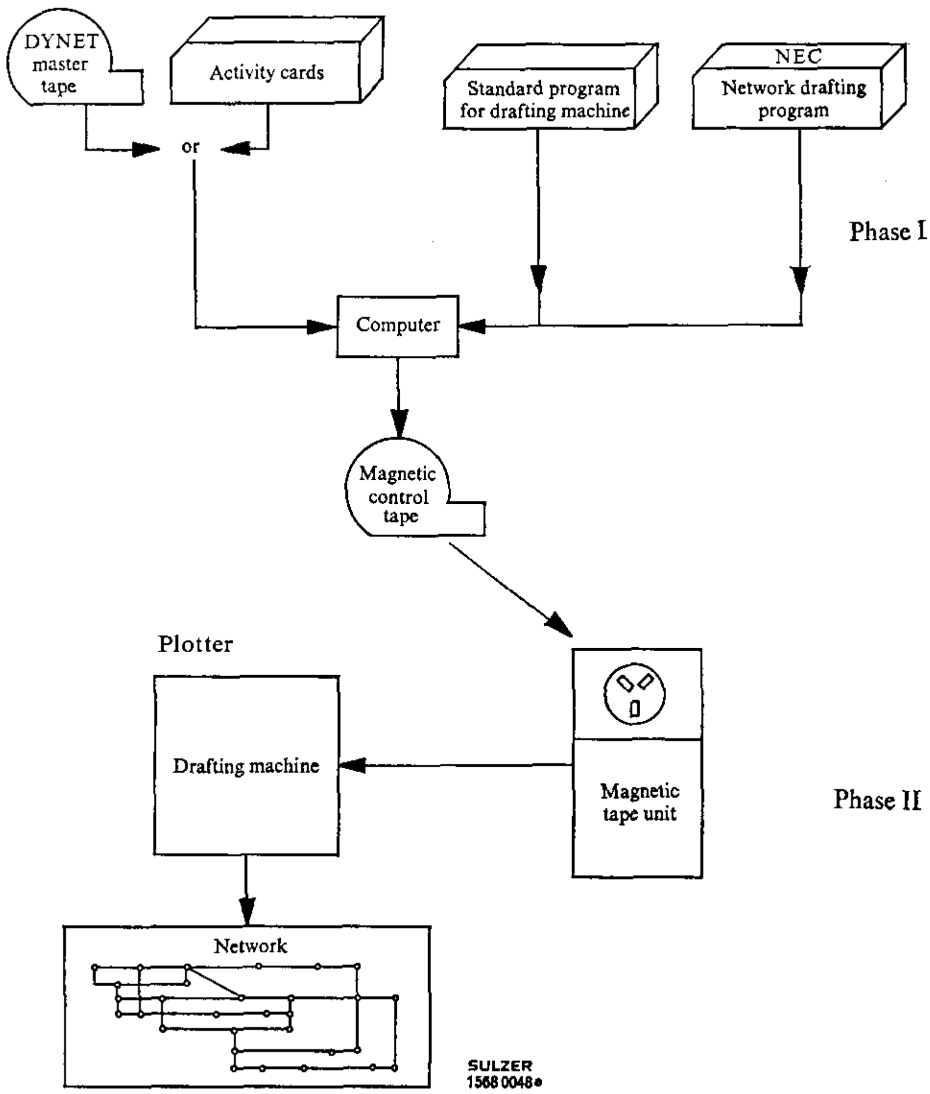


Fig. 2 Schematic procedure for automatic network drafting

starting event in the form of a square
final event in the form of a square
starting and final event squares joined by a straight line representing the activity
starting and final events numbered by the printer of the drawing head
duration of activity printed below the activity line.

The logic and interpretation of the network will now be discussed.

Presentation and interpretation of the network

The network is drawn in ink on traceable paper (Fig. 3). Since the printer of the drawing head on the available plotter has no alphabetical symbols, the activity cannot be given its designation automatically. This is entered by hand by an assistant, from a list of activities arranged according to earliest start like the drafted network.

Like every computer program, the NEC program is based on strict logic. However it makes no allowance for graphical groupings by logical subgroups or other drafting or aesthetic aspects. Thus, in order to interpret the computer-drafted network, we have to be acquainted with its drafting logic, which is summarised below.

The network drafted by the NEC program is always read from left to right, so that arrows indicating the direction are superfluous.

An activity is split once at the most, into a vertical and a horizontal part.

The program attempts to present activities in the form of horizontal and vertical lines. If the horizontal and vertical paths are blocked already, the two events belonging to an activity are linked by a sloping line. Such activities are not given any duration.

Vertical lines are connecting lines; horizontal and sloping lines represent the activities.

Events appear in the form of squares (3 × 3 mm).

Each activity is given the numbers of its starting and final events, and its duration in the appropriate time units.

Dummy activities bear no duration and are represented by solid lines, like all other activities.

Small circles link connecting and horizontal activity lines belonging to each other.

A horizontal activity line and a vertical or sloping connecting line which cross without any connecting circle at the intersection are completely independent of each other.

The activities in the network are ordered by the earliest start, and are not drawn to a fixed scale.

The vertical intervals between two lines (chains of activities) are variable, but are normally 10 mm.

Program capacity

At the present time the size of the drawing table, 750 × 750 mm, prevents networks of larger extent (number of activities and running time) being drafted automatically.

The capacity of the program is governed by the following factors :

(a) duration of project in schedule units, or length of critical path in days or weeks
(b) number of activities
(c) number of activities determining the critical path
(d) structure of network degree of intermeshing).

Otherwise the network may contain any number of starting and target events. Any numbering may be adopted for the events in the network.

With such a multitude of conditions it is almost impossible to state exact capacity limits. Experience so far would indicate that about 300 activities, or a project duration of 120 days or weeks, constitutes the maximum. The longer the activities of the critical path last, and the more numerous the parallel activities in the network (vertical structure), the bigger the network that can be drafted with the program.

Networks which exceed the capacity of the program can be broken down into a number of subnetworks, which are then automatically drafted in sections.

Program language, computer and drafting machine

Besides the software of the drafting machine the computer program comprises some 900 commands and is written in Fortan IV. In its present shape the program runs on a computer with a 32 000-word core memory (24 bits per word), of which only 18 000 words are utilised. In addition, there are two magnetic-tape units, a card reader and a printer.

The highest drawing speed of the tape-controlled drafting machine is 100 lines of 100 mm per minute. positioning accuracy of the drawing head is ±0·2 mm, drafting accuracy 0·1% for lines of up to 100 mm. The printer of the drawing head contains the digits 0–9, plus 14 special symbols. The calculation and drawing time depends on the size of the network (number of activities). A network with about 250 activities takes only 10 min to calculate on the computer (phase 1), and about 45 min drawing time (phase 2) on the plotter.

Future prospects

The NEC program is being developed further, so that in future it will be possible to produce several continuation sheets automatically. It will then become feasible to draft automatically networks of major extent without manual subdivision.

References

[1] BECKER, A. M.: 'Dynamic network technique', *Sulzer Tech. Rev.*, 1968, **50**, pp. 73-88

[2] BECKER, A. M.: *'Handbuch der Dynamischen Netzplantechnik'* (Sulzer, 1967)

Problems associated with boiler-feed water treatment: causes and prevention

by C. O. Smith, B.Sc.*

Scale-formation process

A principal problem facing boiler operators is that of scale and sludge formation due to the low solubility of certain salts of calcium and magnesium -which are present in all raw waters. The increasing concentration of these salts in the boiler as water is taken off in the form of steam reaches a limiting value, at which precipitation occurs. Solids form sludge if they are precipitated in the bulk of the water away from evaporating surfaces, but at the evaporating surfaces themselves, the insoluble salts are precipitated in close contact with the metal, and under the prevailing conditions of temperature and pressure are bonded to it. The initial layer forms a 'keyed' surface on which further scale formation can take place.

One of two courses is necessary to avoid sludge and scale formation :

(*a*) remove the calcium and magnesium salts from the raw water by an external process before feeding it to the boiler

(*b*) apply chemicals to the boiler or boiler feed water to precipitate scale-forming salts away from the heating surfaces, and to effectively fluidise the sludge formed so that it is easily ejected by blowdown.

External treatment

The older process of lime-soda softening has declined in importance with the advent of higher steam pressures and the need for extra-quality feed at these pressures. This process is still technically valid for low-pressure boilers, but the higher capital cost for plant, and the difficulty of disposing of the sludge formed, have caused ion-exchange processes to be favoured.

For fire-tube boilers operating below 300 lbf/in^2, the simplest ion-exchange process, which operates on the sodium cycle, is usually quite adequate to deal with scale and sludge problems. The process involves passing the raw water through a bed of greensand, synthetic zeolite, or other cationic resin-exchange material, which has been previously converted to the sodium form by treatment with brine. The calcium and magnesium in the water are exchanged for the sodium in the exchange material. The exhausted material is regenerated to the sodium form with brine, and the cycle is repeated. The depleted brine solution is more easily disposed of than is a lime-soda sludge.

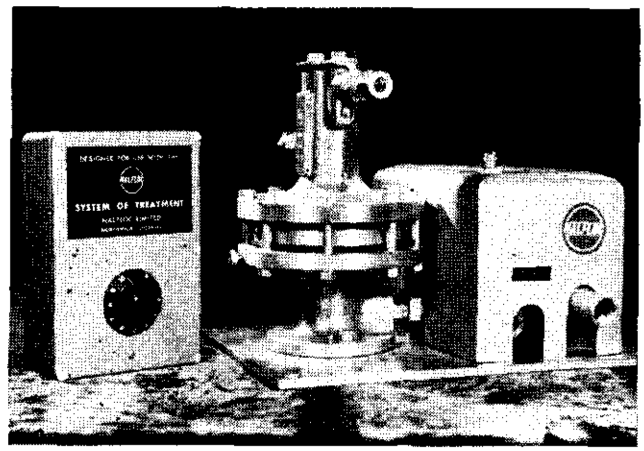


Fig. 1 Typical chemical pump for the timed injection of internal treatment

Other ion-exchange processes are available which will reduce, or virtually eliminate, high concentrations of dissolved solids, including, in some cases, silica. They involve the use of acids or concentrated alkalis as regenerants in place of brine, and, while they have proved most valuable for high-pressure work, they do not come into question for low-pressure fire-tube boilers, except where the makeup is of poor quality and constitutes a high proportion of the boiler feed.

With any external process, the final quality of the water is adjusted by the addition of chemicals, generally known as a conditioning treatment, the purpose of which is to minimise any tendency to encrustation or corrosion in the feed system, and often also to optimise boiler

*Nalfloc Ltd.

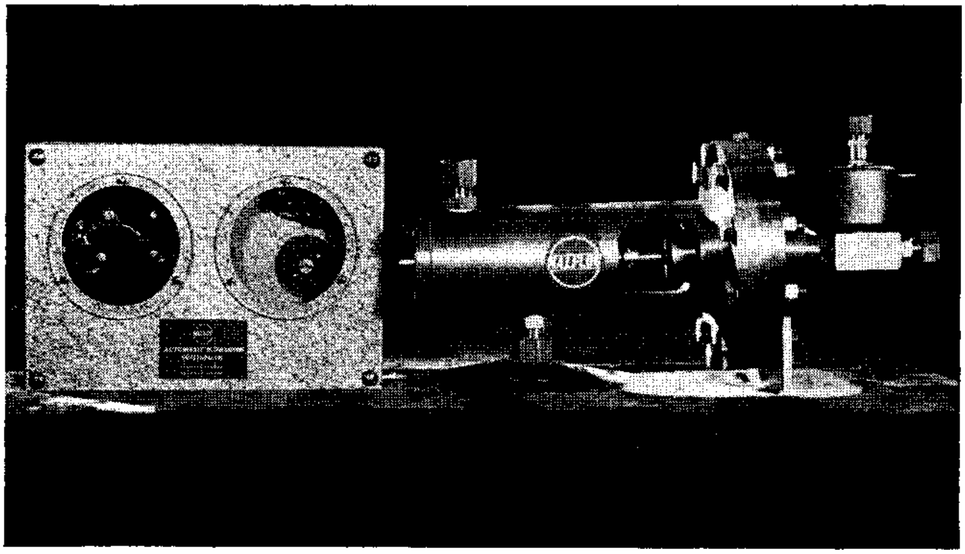


Fig. 2 Automatic blowdown valve

quality. This subsidiary treatment will vary, with details appropriate to each particular boiler plant.

