THE HOSPITAL ENGINEER

THE JOURNAL OF
THE INSTITUTE OF
HOSPITAL
ENGINEERING

VOL XXIII No 4
APRIL 1969

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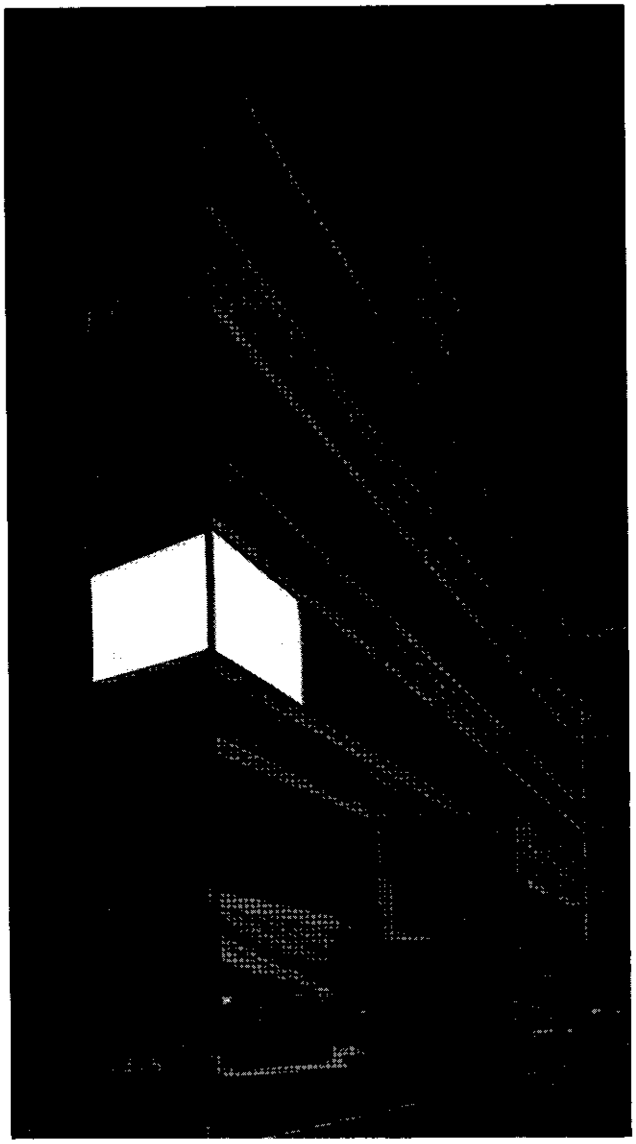

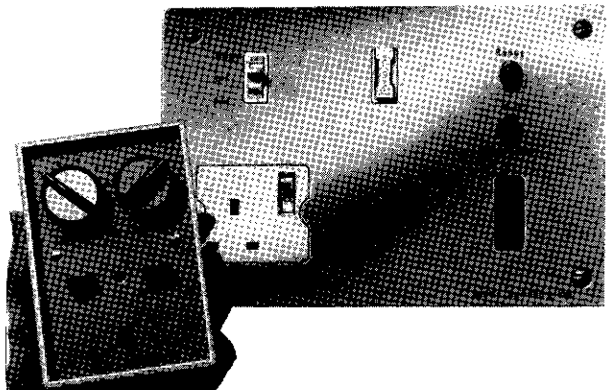

Member of the
International Hospital Federation

**THE JOURNAL OF
THE INSTITUTE OF
HOSPITAL ENGINEERING**

**Published monthly at
16, SPRING STREET,
LONDON, W.2.
Telephone: 01-262 7454
(For London 262 7454)**

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THE INSTITUTE OF
HOSPITAL ENGINEERING

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Environmental Control

By K. H. BOURNE (Member)

ENVIRONMENTAL CONTROL is a vast subject embracing the control of environments not only for man but for food, animals, machinery and many industrial functions.

However, this article is concerned mainly with the control of man's environment and, in particular, the art and science of air conditioning as a means of achieving this. Hospital engineering is particularly rich in the scope offered for the practice of environmental control and it is in this field that it is proposed to review some of the current trends in design and application.

The paper will cover generally:—

(1) Man and Psychrometrics.
(2) Packaged Air Conditioning Equipment.
(3) Humidification.
(4) Refrigeration.
(5) Controls.
(6) Applications.

Man and Psychrometrics

First of all, then, let us look at man or woman and their relationship with psychrometrics.

Human beings are more or less continuously consuming and expending energy and can be considered, among other things, as a heat engine. Food is taken into the body and converted into heat and mechanical work.

An apparent essential part of this function is to maintain a body temperature of 98·4°F plus or minus ½°F. To achieve this, heat is given off by conduction, convection, radiation and evaporation. The reverse is also true, heat being absorbed when necessary and the evaporation rate diminishing. When the limits of intake or rejection of heat are reached, we state that it is either too cold or too hot and corrective action must be taken. In its simplest form, this means standing nearer the radiator or fire, or conversely, removing excess clothing. These remedies are not always convenient and other, more sophisticated means are required to permit the natural processes of body heat transfer to take place.

In order to feel comfortable it is not only necessary to maintain an ambient temperature below the normal body temperature, but to ensure the humidity is also at a comfortable level. A temperature of 70°F. allows good conduction to take place and generally, as long as the relative humidity is between 40% and 60%, evaporation is also satisfactory.

Higher ambient temperatures may be quite comfortable provided the R.H. is low but extremes of temperature and humidity are particularly troublesome and are accentuated when experienced even under normal working conditions or especially when it is important that tasks are performed at peak efficiency, such as in an Operating Theatre.

It would appear reasonable to state, therefore, that temperature and humidity must be controlled in order to achieve a comfortable living and working environment.

Psychrometry is the study of the properties and behaviour of mixtures of air and water vapour. The psychrometric chart has been devised as a means of showing the state of air and water vapour mixtures under varying temperature conditions and is one of the main tools of the air conditioning or environmental engineer. Upon this chart can be shown complete air conditioning cycles involving cooling, de-humidification, heating and humidification.

Fig. (1) shows a psychrometric chart upon which is drawn a typical heating cooling cycle for winter and summer, based upon internal design conditions of 70°F.

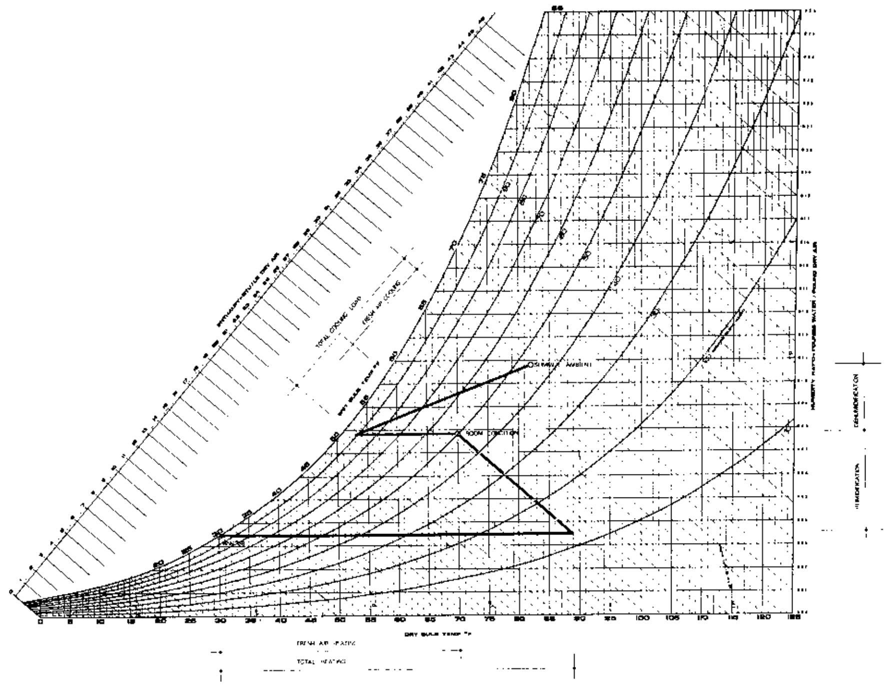

Fig. 1. Typical Fresh air chart.

DB, 50% RH with external conditions in winter of 30°F. DB saturated 82 F. DB, 67° WB in summer.

The cycle shown on this chart is in fact applicable to most total fresh air systems.

It will be seen that in winter the air is heated from 30°F. to 70°F. and then further to a supply temperature which is higher than the room temperature to allow for heat losses. (The supply temperature here is shown as 89°F. but this will vary according to each application.)