Internal treatment

The injection of appropriate chemicals into the boiler or boiler feed, without the prior use of an external process, is called the internal-treatment method. The alkalis which discharge calcium and magnesium from solution are caustic soda, sodium carbonate and sodium phosphate. However, because sodium carbonate is partially converted to caustic soda under boiler-water conditions, it is unnecessary to add the latter. Above pressures of 180-200 lbf/in^2 any sodium carbonate is entirely, or almost entirely, converted to caustic soda, so that it is then essential to include phosphates to obtain calcium precipitation.

As indicated above, precipitation of the scaling constituents is insufficient to ensure a clean boiler. Some additive must be present to maintain a fluid and mobile nonadherent sludge. A number of materials have been, and are still being, successfully used; e.g. tannins, lignin sulphonates, sodium aluminate, starch, magnesium salts etc. The latest—and possibly most successful—additions to these materials are a class of synthetic organic polymers. The degree of polymerisation of such materials affects their molecular weight, the number of active sites available for sludge conditioning and other characteristics of importance. The correct choice of sludge fluidiser is a specialist's concern, and a reputable water-treatment firm should be consulted where advice is needed on this subject.

Internal treatment, in general, offers the lowest initial capital cost, and on that account has been much favoured for small and medium-sized installations (Fig. 1).

Carryover

Carryover of water and its associated solids with steam is affected by

(a) boiler design
(b) boiler operation
(c) boiler-water constitution.

As steam bubbles burst at the water surface, minute particles of water are ejected into the steam space. The majority of these are likely to fall back, but some will be entrained into the steam. The amount so entrained will depend on the distance of the water surface from the stop valve, and the number of bubbles per unit area of surface (i.e. lb/h of steam per ft^2 of surface). These factors, together with the thermally induced flow patterns defined by the general design of a boiler, decide its characteristic minimum steam wetness under easy loading; at high loads, some increase will occur. In the modern packaged fire-tube boiler, these factors have been altered without sacrificing output, and steam wetness may be expected to be somewhat higher than from older-type boilers of the same rating. Steam-separating devices for fire-tube boilers have not been developed to the same degree as for water-tube boilers.

Overloading and high water levels are two well-known factors which cause carryover. With modern automatic systems for boiler regulation, water levels should have been correctly set during acceptance trials, and high water levels should not occur. The choice of boiler size should, of course, be considered in relation to the overload requirements which are foreseeable when the plant is installed. Another factor in boiler operation which is capable of initiating carryover is sharp variation of load. It is not always realised that, if steam requirements rise from, e.g. 4 000 lb/h to 7 000 lb/h, over a sufficiently short period, carryover can occur from a boiler of 8 000 lb/h nominal capacity. It has been suggested that this can be mitigated by fitting an orifice plate, sized for 110–125% of the nominal output, in the steam line after the stop valve.

As is well known, the amount of suspended and dissolved solids in boiler water affect the tendency to carryover. Over-concentration can be controlled by carefully arranged blowdown schedules, or, nowadays, automatic blowdown valves can be used, which eliminate attendance of personnel for this duty (Fig. 2).

Among the normal individual constituents of boiler water, caustic soda is the one which, when present in excessive amounts, has the greatest effect in promoting carryover. Some reserve of this chemical has to be held, for both scale and corrosion prevention, but this should not be too great. Fig. 3 shows the type of blockage to be expected.

Foaming of boiler water arises owing to a concentration of trace organic contaminants in feed water. These materials decrease surface tension at the steam-bubble surface, steam is not released, and the bubbles collect as a foam layer. Traces of lubricating oils, breakdown substances from decayed vegetation, algae from natural water and synthetic detergents are among the many materials which can act as foam formers. Antifoam materials which deal very efficiently with this problem have been available for about 20 years.

Corrosion

Metals dissolve in acid solution to form the corresponding salts, and weak acids at low concentrations are no exception to this general rule. Carbonic and sulphurous acids are of interest with regard to boiler-feed systems. Carbon dioxide is present in greater or lesser quantities in all natural waters, and forms carbonic acid when dissolved in water. Depending on the other constituents, this may be sufficient to impart an acid reaction to the water. More carbon dioxide is formed by the breakdown of bicarbonates under the influence of heat. In industrial atmospheres, sulphur dioxide occurs from fuel combustion and dissolves in water to form sulphurous acid. However, the pickup of this gas in boiler-feed systems is not thought to be significant.

To prevent acid attack of this nature, the first measure of corrosion protection is that the feedwater should be made alkaline. In deciding the degree of alkalinity required, account has to be taken of the conflicting requirements of corrosion protection, calcium stability and alkalinity concentration in the boiler. Even in neutral or alkaline solution, metal will dissolve if dissolved oxygen is present, albeit at a slower rate. Two scavengers are available to remove oxygen : hydrazine and sodium sulphite. Hydrazine has the advantage of not increasing the dissolved solids of the water, but reacts slowly up to pressures of the order of 450 lbf/in^2. Catalysed forms of sulphite will react completely within periods as short as 20 s, and therefore give a useful degree of protection to the feed systems of those low-pressure boilers which are not fitted with deaerators (Fig. 4).

Unlike oxygen, which is 'fixed' by reaction with hydrazine or sodium sulphite, carbon dioxide is released into the steam by the breakdown of carbonates and bicarbonates within the boiler. This makes condensate very corrosive by virtue of the acid reaction produced. In most industrial plants this situation can be dealt with by using neutralising or filming amines which volatilise with the steam and protect the condensate lines. However, where steam is used in connection with food products, the neutralising amines cannot be considered suitable because of their toxicity. They can also be unsuitable—because of cost—where the amount of carbon dioxide is high, and in both of these cases filming amines have to be considered. In the US, the filming amine octadecylamine is permissible in steam concentrations of up to 3 p.p.m., except where steam is used in processing milk or milk products.

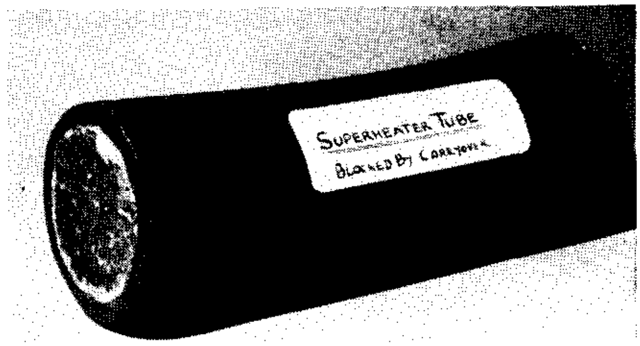


Fig. 3 Sample of tube blocked by carryover

Fig. 4 Feedline corrosion resulting from inadequate oxygen scavenger

In this country, the use of filming amines is not allowed in hospitals at present, where steam is used for food preparation, sterilisation, preparation of distilled water etc. The resultant losses of condensate piping and other constructional items due to corrosion must be considerable. In many cases these usages comprise only a minor proportion of the steam output, and the provision of indirect-heating appliances, or steam–steam generators, to cater for such applications, would effectively remove the possibility of the filming amine reaching food, distilled water or sterilisers. Then the bulk of the steam supply could be effectively treated in accordance with modern practice, with substantial economies due to the elimination of corrosion in condensate piping etc.

Idle-boiler corrosion

Severe corrosion can occur in idle boilers, and cases are known of boilers having to be condemned after lying idle for six months or so. Boilers which are not in use either should be filled to the stop valve with properly conditioned water, or should be thoroughly dried out, have trays of quicklime inserted, and be sealed again.

Fig. 1 Multioperating theatre suite, with each operating room served by its own air-handling plant

AUTOMATION IN HOSPITAL ENGINEERING

by G. D. Conn, B.Ss.*

A new era in the automation of buildings has arrived, and is having an impact on hospitals that was hardly dreamed of a few years ago. Even in small hospitals, building automation is now so profitable that it merits study not only by the consulting engineers and RHBs, but also by medical staff and HMCs. The automation of hospital buildings can save a surprising number of man-hours now wasted by operation and maintenance men through no fault of their own. It can cut other costs, including those of power, fuel and steam, assure greater environmental comfort of patients and help to improve patient care and to increase the safety of all hospital occupants. At the same time, the need for automation is increasing as the mechanical and electrical systems approach 50% of the cost of a new hospital, making it a machine almost as much as a structure. As a machine, it will respond best to automation, and perform best at lowest cost, only with a large automatic 'nerve system', centrally controlled.

A major step in automation is in using a central panel to supervise any or all systems such as air conditioning, heating, fire detection and alarm, security against intrusion and theft, clocks and surveillance of equipment, gases and liquids. This, of course, is only the beginning. Automation can also start and stop equipment such as fans and pumps, and can operate oil burners and air-conditioning compressors in the right sequence and loading combinations for optimum efficiency at all loads. The resultant boost in efficiency of this type of plant can save many thousands of pounds.

The only question today is that of the degree of automation which is most profitable for hospital buildings. New advances now permit systems that were either unavailable or too costly a few years ago. These range from new and simpler types of central control for smaller buildings, through special panels for controlling the environment in operating rooms and maternity departments, to computer-guided robots that analyse groups of variables, including weather, internal load and fuel costs, and instantly allocate load to equipment to give the desired results for the least expense.

Automated central control often pays for itself in-

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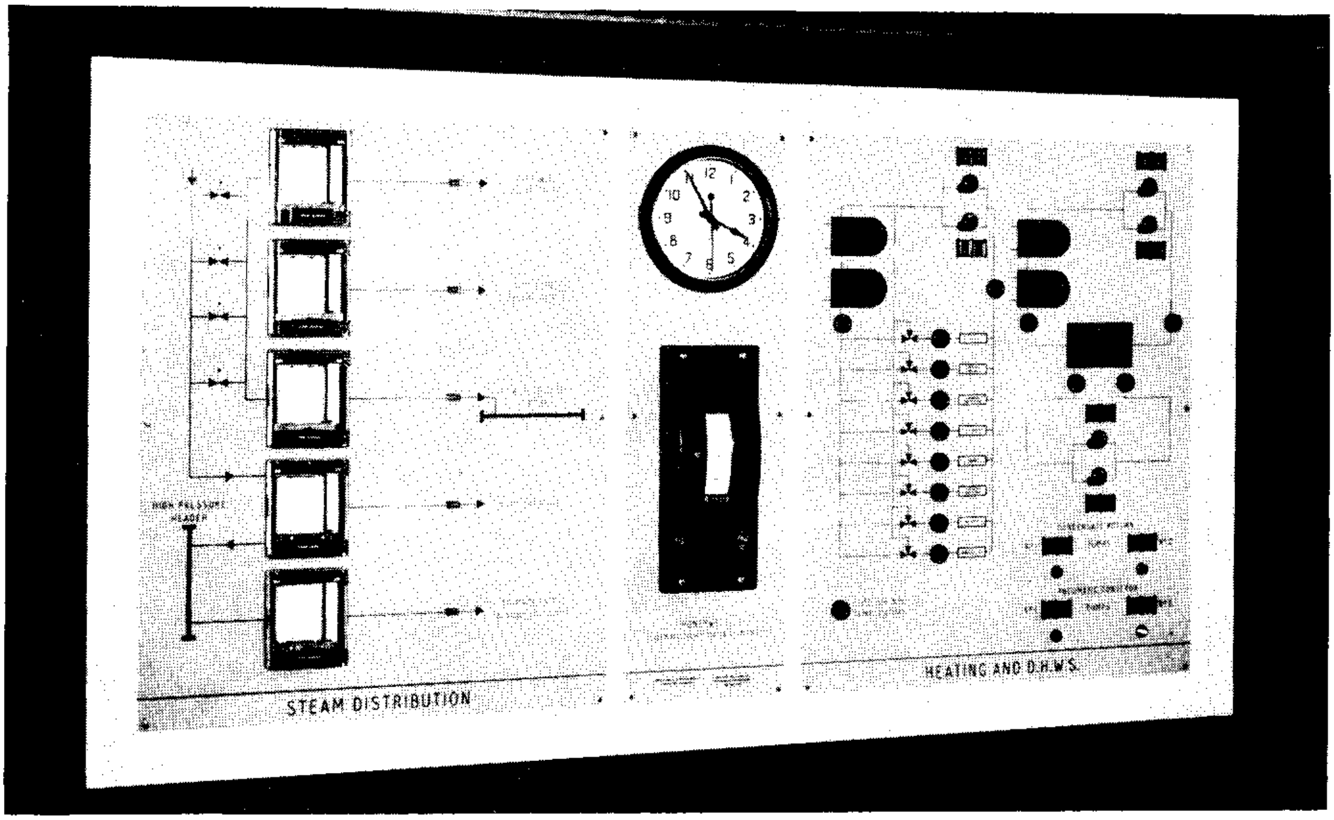