Humidification is shown taking place along the slope of the constant heat line and assumes a spinning disc or cold water spray type is used. More will be said about this later.

When considering the cooling cycle, basically the same action takes place as for heating, except the temperature is lowered. It will be appreciated that in order to arrive at the design room condition, the air must be cooled to a lower temperature to allow the air to pick up the internal heat gains in the space. Most cooling coils are designed to remove humidity and therefore the cooling slope follows a course of reducing temperature and humidity. This is a useful feature, although on total fresh air system, with simple on/off cooling, excess de-humidification can occur which would need correction by re-humidifying.

The complete air conditioning cycle represents the boundary limits of a given system and under good control the graphs will alter position within these limits to achieve the desired room condition.

This cycle can be modified (as Fig. 2) so that the majority of the air is recirculated, say 90%, and 10% of the air is introduced as fresh air. With this system, considerable economies can be made on the heating, cooling and humidification loads and the size of plant can be reduced.

This system is commonly employed for straightforward comfort applications.

To summarise, therefore, it is necessary to:—

(*a*) Decide upon the temperature and humidity conditions required.

(*b*) Compute the heating and cooling loads.

(*c*) Decide upon the type of system, i.e. whether all fresh air or part recirculation.

(*d*) Draw up the complete cycle upon the psychrometric chart.

When these functions are fulfilled, it is then possible to consider the selection of the plant most suited to the application. The type of equipment selected will depend upon many factors, not least is the financial budget available.

Packaged Air Conditioners

In this country over the past 10 years or so there has been a steady development of the packaged unit form of construction, which, in the majority of cases, shows considerable advantages over the on-site purpose built installation.

Packaged air conditioning equipment, as it is generally described, is basically factory made air handling and refrigeration equipment which is completely assembled.

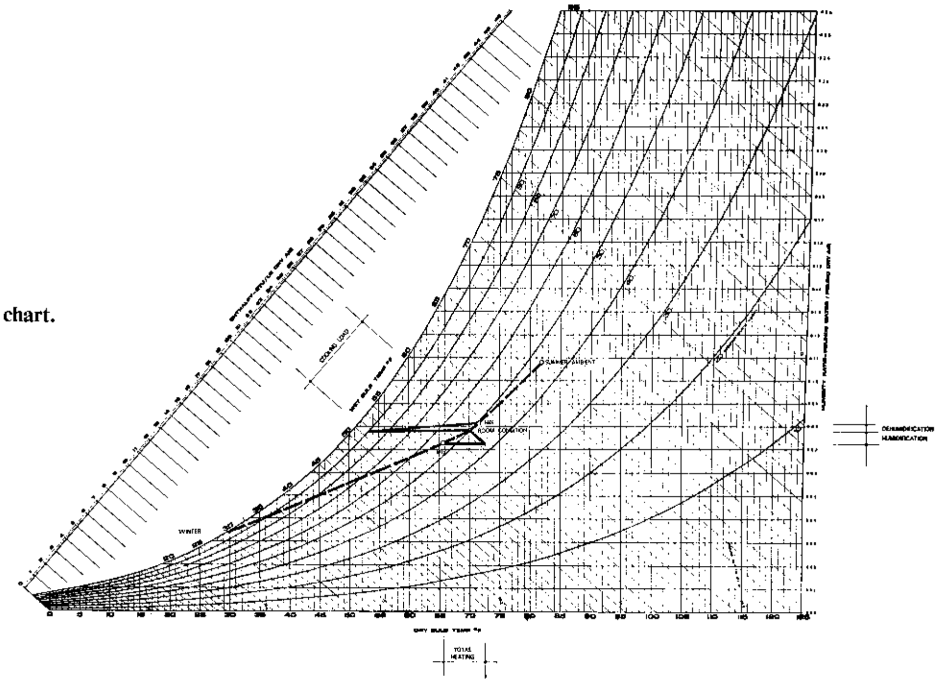

Fig. 2. Typical Return/recirculated air chart.

pre-piped and wired requiring the minimum installation time on site. By standardising upon manufacturing techniques and unit sizes, system design is simplified and unnecessary repetition is avoided. The result is, or should be, a better product at a lower cost.