Fig. 2 Graphic control panel giving a check of the flow temperatures within the control zones, and on/off states of burners and pumps. Use is also made of miniature instruments to measure and integrate the daily steam flow

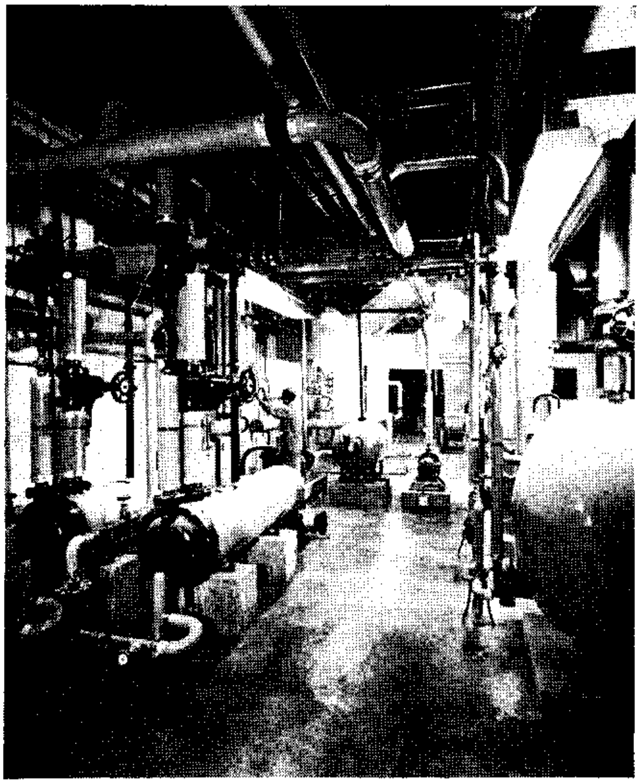


Fig. 3 General view of a typical hospital calorifier room

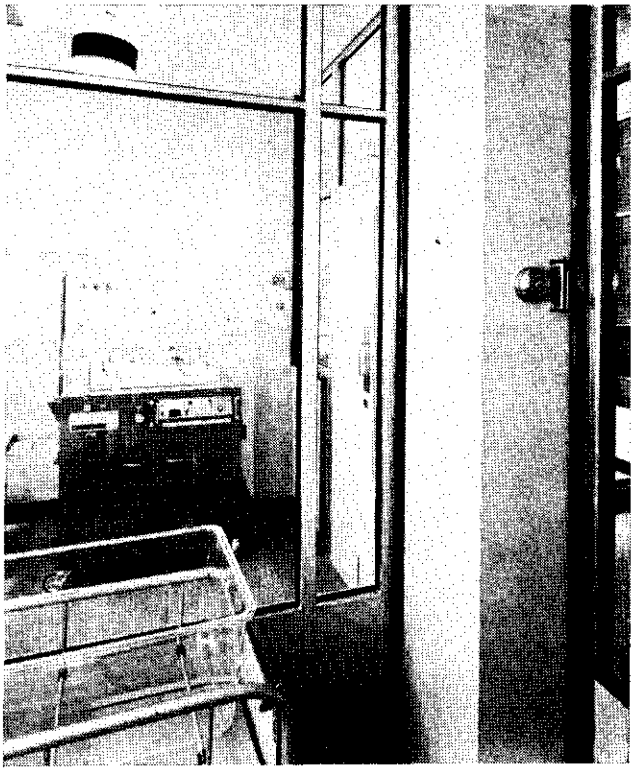


Fig. 4 Typical premature-baby unit with individual control of temperature and humidity

credibly swiftly—in as little as 3–5 years. One reason is that it is now far simpler to automate only the systems needed in any combination. Some of the functions capable of automation are listed below.

Equipment operation and surveillance

Start/stop from a central panel
Offnormal conditions pinpointed automatically, cutting human error
Monitoring of oxygen and anaesthetic-gas pressures.

Temperature, humidity

Central monitoring, and adjustments of key points in major zones and basic systems
Central-station monitoring of room conditions even though patients adjust their own thermostats
For critical areas such as operating rooms, special satellite panels may assume control.

Building, security, fire-alarm systems

Monitoring of electronic, sonic and other detectors working in the dark or over distance. A wisp of smoke that heralds a fire can be spotted, and an intruder detected even when approaching a security zone.

Systems analysis

Operation of systems at the optimum efficiency.

Automatic data logging

Automatic typing of records for systems analysis and accounting
Tamper-proof recording of conditions at critical points.

This is only a sample of hospital-automation capabilities. Only an analysis of each building will show which functions can be automated most profitably. Figs. 1–6 show some examples of hospital installations of automated equipment.

As a further example, the biggest single item in the cost of operating air-conditioning systems is the cost of the personnel required to supervise, maintain and inspect the equipment, and to investigate and handle complaints. In a large hospital, especially, checking the performance of a system and making adjustments can take much time. In addition, there is a variety of equipment which must be started and stopped periodically. Not only the rooms directly controlled by pilot thermostats, but also the temperatures in public spaces, in the primary air-handling systems, and in the basic heating and refrigeration plants, must be supervised. This requires constant trips throughout the building. A centralised control system can be designed to reduce the cost of operating air-conditioning systems and to improve the performance. It can collect at a central location all the key data the operator needs to inspect the system, and incorporate all the remote-control devices needed to supervise the operation. It will add to the operator's efficiency, and will help him train new personnel.

Maintenance engineers can now be relieved of systems-performance duties, enabling them to perform the very important preventative-maintenance work on the mechanical equipment itself more efficiently.

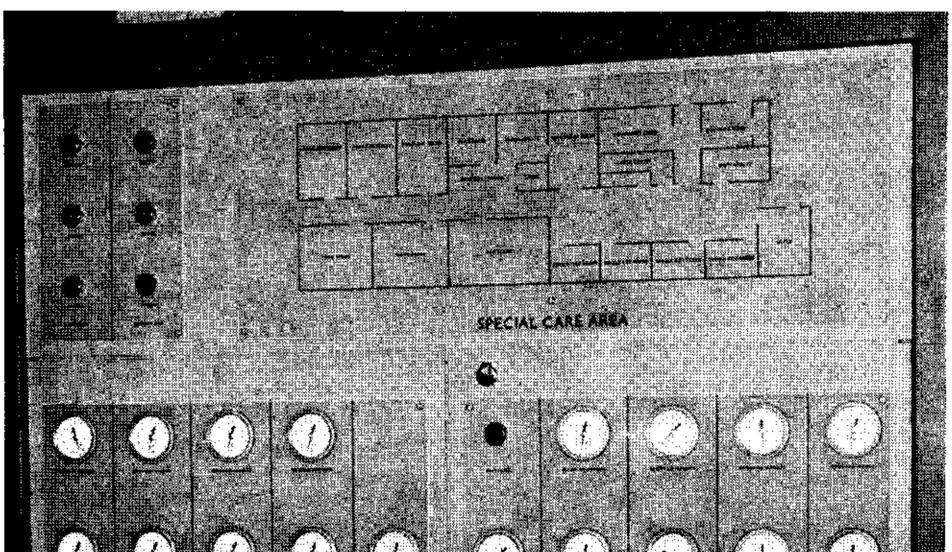


Fig. 5 Graphic control panel giving, besides manual adjustment, a visual indication of temperature and humidity in the cubicles, and optional alarms. An engraved floor plan permits easy identification of the areas served; its use obviates the need for the nurse to enter cubicles, and so helps eliminate possible cross-infection

Reprinted from 'The Royal Television Society Journal'

Infrared Thermography as a Medical Aid

By J. N. Orrin*

The detection of local temperature gradients and hot spots by infrared thermography or thermal imaging has many features in common with television—even though, in some respects, it is still at the stage of mechanical scanning. In this article the author describes how such techniques, many of which were developed initially for military purposes, can be applied to medicine as a valuable diagnostic aid for breast cancers.

The value of infrared energy, in the form of heat treatment for pain, has been realised for many centuries by those practising medicine; though with little or no knowledge of the physics involved. However, the achievement of the reverse process—that is the detection of thermal-radiation patterns emitted by a human being, so that pictures may be rapidly produced of the temperature gradients on any part of the skin surface—has become possible only in the last 10-15 years.

The experimental equipments necessary to determine the practical value of such temperature-gradient pictures could not be made until sensitive thermal detectors, with a rapid enough response time and an adequate signal/noise ratio, were developed, using techniques

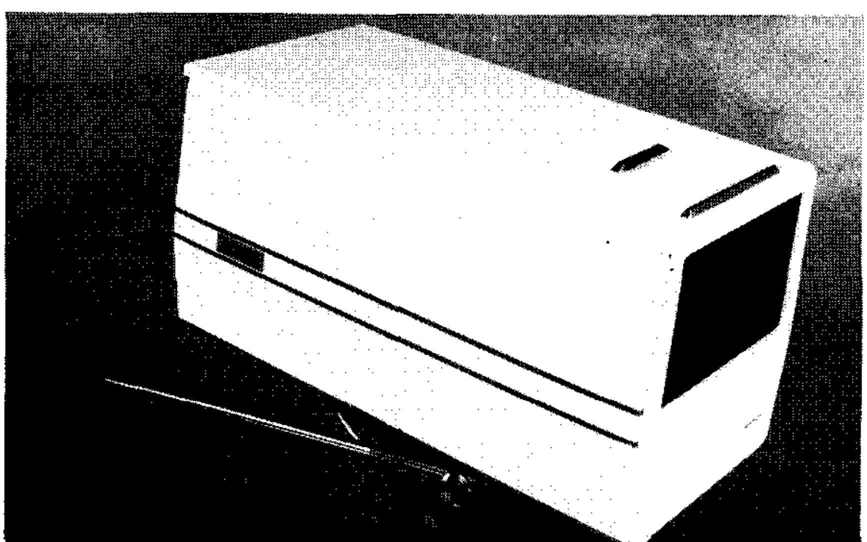


Fig. 1 The EMI 'Thermoscan' camera intended for industrial and for medical applications including detection of breast cancer, investigation of circulatory disorders, cellulitis and skin grafts.

*EMI Electronics Ltd.

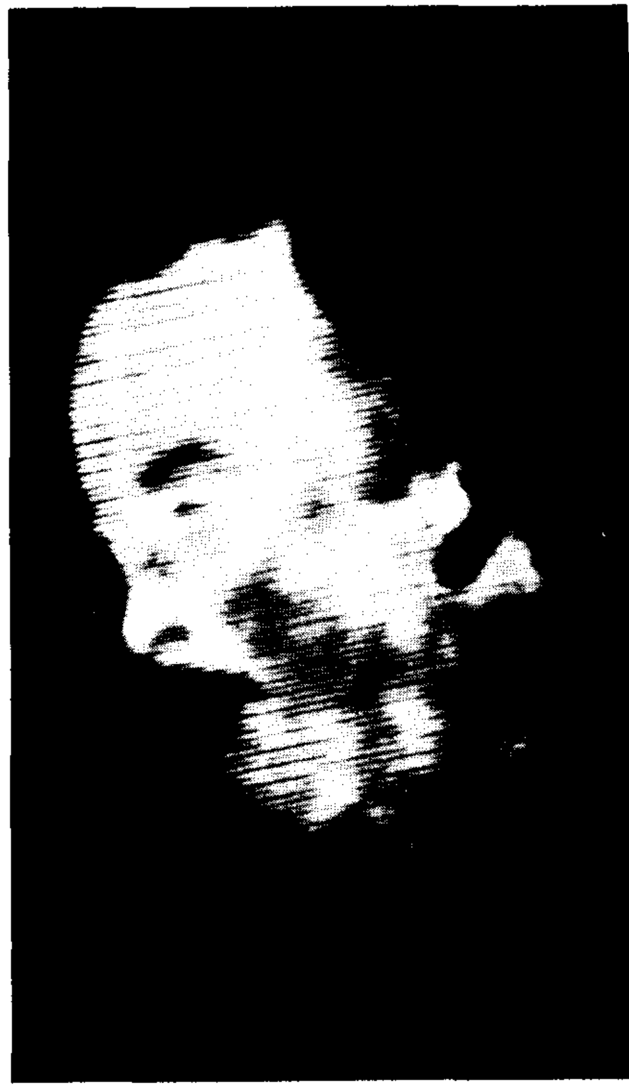


Fig. 2 Thermograph of man's head. High-temperature areas show up as white. Points of interest are cold lips and outer edge of ear, whilst the ear centre is the hottest point and can be used as an indication of body temperature

very similar to those used in the manufacture of transistors.

Dr. R. M. Lawson, of the Department of Surgery, Royal Victoria Hospital, Montreal, was one of the first (*Can. Med. J.*, 1956, **75**, p. 309) to report on the clinical value of surface-temperature measurement in the diagnosis of breast cancer.

Experience by workers in the field of medical infrared using television-type display techniques has indicated that breast tumours have a higher than normal metabolic rate, owing to the increased chemical activity. Even though the root of the trouble may be many centimetres below the surface, a localised heating effect is usually produced at the surface of the breast, adjacent to the disease. The exact mechanism of this effect is not yet understood. But medical authorities report typical changes in surface temperature of 2 deg C above the general breast ambient, minimal changes of about 1 deg C, and a case has been known of localised surface temperature 5 deg C above the rest of the tissue.

It is this difference of temperature between adjacent skin areas that is of prime importance; the absolute determination of a patient's general temperature is of only secondary interest, since this can vary considerably from patient to patient, even in quite normal healthy conditions.

Early warning by thermography

The normal early warning that a breast tumour is developing consists of a small lump which can sometimes be felt by manual pressure in the affected region. But, as with many diseases, the earlier it can be diagnosed the better the chance of a satisfactory cure. The disease has to have established itself, at least to some extent, before a lump may become noticeable.

For this reason, doctors have always searched for more reliable and more sensitive methods of diagnosis. Microscopic cell examination by experienced workers provides a highly reliable method of diagnosis, but such methods are patently out of the question for mass breast screening, which, ideally, is where early cases should be detected. X ray examination can sometimes be successful in showing diseased conditions, but, by itself, is far from being diagnostically reliable in this situation; furthermore, doctors are increasingly unwilling to subject patients to more high-energy radiation than is absolutely necessary.

From this viewpoint, the introduction of infrared thermography as a diagnostic aid should be most welcome, in that it is entirely passive, as well as requiring a minimum of preparation of the patient. Nevertheless, it must be admitted that to date the understanding and acceptance by doctors of thermography (which is also known as thermal imaging) could fairly be considered as generally tardy. Perhaps a degree of conservatism in such matters is natural and to be expected, particularly when the capital investment in such equipment is a matter of several thousand pounds per system.

Practical applications

A number of screening clinics using thermography are, however, now in operation in this country. An example is the screening clinic in operation by Mr. Stanley Way, consultant surgeon at the Queen Elizabeth Hospital, Gateshead.

Mr. Way has had constructed a series of interlinked temperature-controlled rooms (about 68°F). The patient normally enters a cubicle and strips to the waist, and remains in this state for about ten minutes to remove temperature effects associated with clothing etc. The patient is then placed before an infrared camera and the thermographic picture appears on a display cathode-ray tube. When the patient has been suitably positioned and is in focus, a photographic exposure is made from the display using a 35 mm camera. Should an apparently positive identification be made (which may or may not be supported by the presence of a lump or complaint of pain), an X ray picture is taken to furnish further supporting evidence.

If the surgeon's suspicions are strong enough, he will then normally advise an exploratory biopsy (sometimes under local anaesthetic) to allow cell examination; only after a series of such safeguards would major surgery be recommended.

Techniques

Thermal detectors, and therefore temperature resolution, have improved steadily, and modern equipment can now readily resolve temperature differentials as low as 0·1 deg C. The detector most favoured is indium antimonide (InSb), cooled by liquid nitrogen to approximately 80 K, and operated in the photoconductive mode. Such detectors have high reliability when mounted properly in a clean high-vacuum Dewar assembly. This type of detector is normally insensitive to radiation wavelength beyond about 5·5 μm. To avoid confusion from energy in the visual bands, cut-on filters, such as lead telluride, are normally fitted; these rapidly attenuate wavelengths shorter than 3·5 μm. The energy which is detected therefore corresponds to radiation covering a band of some 2 μm, only a fraction of the total radiant energy emitted by any warm body.

Normal optical glasses do not transmit much beyond 2 μm; reflective surfaces of aluminised or evaporated gold on glass are favoured for image forming. Glasses such as calcium aluminate, arsenic trisulphide or pure sapphire are technically suitable as lenses, but their cost normally precludes their use in commercial equipments.

An ideal method of picture forming would be an infrared vidicon covering the waveband already detailed; unfortunately, such a tube has yet to be developed. In one sense, thermography is thus still in the Nipkow disc or mirror-drum mechanical-scanning stage of television. Nevertheless, reasonably compact cameras can be made which produce pictures on display tubes comparable with standard television systems in terms of field rate, number of lines and number of picture points per line.

Where the subject to be studied is in motion, high field rates (upwards of 16 field/s) are imperative to avoid blurring of the image; alternatively, a line-scan system can be adopted in which movement of the subject through a single scanned line obviates the need for any field scan.

However, in medical usage, particularly in the investigation of breast cancer, the subject is virtually motionless. A slow field rate can thus be used (0·25–2 field/s is typical), with a consequent saving in bandwidth, and bandwidth improvement in signal/noise ratio—or a higher system sensitivity, whichever is preferable.

Several firms are now producing thermal-imaging equipment for a variety of applications. The majority of infrared research carried out by my own company over many years has been directed towards the development of military systems. Of late, however, more emphasis is being given to civil applications, and an imaging system has been demonstrated at the 1969 Physics Exhibition.

World's First Neutron Therapy for Cancer Treatment

The development of a new type of equipment harnessing neutrons for cancer treatment is now well advanced, and the first unit will be installed at the Christie Hospital, Manchester, in August 1970. The biological effects of neutron beams have been studied at a number of laboratories, and now, at the Hammersmith hospital, following encouraging results from pilot trials, the neutron beam from the Medical Research Council cyclotron is actually being used for the treatment of patients. The results have indicated that, in certain types of cancer, neutron beams may offer some advantages over other forms of treatment.

Radiotherapeutic treatment of cancer has in the past made use of X rays, gamma rays or electrons beamed onto the tumour. Unfortunately some tumours resist this treatment, and for many years scientists have been searching for ways of overcoming or reducing this resistance. Many tumours, particularly the large deep-seated ones, contain a significant proportion of oxygen-starved (or anoxic) cells, and it is the increased effectiveness of neutrons on these cells which is thought to be a vital factor in the success of this treatment. Unfortunately, fast neutron beams of sufficient intensity have not been easily obtainable hitherto, so that clinical verification of this has, even now, not yet been completed.

Meanwhile, at the Christie Hospital, the potential importance of neutrons for radiotherapy, and the need for suitably compact and relatively inexpensive neutron generators, was realised, and an experimental programme was started using small neutron-source tubes (rather like X ray tubes) which were being developed by the Services Electronics Research Laboratory of the Ministry of Defence.

In 1967, SERL showed the feasibility of a tube having a neutron output at least ten times that of their existing tubes. The Neutron Division of Elliott-Automation Radar Systems Ltd. (who manufacture the SERL tubes) then submitted a proposal to the Department of Health & Social Security for the development of a neutron-therapy equipment suitable for routine clinical use in hospitals, and this was accepted.

The development of the neutron tube is now at an advanced stage, several prototypes having already been made and satisfactorily operated at outputs approaching 10^{12} neutron/s.

The equipment is known as the Hiletron (since neutrons have a high linear-energy transfer). The neutron source is housed in a shield through which the neutrons are beamed. A series of interchangeable applicators determines the size of the beam, and the head unit, comprising the neutron source, shield and applicator, is mounted on a rotating structure so that fully isocentric movements are available for easy and accurate alignment of the tumour in the neutron beam.

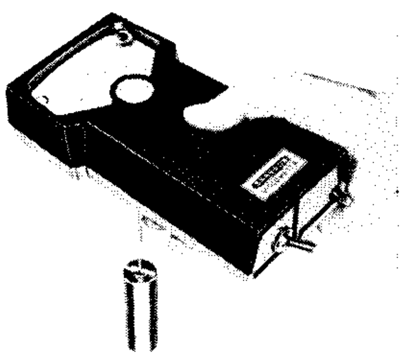
∗ Market News ∗

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

Pocket-size viscometer

A completely self-contained pocket-size viscometer is now available from Shandon Scientific Co. Ltd. It makes accurate viscosity determinations in Newtonian fluids, and is also extremely useful for check readings in nonNewtonian materials.

It is as easy to use as a thermometer, even for unskilled workers: it is only necessary to dip the rotor into the test material and flick the switch. Viscosity is indicated directly in centipoise, accurate to within 5% of viscosity standards.



Two models are available; the VT-01 covering the range 2–330cP, and the VT-02 for 30–400 000cP. Both models use a specially designed governor-controlled micromotor which drives a cylinder through a gear train. When the rotating cylinder is immersed in a cup containing the sample, viscous drag produces a scale deflection proportional to the viscosity of the test material.

The viscometer is powered by four penlight batteries; a 240V transformer is available for applications where mains operation is convenient.

Cups and cylinders are easily installed or removed, and a rotor extension can be supplied to increase the length of the rotor shaft of model VT-02 by 1, 2 or 3 ft for use in deep vessels or at high temperatures.

Weighing only 1½ lb and easily carried in the pocket of a works coat, the Shandon portable viscometer costs £92. **HE 90**

Shandon Scientific Co. Ltd., 65 Pound Lane, London NW1

Waste-disposal unit

Scapa Engineering Ltd. are to make and sell under licence the entire range of Wascon waste-disposal equipment in the UK. Wascon systems are efficient assemblies for the disposal of food and office waste. They ensure a very substantial reduction in onsite handling and in the volume of waste required to be moved.

The main units involved are a pulper and a water press. Material for disposal is fed to the pulper, in which a rotating impeller disc reduces it to a fine macerated pulp with the addition of water. This pulp is pumped to the water press, which removes a considerable proportion of the liquid and discharges the solid waste into convenient containers. The waste is then in the form of a semidry, completely odourless slurry, and is much reduced in volume. Water from the press is recirculated to the pulper, obviating unnecessary water consumption.

The system is designed to accept waste material such as paper, corrugated cartons, disposable plastics items, waxed milk cartons, disposable tableware and similar substances. Metal and other 'contraries' are beaten and much reduced in volume before being rejected into a special receptacle. **HE 91**

Scapa Engineering Ltd., Blackburn, Lancs.

Emergency power supply

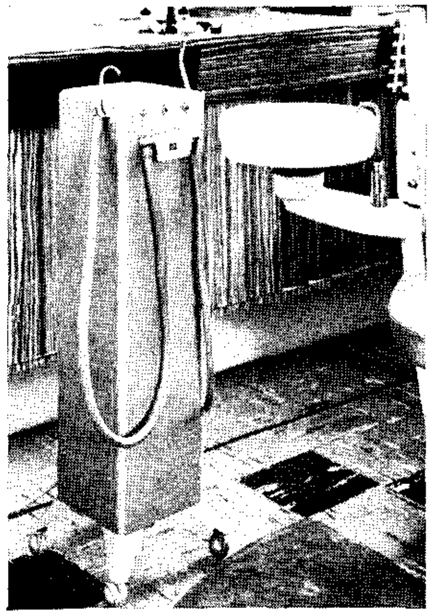
Industrial Instruments Ltd. have introduced a new range of high-power a.c. emergency power supplies, which have been specially designed to enable continuous operation of vital loads regardless of mains interruptions.

Known as the Transipack type 115/ST/1H/15K, the unit employs power thyristors controlled by integrated circuits mounted on plug-in cards. In this way, it has been possible to achieve very economic design, accessibility for ease of maintenance and compact layout. The 30kW thyristor-regulated charger measures 2 × 2½ × 6 ft. This small volume for such a high power output has been achieved through the thyristor circuits, which enable an 85% conversion efficiency. **HE 92**

R. D. Edwards Industrial Instruments Ltd., Stanley Road, Bromley, Kent

Dental aspirator

Gresham Instrumatic Ltd. have announced the introduction of a new dental aspirator, Series 300. The unit is mobile, and has been acoustically insulated for quiet operation. It has an aspiration rate of up to one pint of liquid in 3½ s, with a low vacuum action which will not harm



delicate tissue. It is fitted with an automatic cutout and a bottle-level indicator, and has a 4pt capacity with easy access to the container for emptying. Six interchangeable heads and a spittoon are provided, and the instrument costs £74. **HE 93**

Gresham Instrumatic Ltd., Weybridge, Surrey

Microwave-radiation meter

A lightweight, portable unit that measures microwave field density reliably and with repeatable accuracy has been introduced by the Narda Microwave Corporation. The unit, model 8100 electromagnetic-radiation survey meter, is designed to check accurately radiation from, e.g., microwave ovens and medical diathermy equipment.

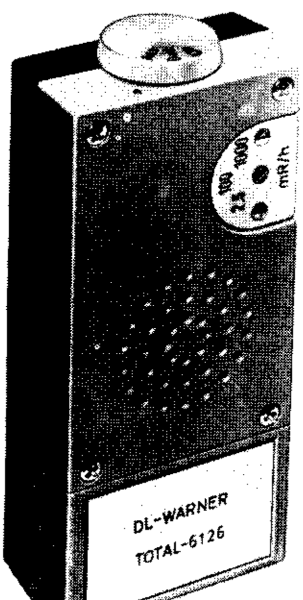
The instrument comprises a meter and a probing unit. A choice of three probes with metering-range selection enables measurements in four density ranges, in 10dB steps, from a minimum of 10 $\mu W/cm^2$ to 200 mW/cm^2. An alarm sounds if the level of field intensity is greater than a preset level. If the instrument becomes inoperative for any reason, including failure to connect a probe, an alarm sounds automatically to protect the operator. To assure consistency of measurement, each probe is fitted with a spacer which enables the user to maintain a precise 2 in distance from the point being measured.

The meter is directly calibrated at 2 450 MHz and 915 MHz, and reads to 1 dB accuracy. It can be operated from a battery or from mains and the output can be recorded. **HE 94**

Narda Microwave Corporation, Plainview, New York 11803, USA

Pocket radiation-warning device

The Total Model 6126 is a completely new pocket radiation-warning device which gives a clear audible alarm when the dose rate exceeds one of three preset threshold values. The lowest level is 2·5 mR/h, which is the maximum dose rate for occupationally exposed workers; the other dose rates are 100 and 1 000 mR/h.



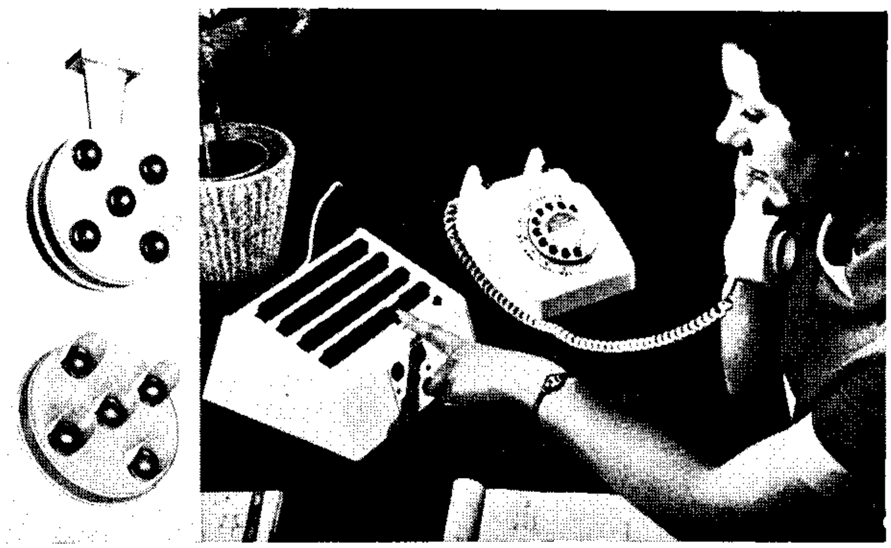
Adjustment is by screwdriver, preventing accidental movement.

The instrument is housed in a robust shockproof case. It weighs less than 8 oz and will operate for 150 h on one battery.

Radiatron Ltd., 76 Crown Road, Twickenham, Middx.

Visual-signal staff-location system

Now being marketed by Contarnex Ltd. is a Finnish designed and manufactured staff-location system which, whilst new to the UK, has been used in Scandinavian countries for a number of years.



Any one of a selected number of people can be individually signalled by means of a simple combination of five lights in a neat circular housing. Up to 31 different codings can be used; this number can be doubled by the use of flashing signals. If required, a buzzer signal alerts personnel when a call is being signalled.

The system is operated through a code-selector unit, usually controlled by the telephone operator. This can be either manual, with lever switches set in the same position as the call lights, or automatic, with a key switch for each individual.

The visual units are of two main types, for internal or external fixing—the latter having antiglare shields fitted to the lamps. A round lamp board of white plastics with red lenses is used for the two smaller sizes, which can be fixed to the wall or ceiling. The third and largest size is made in white stove-enamelled sheet metal, and is normally used for external fixing. All lamp boards can be double sided.

Should the number of personnel included in the coding be greater than 62, a variation of the system with a selector unit for up to 242 codings can be supplied. **HE 96**

Contarnex Ltd., 42 Sydenham Rd., Croydon, Surrey

Patient automatic monitoring

Available from SE Engineering (Laboratories) Ltd. is a brochure describing their new 'Pam' series of patient-monitoring equipment, and the modules available for use with it. The series comprises four display units, two for bedside use, with oscilloscope, pen and tape recording, bar indicators and alarms, a central-station unit and a 6-channel trend recorder. A second brochure describes the 'Emma' system of multi-channel amplifiers. **HE 97**

SE Laboratories (Engineering) Ltd., North Feltham trading estate, Feltham, Middx.

Rapid access to radiographs

The 500th Kodak automatic Xray film processor to be installed in Britain's hospitals has commenced operation at High Wycombe, Bucks. Known as the RP 'X-Omat' processor, it is being used for the immediate examination of accident and emergency cases in the hospital's new radiological department.

Wycombe general hospital is one of the few hospitals in Britain to have separated emergency radiography from the routine Xray examination of patients, in order to speed the radiography service and allow priorities to be given to accident cases, without interfering with the regular examination of in- and outpatients.

The 'X-Omat' processor enables doctors to have a radiograph of an emergency patient within five minutes of arrival at the hospital, as the Xray film is developed, dry and ready for viewing in 90 s. **HE 98**

Kodak Ltd., Kodak House, Kingsway, London WC2

Electrically conductive plastic

Considerable interest is being shown in an electrically conductive plastic known as 'Abbey 100', which has a cost per cubic foot around one third the current price of copper.

'Abbey 100' is a fully compounded p.v.c.-based material of very low electrical resistivity; flexible and rigid grades are available in both granular and powder form.

Many applications exist for this material, not only in the electrical field, but also for surgical equipment, where it is used for the manufacture of antistatic surgeons' masks, aprons and shoes, the floors of hospital operating theatres, conductive blood-transfusion tubing, surgical sheeting, catheters etc. **HE 99**

Croxton & Garry Ltd., Windsor House, High Street, Esher Green, Esher, Surrey

Adjustable cable saddle

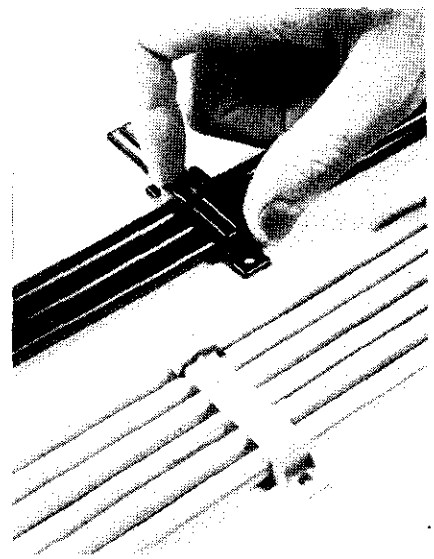
A nylon saddle for securing cables, adjustable to cover a wide range of cable diameters, has been developed by Mineral Insulated Cables Ltd.

A single saddle can be used to secure from one to six cables of $\frac{1}{4}$ in diameter, and a simple locking piece enables a further adjustment to be made for cables of up to $\frac{5}{8}$ in diameter. Once fitted, any excess can be trimmed off.

The saddle is designed for use with p.v.c.-covered mineral-insulated cables, but can be used for securing any cables or small tubes of $\frac{1}{4}$-$\frac{5}{8}$ in diameter.

The saddles are in black or orange but other colours are available by special request. They cost 25s. per 100. **HE 100**

Mineral Insulated Cables Ltd., Oxford Street, Bilston, Staffs.



H.E.P.A. filters

What is believed to be the largest mass-produced h.e.p.a. (high-efficiency particulate-air) filter in the UK, a new range of h.e.p.a. filters with special facings and a recently introduced duplex filter, were all displayed for the first time on the Fram stand at the International Filtration and Separation Exhibition at Olympia on 23rd-26th September.

The giant 72 × 24 × 12 in h.e.p.a. unit was seen alongside the smallest unit in the established range—8 × 8 × $3\frac{5}{16}$ in. Both give a filtration efficiency of 99·997%.

Also on view were recently introduced units with attractive anodised facings that can be custom-built to any specification above $2\frac{1}{4}$ in.

Fram Filters Ltd., Industrial Division, Llantrisant, Glam. **HE 101**

Clippings

Mather & Platt (Contracting) Ltd. of Manchester have obtained a contract worth £45 000 for the mechanical-engineering services at the Forces Memorial Hospital, Nairobi, Kenya.

The order, won in the face of strong competition, calls for the supply of boiler plant, hot and cold water services, sanitary systems, ventilating equipment etc.

An integrated team of specialist engineers has recently been formed by Mather & Platt to handle the provision of mechanical and electrical services for hospitals and institutions anywhere in the world.

The Nuffield Nursing Homes Trust, which already administers 14 private 'minihospitals', will have built a further three modern surgical nursing homes within the next nine months, it was announced at the Trust's annual general meeting. The three new homes now being built are at Brentwood, Huddersfield and Leicester, and a site has been secured in Plymouth for another new home to be started.

The Trust has also approved projects for new homes at Cheltenham, Hereford, Newcastle and Glasgow, on condition that local fund-raising appeals are successful.

Mr. P. Meighar-Lovett, O.B.E., Chairman of NNHT, told the meeting that the Trust had treated 14654 patients during the year up to the 31st March 1969, compared with 12499 in the previous year.

Blood-sample analysis has been further automated at the Royal Berks. Hospital, Reading, by the installation of a LINC-8 computer to process data from three multichannel analysers. The computer is programmed to provide not only warnings of diagnostic irregularities but also automatic checking of the analysers. Standardised samples are tested at regular intervals, and if any reading deviates from the preset level it is immediately indicated. Sudden changes or wide spreads in readings from a particular patient also cause an alert to be given.

Data can be displayed on a cathode-ray tube, and a printout serves as a permanent record, as well as giving statistical information.

* Members Diary *

ANNUAL CONFERENCE 1970

As previously announced, the next annual conference is to be held at the University of Aston in Birmingham on the 6th, 7th and 8th May 1970. The programme is being arranged; details will be circularised as soon as they are available. One important detail that has been arranged already is the conference dinner. This will be held at the Savoy Hotel, on the Thursday evening. The principal guest and speaker will be the Right Honourable R. H. S. Crossman, O.B.E., P.C., M.P., Secretary of State for the Social Services.

INTERNATIONAL HOSPITAL-EQUIPMENT, MEDICAL-ENGINEERING AND SERVICES EXHIBITION

The 1970 Exhibition is to be held at Earls Court, London, on the 16th–19th June. The arrangements for the Institute's conference in May are well advanced, and clearly it would not be advisable to stage two three-day conferences in successive months. However, Council is most anxious to continue the Institute's association with the exhibition, and has decided to hold a one-day conference during it. Further details will be available in due course.

CHANGE OF ADDRESS

Please—when you advise the Secretary of a change of address, it is most helpful if you mention the details of your new appointment and employing authority, so as to help keep the Institute's records up to date. Indeed, we are happy to publish these details in the Journal—so don't miss your opportunity of establishing your claim to fame!

NEW FACES

M. T. Dunn, A.M.I.Hosp.E., has been appointed Deputy Group Engineer, Doncaster HMC.

D. K. Howie, M.I.Hosp.E., is the new Group Engineer, BOM for Greenock and District hospitals and Cambrae hospitals BOM.

* Among the Branches *

LONDON BRANCH

The branch is being honoured by the presence of the Institute as a whole in November; a joint open meeting is being held at the offices of the Metropolitan RHB, at which the speaker will be Councillor W. J. Wilson, J.P., Warden/Tutor of Birmingham RHB.

The subject of the meeting is 'The report of the Royal Commission on local government in England, 1966/69—the possible implications for the health service'. The meeting will be chaired by the Institute's President, G. A. Rooley, and all members are warmly invited to attend. Note that this is intended to be very much an open meeting—anyone interested in coming will be very welcome.

The address to come to is 40 Eastbourne Terrace, London W2, and the date for your diary is Tuesday, 25th November, at 5.30 p.m. Come in by the main entrance and head for the board room, which is on the fourth floor of 'C' block.

SOUTH-WESTERN BRANCH

The branch found that a 7.30 p.m. start helped to boost attendance at their meeting at Tone Vale Hospital, Taunton on 16th July. Mr. J. Wallace, in the chair, introduced Mr. R. Hamilton, of the South-Western RHB who spoke on 'Management training', a subject providing plenty of material for discussion. Mr. Hamilton described various types of management and the techniques involved. One topic of particular interest was the provision of incentive-bonus schemes, by which the employee might earn an extra amount of between 20–50% of his salary. Members were surprised to hear of many management-training courses of which they had been unaware, and the point was made that HMCs should take the responsibility for informing engineers of these. Otherwise engineers would find themselves coming a poor second to the administrators.

EAST-ANGLIAN BRANCH

At the meeting on 20th September, members held a general discussion on technical problems. The discussion ranged over such varied topics as incineration, onsite electricity generation and the use of plastics tubing. The merits of calor gas as an alternative to natural gas were covered, and the concept of the 'best-buy hospital' was described as a complete planning method of economising by considering operation and organisation as well as building.

The meeting was chaired by Mr. Holtz.

YORKSHIRE BRANCH

A meeting was held on the 13th September 1969, at Doncaster Royal Infirmary. Malcolm Smith, M.I.H.V.E., Main Grade Engineer, Sheffield RHB, gave members an interesting talk on 'Diesel alternators and essential services', explaining design and operation with the aid of slides and diagrams.

Mr. Smith spoke of the bad winter of 1963, which had, in a sense, helped the hospitals to obtain standby plant. The electricity authorities had been unable to guarantee a full electricity supply over peak periods, and money had therefore been allocated to regional boards to purchase plant to meet the demand for essential services.

After tea Mr. Smith, together with Mr. Batey, Group Engineer, and Mr. Clarke, Hospital Engineer, of Doncaster HMC, showed members the plant rooms, where the generators were run up to give an opportunity of observing the design features and to judge the noise level, and the boiler house.

Classified Advertisements

For full information please write or telephone:
Classified Advertisement Department, *THE HOSPITAL ENGINEER*
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PO Box 8, Southgate House,
Stevenage, Herts
Telephone Stevenage (s.t.d. 0438) 3311 ext 27

OFFICIAL APPOINTMENTS
SITUATIONS VACANT
MISCELLANEOUS

APPOINTMENTS AND SITUATIONS VACANT

BOARD OF MANAGEMENT FOR GLASGOW WESTERN AND GARTNAVEL HOSPITALS
GARTNAVEL DISTRICT GENERAL HOSPITAL
HOSPITAL ENGINEER

Applications are invited for the above new post. The successful candidate will be responsible to the Group Engineer for the operation and maintenance of all engineering services in this new General Hospital of 576 beds. Initial duties and responsibilities will be in connection with commissioning the engineering services, the preparation of operational and maintenance schedules and the training of staff. Applicants must have completed an apprenticeship in Mechanical or Electrical Engineering and must hold one of the following qualifications or an approved equivalent:—

(i) H.N.C. or H.N.D. in (a) Mechanical Engineering with Endorsements in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, or (b) in Electrical Engineering with endorsements in Industrial Organisation and Management, and including (at S.III or 02 level) endorsements in Applied Heat and Applied Mechanics, or

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

Salary scale £1370 to £1605 per annum with an additional £50 responsibility payment on the issue of the final taking-over certificate. Applications stating age, qualifications and experience, with names and addresses of two referees, should be sent to the Secretary, Board of Management for Glasgow Western & Gartnavel Hospitals, 10 Park Circus, Glasgow, C.3, not later than 15th November, 1969.

BOARD OF MANAGEMENT FOR THE BANFFSHIRE HOSPITALS
ASSISTANT HOSPITAL ENGINEER

Applications are invited for the post of Assistant Engineer at Chalmers Hospital, Banff. Applicants should have completed an apprenticeship in mechanical or electrical engineering or otherwise have acquired a thorough practical training appropriate to the post, and must hold an Ordinary National Certificate in engineering or a recognised equivalent qualification.

The salary scale is £975–£1270. A four-roomed house is available for rental.

Applications, stating age, experience and qualifications together with the names of two referees, should be sent to the Group Secretary, St. Catherine's, Banff.

DEPARTMENT OF HEALTH & SOCIAL SECURITY
ENGINEERS

At least seven posts for men and women in the Engineering Division, London.

DUTIES include design, specification, supervision of installation and final commissioning of mechanical and electrical plant and services for the Department's development building projects; derivation and application of engineering standards to hospitals and research into special engineering requirements.

QUALIFICATIONS: Candidates must have achieved corporate membership of the IMechE or IEE (those awaiting election also considered) and have an enthusiastic interest in research and development of services engineering for hospitals. Relevant experience normally required; knowledge of operating and maintenance practices connected with this kind of engineering desirable.

SALARY: £2350–£3050 (from the 1st January 1970). Starting salary may be above minimum. Subject to certain conditions, previous pensionable public service may be aggregated with Civil Service for pension purposes. Noncontributory pension. Promotion prospects.

WRITE to Civil Service Commission, Savile Row, London WIX 2AA, or TELEPHONE 01–734 6010, ext. 229 (after 5.30 p.m., 01–734 6464 'Ansafone' service), for application form, quoting S/7268/69. Closing date 25th November 1969

ST. MARY ABBOTS HOSPITAL, MARLOES ROAD, KENSINGTON, W8.

HOSPITAL ENGINEER required. Must have served an engineering apprenticeship and hold a recognised qualification; Higher National Certificate in Mechanical Engineering or City & Guilds M.E. (Part II), Plant Engineering or M.O.T., ONC. Building knowledge an advantage. Consideration would be given to the appointment on an abated scale of candidates without the stipulated qualifications, but wide experience in the management of hospital plant essential. Salary £1360 to £1590 p.a. Successful candidate must reside within easy reach of the hospital. Apply in writing, naming three referees, to Secretary, Chelsea & Kensington Hospital Management Committee, 5 Collingham Gardens, London SW5.

HOSPITAL ENGINEER
ROYAL BERKSHIRE HOSPITAL, READING, BERKSHIRE

Applications invited for post of HOSPITAL ENGINEER at above hospital, vacant on 30th November 1969 on retirement of current holder.

This hospital is main district hospital of Group; the Hospital Engineer is also responsible for Wokingham Hospital. Both hospitals currently undergoing major redevelopment.

Applicants must possess HNC in either mechanical or electrical engineering with appropriate endorsements and have completed apprenticeship in mechanical or electrical engineering, or have otherwise acquired thorough practical training. Applications might be considered from those not possessing full academic requirements, in which case salary scale would be abated by £200.

Salary scale: £1370–£1605, plus £100 responsibility allowance. Three-bedroom detached house available for rental if required.

Good experience will be gained of modern engineering plant, and encouragement given to further studies and career.

Application forms from Group Engineer, Reading & District Hospital Management Committee, 3 Craven Road, Reading

FAIRFIELD HOSPITAL STOTFOLD, HITCHIN, HERTS.
HOSPITAL ENGINEER

Applications are invited for the post of HOSPITAL ENGINEER at the above psychiatric hospital to act as deputy to the Group Engineer. Applicants must have completed an apprenticeship in mechanical or electrical engineering or have otherwise acquired a thorough practical mechanical training, and must possess a sound knowledge of the principles and practices as are appropriate to the responsibilities of the post.

Applicants must hold one of the following qualifications, or an equivalent qualification approved by the Ministry of Health or Secretary of State for Scotland:

High National Certificate or Higher National Diploma in mechanical engineering with endorsements in industrial organisation and management and in principles of electricity or electrotechnology, if this was not taken as a subject of the course; or

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, provided he has suitable practical experience in mechanical engineering; or

City & Guilds mechanical engineering technicians full technological certificate (part III) which must include plant maintenance and works service.

Salary ($24\frac{1}{2}$ points) $£1370 \times £40 \times £45(2) \times £50 \times £55$. Maximum £1605.

Married accommodation available at a reasonable rental.

Applications, with full details and names and addresses of three referees quoting Reference E51 to Group Secretary as soon as possible.

CLASSIFIED ADVERTISEMENTS continued from ad 7

APPOINTMENTS AND SITUATIONS VACANT

THE ROYAL MASONIC HOSPITAL
DEPUTY CHIEF ENGINEER

Applications are invited for the post of Deputy to the Chief Engineer of this 270-bed hospital–the largest private hospital in the UK. This hospital is shortly to be extended by the construction of a new residential block and new operating theatres, and by extensive modernisation of the main hospital block.

Applicants must have served an accredited apprenticeship in mechanical engineering and must hold a Higher National Certificate in Mechanical Engineering with endorsements in Industrial Organisation and Management and in Principles of Electricity or Electrotechnology, or equivalent qualifications. The person appointed must be capable of carrying out the entire range of duties of the Chief Engineer, and must therefore have had wide experience of engineering plant and services and of modern methods of planned maintenance. Ability to supervise general maintenance of buildings will be considered important and applicants are therefore asked to state any previous experience in this field.

Annual salary will be in the range £1370 to £1605, plus £90 London weighting allowance, plus £75 special-responsibility allowance, plus 10% of basic salary for long house gratuity; i.e. equivalent to NHS standards. Residential accommodation will either be available or an allowance made in lieu thereof.

Applications stating age and full details of education, training and experience, with names and addresses of not less than two referees, should be sent to the Secretary, Royal Masonic Hospital, Ravenscourt Park, London W6, marked 'Private and Confidential'.

YORK 'A' HOSPITAL MANAGEMENT COMMITTEE
HOSPITAL ENGINEER

For duties at City, St. Mary's and associated hospitals in York. Applicants must have completed an apprenticeship in mechanical engineering, have a sound knowledge of steam-boiler plants (oil-fired at the City Hospital) with a wide experience in the management of mechanical and electrical-engineering plant similar to that of modern hospitals. Candidates must hold City & Guilds' Mechanical-Engineering Technician Certificate (Pt II), which must include plant maintenance and works service, or City & Guilds' Certificate in Plant Engineering or Ministry of Transport First Class Certificate of Competency, which includes an OND or ONC. Applications will, however, be considered from candidates without the stipulated qualifications, the salary being suitably abated.

Salary £1270 p.a. rising to £1500 p.a. plus £50 p.a. special-responsibilities allowance.

Applications stating age and giving full details of education, experience and qualifications, together with the names and addresses of two referees, to Group Engineer, Bootham Park, York.

Harefield and Northwood Group
Hospital Management Committee

HOSPITAL ENGINEER
for Harefield Hospital, Middlesex

Applications are invited for this interesting and rewarding post. The work is extensive and varied and will include acceptance of the responsibility for the efficient running and maintenance of the complex engineering plant and services in this busy hospital specialising in thoracic work.

The salary scale, including allowances, is £1410–£1640 per annum, in five annual increments. Full details, job description and application form may be obtained from the Group Secretary, Harefield and Northwood Group HMC, Mount Vernon Hospital, Northwood, Middx., to whom applications must be returned not later than the 24th November, 1969.

NORTH WIRRAL HOSPITAL MANAGEMENT COMMITTEE

HOSPITAL ENGINEER required to be directly responsible to the Group Engineer for the engineering services of certain hospitals within the Group.

Salary scale: £1370–£1605 p.a. plus responsibility allowance of £100 p.a.

In addition to having served an engineering apprenticeship, applicants must have a sound knowledge of mechanical and electrical equipment, wide experience of its maintenance, and should possess one of the following qualifications or an equivalent qualification approved by the Secretary of State for Social Services:

(1) Higher National Certificate or Higher National Diploma 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

(2) Higher National Certificate or Higher National Diploma in electrical engineering with endorsements in industrial organisation and management and including (at S111 or 02 level, or with endorsement in) applied heat and applied mechanics, provided that he has suitable practical experience in mechanical engineering

(3) City & Guilds mechanical engineering technicians full technological certificate (part III) which must include plant maintenance and works services.

Applications giving details of training, qualifications, etc., together with names and addresses of two referees to the Group Secretary, Group Headquarters, Mill Lane, Wallasey, Cheshire L44 5UF, by Monday 24th November 1969

HOSPITALS FOR DISEASES OF THE CHEST

Hospital Engineer

required to be based at the Brompton Hospital and responsible to the Group Engineer to assist with the introduction of incentive bonus schemes and planned maintenance within the Group (including hospitals at Bethnal Green and Frimley) and to prepare contract specifications and drawings.

This is a challenging new appointment and offers a wide range of interesting work in the above fields. Previous hospital experience not essential. Further details of responsibilities and necessary qualifications will be sent on request.

Salary £1270-£1500 plus £90 London weighting and £25 extra responsibilities.

Applications, giving names and addresses of two referees, to:

House Governor
BROMPTON HOSPITAL
Fulham Road, London SW3

APPOINTMENTS AND SITUATIONS VACANT

NORWICH, LOWESTOFT AND GREAT YARMOUTH
HOSPITAL MANAGEMENT COMMITTEE
HOSPITAL ENGINEER

Required to be responsible to the Group Engineer for the maintenance of all engineering services at the Norfolk and Norwich Hospital, where major redevelopment is in progress, and three smaller hospitals in the Norwich area.

Applicants must have completed an apprenticeship in mechanical or electrical engineering, or have acquired a thorough practical training as appropriate to the duties of the post, and also hold one of the following qualifications:

(a) HNC or HND (mechanical engineering) with endorsements in principles of electricity or electrotechnology if this was not taken as a subject of the course

(b) HNC or HND in electrical engineering and including (at S111 or 02 level or with endorsements 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.

Consideration will also be given to the appointment on an abated scale of persons without the stipulated qualifications.

Salary scale £1370 to £1605 per annum, plus a special responsibility allowance of £100 per annum.

Further particulars and application form obtainable from the Group Secretary, St. Stephen's Road, Norwich, Norfolk, NOR 53A.

Closing date for application: 26th November 1969

HOSPITAL ENGINEER

Responsible to Group Engineer for engineering services at North Wales Hospital, Denbigh and three other hospitals in area. Salary £1370–£1605 plus £50 units responsibility allowance. Applicants must possess HNC or HND in mechanical or electrical engineering, a knowledge of efficient operation of mechanical fired steam boiler plants and preferably a wide experience of mechanical or electrical services in hospitals.

Further particulars can be obtained from Group Engineer (Telephone Denbigh 2871).

Apply giving full particulars and experience with the names of two referees to Group Secretary, Rhianfa, Russell Road, Rhyl, within ten days of publication.

SALFORD HOSPITAL MANAGEMENT COMMITTEE

require a HOSPITAL ENGINEER at Ladywell Hospital. Qualifications HNC or HND, or approved equal, with appropriate endorsements. Salary scale £1295–£1525. The successful applicant will be responsible to the Group Engineer for the management of engineering and building maintenance at the hospital.

Detailed applications, naming two referees (one technical) to the Group Secretary, Salford HMC, Group Offices, Fairhope Avenue, Salford 6, by 21st November 1969.

MISCELLANEOUS

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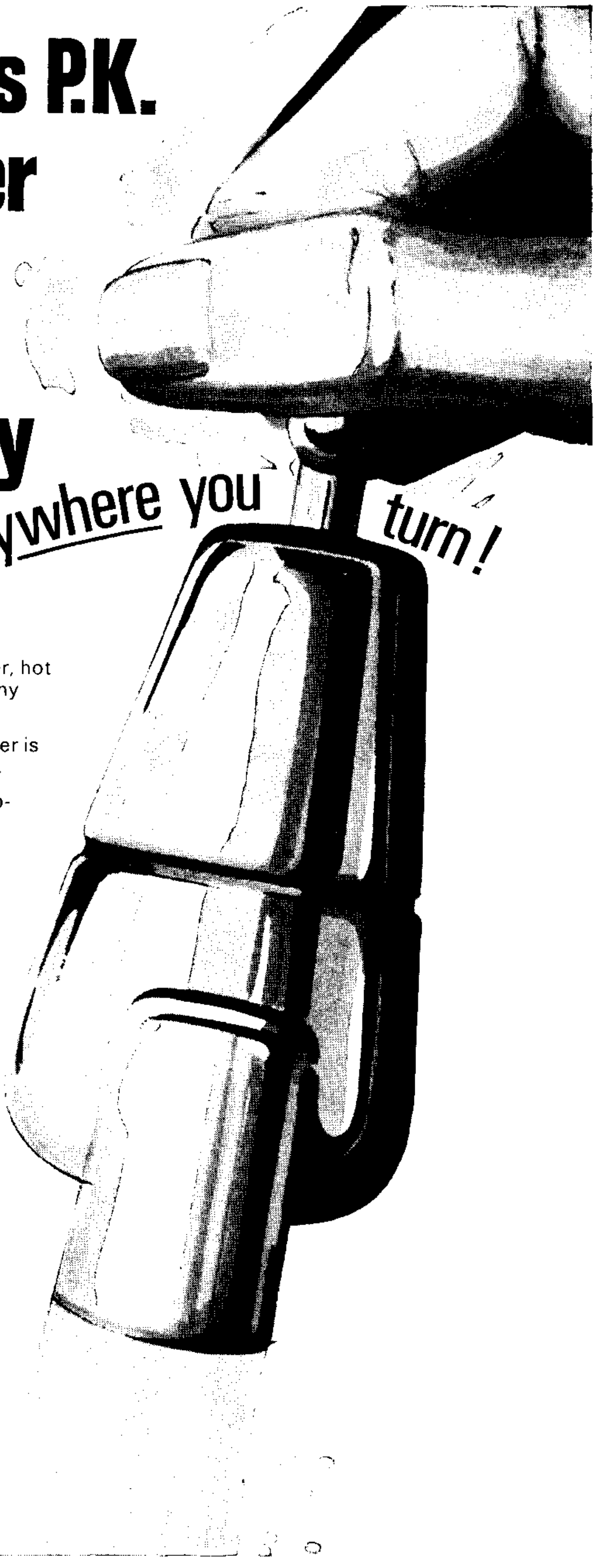

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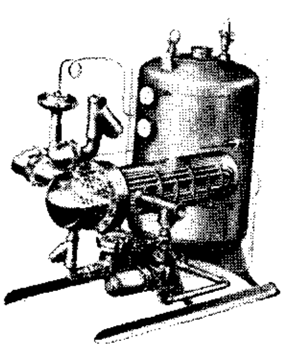

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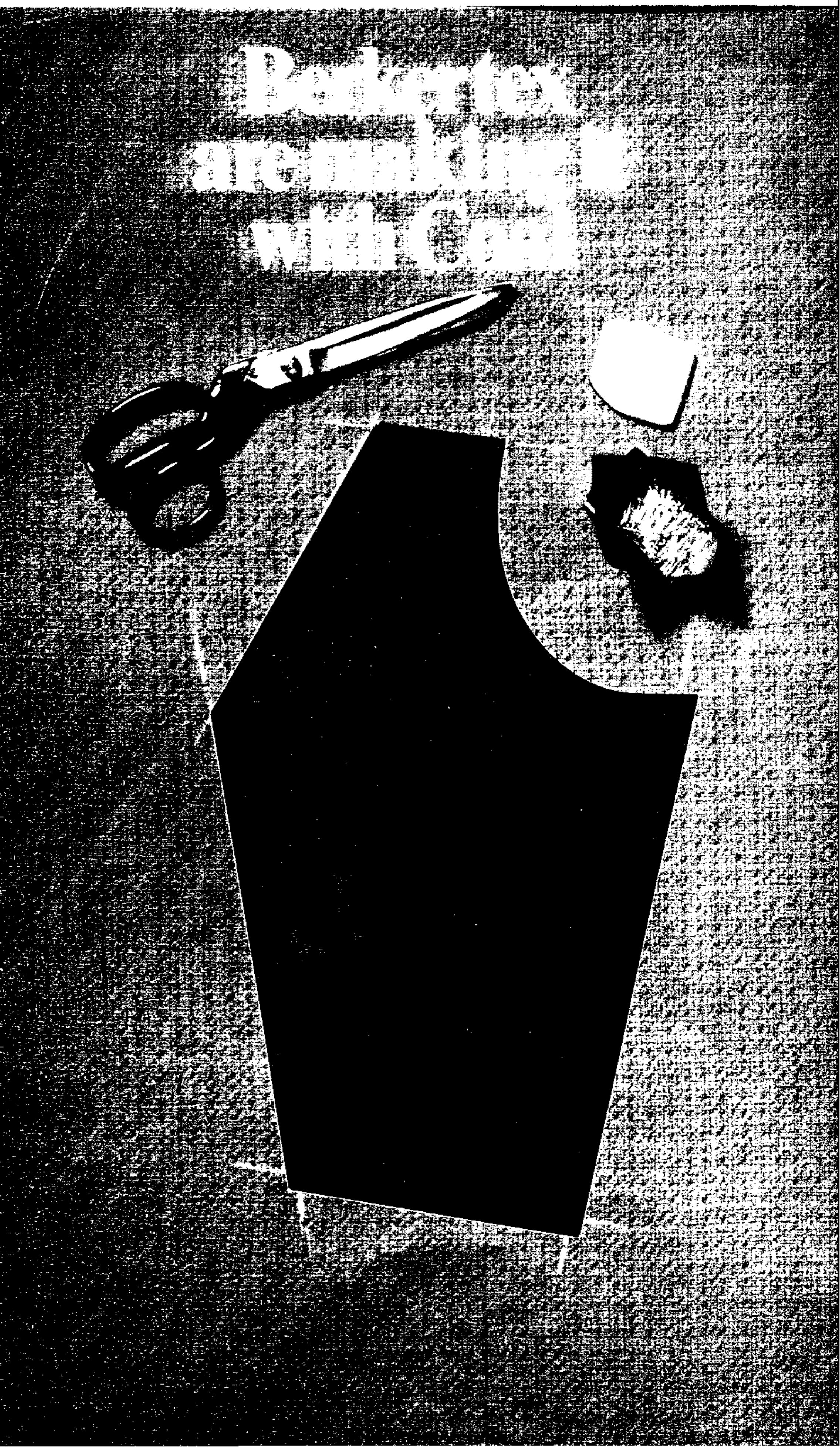
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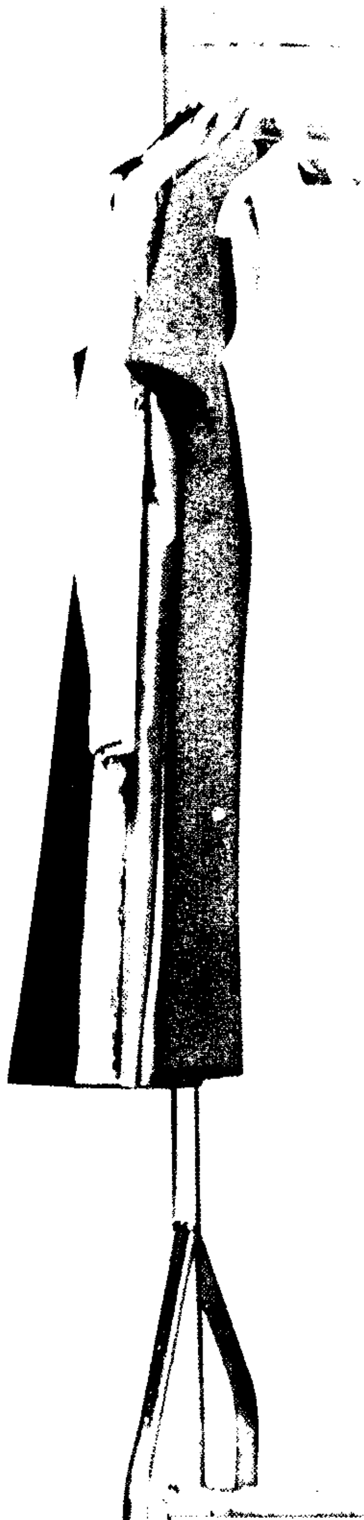


Berkertex make dresses by the million. In the notoriously hazardous world of fashion, success on that scale is an astonishing phenomenon – and rare as well. Vision and enterprise between them have made Berkertex the largest dress manufacturer in Europe, and, almost certainly, largest in the whole world.

The same vision and enterprise led to the idea of the 'shop-within-stores' and, so energetically did Berkertex pursue this idea that they now have no fewer than 102 'shops-within-stores' up and down the country with many more to open in the future. And, as you might expect of such a company, they are making a notable contribution to the country's balance of payments, exporting their dresses all over the world.

It is interesting that a company so vigorous and forward-looking should choose coal for the fuel at their $9\frac{1}{2}$-acre factory at Plymouth. With two Danks 'Economic' boilers (each rated at 4500 lb/hr) and Danks chain-grate stokers and grit arresters, the soundness of their judgement is confirmed by an annual saving of £1,200 in fuel and labour costs.

With economy on that scale, it is no wonder that coal is in fashion.

ex over £1,200 a year in fu

From mammoth smelters to market gardens, coal saves money for go-ahead British Firms.

Five Centrax boilers are accommodated in one compact boilerhouse as a result of their unique shape and design.

Centrax boilers – a happy marriage between Swedish design and British engineering.

Some years ago, A. B. Gustavsbergs Fabriker of Stockholm developed a boiler design offering substantially greater thermal efficiency and fuel economy than the conventional boilers then being produced. The Gustavsberg principle depends upon high fan pressures and large pressure drops in the gas passages, which make possible unusually high flue gas velocities and, therefore, greater heat transfer rates. This, in turn, produces an unusually compact and efficient boiler of a convenient rectangular shape.

There are substantial differences between the original Gustavsberg boiler and the Centrax design, this latter taking into account the stringent requirements of British insurance companies, and conforming to the appropriate British Standards. But the essential principles are maintained, and the resulting operating efficiency of 80% over the full range of output.

Underfeed stokers can conveniently be installed to feed from front, back, or sides of the boiler, and ash can be removed manually or mechanically. Alternatively, chain-grate or coking stokers can be as easily installed. High-speed gas flow minimises soot deposits, and cleaning and maintenance become easy and, therefore, economical.

When the doctor is seen taking his own medicine, you know it must work. The National Coal Board has installed Centrax solid-fuel boilers in several of its premises.

The J. Samuel White Pneumatic Conveying System for greater efficiency and even greater economy.

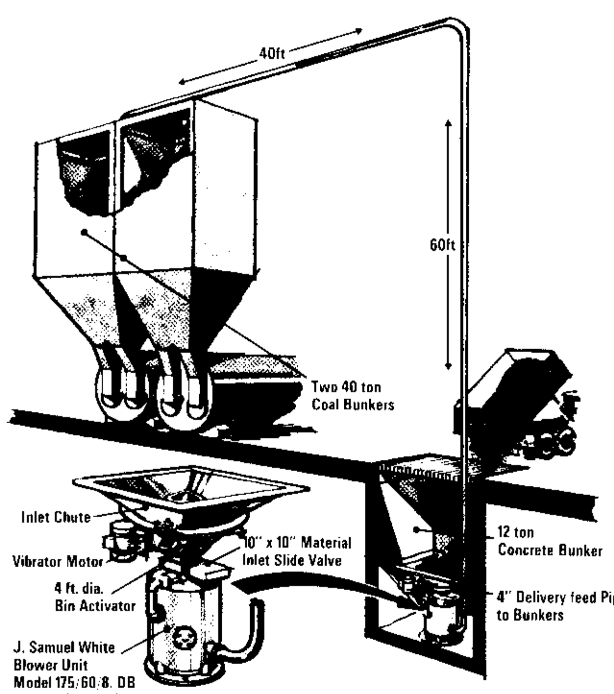
The man with a shovel is very far from obsolete, but needless, back-breaking toil is a very poor use of human resources – and a costly one, too.

Today, it is possible to have a solid-fuel installation without paying either the price of a shovel or the wages of a single man to wield it. Automatic conveying systems can handle the whole job – from the lorry that brings the fuel, to the lorry that takes away the ash.

One such system is that of J. Samuel White. In a typical installation (for the Midland Brick Company, of Desford, Leicestershire), washed coal ranging in size from 1″ to $\frac{1}{16}$″ is delivered in 12-ton loads to a concrete bunker situated over the Blower Unit.

When coal is required in the overhead bunkers feeding mechanical stokers on the two boilers, the operator sets a single control to time the period the Blower Unit will operate. This governs the amount of coal delivered through 100 feet of pipeline. Then he moves a switch to set the Blower in action. The moist coal is agitated by a Bin Activator. This enables it to flow into the Material Chamber through an Inlet Valve which opens and closes in ten seconds, allowing nearly 1¼ cwt to pass. The Blower Unit is charged with air and then blows the coal to the bunker. This cycle is repeated about once a minute.

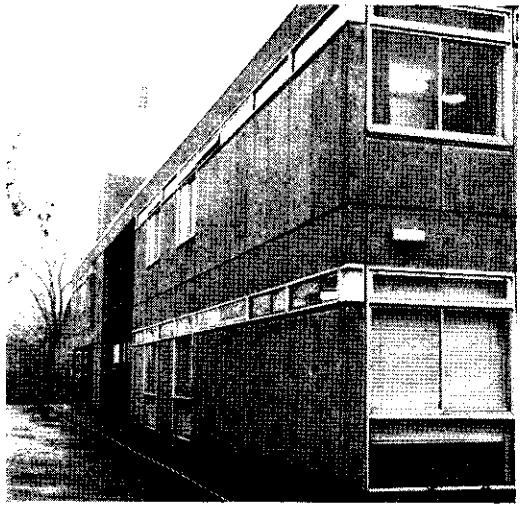
In about 3¼ hours a 12-ton load can be transferred to the bunkers, and all the operator has done is to set the timer and press a button – better than a shovel.



The White Pneumatic Conveying Application in use at the Midland Brick Co., Desford, Leicestershire.

These facts prove it, Coal saves mon

AT MANSFIELD:
coal is chosen for the go-ahead Health Centre



The Health Service of the future can be seen in full swing today – at Mansfield Health Centre, in Nottinghamshire. In a modern purpose-built clinic of outstandingly skilful design, local authority health services are integrated with three busy general practices. Medical health, chiropody, school dentistry, midwifery, and the home help service all have their place in this remarkable building. It is the health centre for about 35,000 fortunate citizens of Mansfield.

As might be expected, the heating installation (by Andrews-Weatherfoil) is as up-to-date as the rest of the building. It comprises warm-air convectors, natural convectors, hospital radiators, and perimeter heaters; it is fired by a single Beeston 7MN sectional boiler (792,000 BThU/hr) side-fired with Thoresby Washed Singles by an Ashwell and Nesbit RL80 bunker-to-boiler underfeed stoker.

There is a sophisticated control system, by Satchwell, to ensure that the building is warm for the start of the working day and that there is protection against frost during unoccupied periods.

In such an important project, and one on which so much skill, ingenuity, and sophistication has been exercised, it is significant that the chosen fuel turned out to be coal

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.

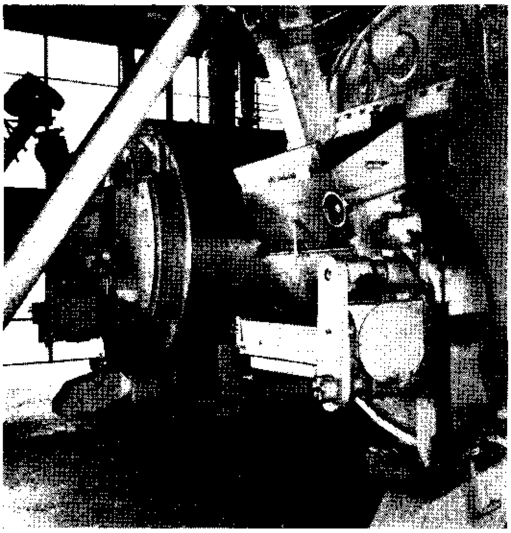
The biggest improvements have been made during the last three years – at a cost of about £1,300,000. New lifts, new kitchens, new staff restaurant, new nurses' flats, new ante-natal ward, new maternity unit, new medical ward block have all been added.

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.

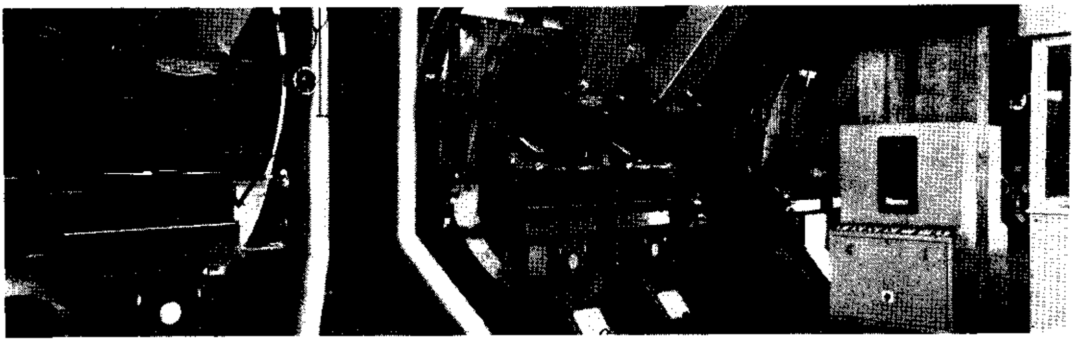
ey for Britain's Hospitals.

AT DUNFERMLINE: up-to-date hospital installs up-to-date heating

The Lynebank Hospital, Halbeath Road, Dunfermline is the first totally new, purpose-built mental hospital to be built in the United Kingdom for a full thirty years. As might be expected, it is up-to-date in its whole concept of treatment of mental disorders and up-to-date in the facilities it offers. It is a whole world in miniature, with its own school for the children, its sports, its film and drama shows, its church services, its workshop block.



Such a building must be equally up-to-date in its mechanical equipment – as, for example, the fully automatic coal-fired boiler plant which supplies all hot water and heating services. There is a mixed heating system (comprising warm air units, radiant panels, underfloor heating, together with domestic hot water from a number of calorifiers), and the boilder plant itself consists of three John Marshall low-pressure hot-water boilers, each rated at 10,000,000 BThU/hr, and fired by Hodgkinson Bennis chain grate stokers.
Coal is delivered into three low-level glass-lined bunkers by a tipper. From here, it is transmitted into the stoker hoppers by Hodgkinson Bennis 6in. screw elevators, fitted with Redler 'Tidal' level controls. Ash is automatically discharged by a Riley 'Convator', the multi-directional conveyer-elevator system. This discharges the ash into a 7½ton overhead hopper for collection by lorry.
Each boiler is fitted with Unitherm automatic combustion control equipment, and the whole plant is fully instrumented by Cambridge Instrument Company indicators and control panels. Lea coal meters and recorders are fitted to each boiler.
Lynebank Hospital provides an excellent example of combining low-cost fuel with the advantages of sophisticated control equipment.



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 13,000lb/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 conveyers. These deliver the coal into overhead bunkers. Ashes are removed by Thompson plough-type ash extractors to a submerged conveyer, 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.

H

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