Packaged units can be divided into the following main categories:—

(1) Room located or through window models, usually 8,000 btu/hr (1 hp) up to 18,000 btu/hr ($1\frac{1}{2}$ hp). Larger units are available but are not recommended for direct room mounting without ducting because of the relatively high noise level.

(2) Free standing models 30,000 btu/hr (3 hp) to 100,000 btu/hr (10 hp) either water cooled or with

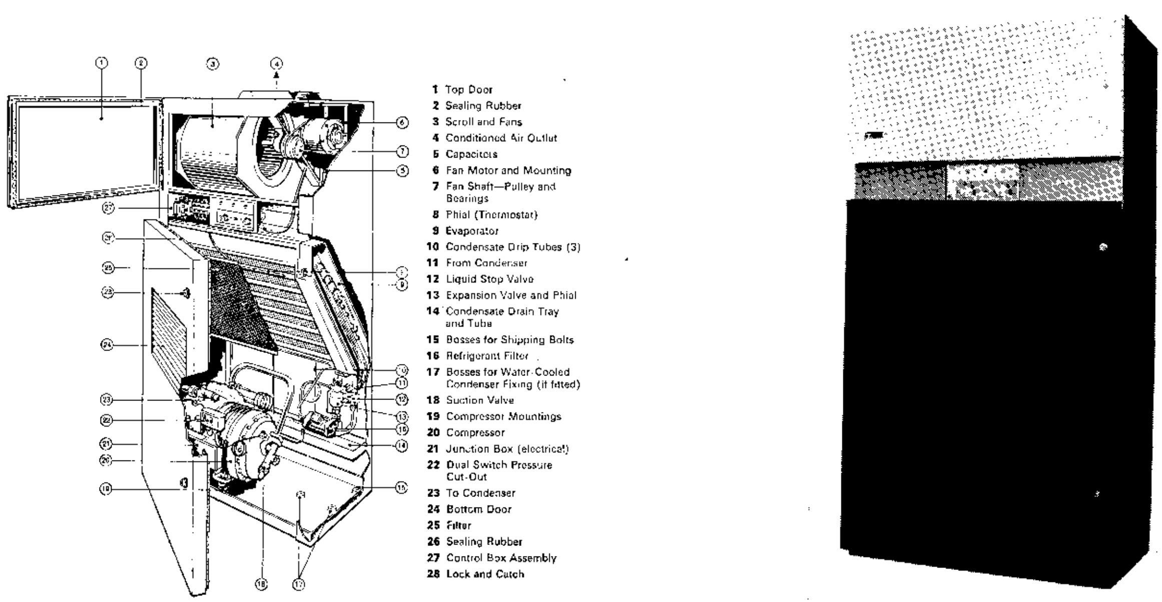

Fig. 3. Large freestanding unitary Air Conditioning Unit for remote condenser. Tempair Ltd. 5000.

interconnected remote air cooled condensers (Fig. 3). These are designed for location either in the conditioned space or adjacent to it, the air being delivered through ducting. Location outside the conditioned area is preferable but can be considered in some cases where the general noise level is already high, such as in a Typing Pool or Workshop.

(3) Split system units comprising an air handling unit (Fig. 4), and an air cooled condensing unit (Fig. 5). These range in size from 40,000 btu/hr (5 hp) up to any size, but are usually limited to 600,000 btu/hr (50 tons). Above this, most applications are purpose built.

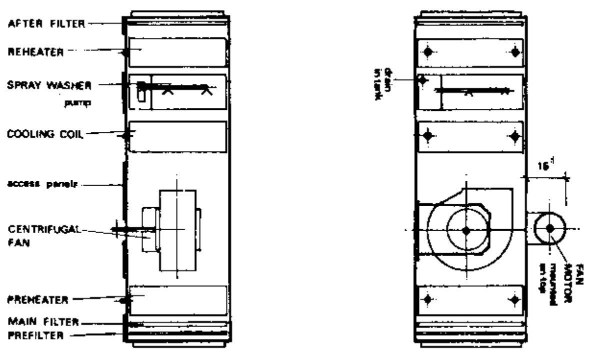

Fig. 4. A H 400 unit.

At this stage it may be of interest to examine the basic components of a packaged air conditioning system and briefly explore the design philosophy behind the selection of equipment.

Let us suppose it is desired to provide 20 air changes to an Operating Theatre maintaining 70°F. DB, 55% RH summer and winter and that the air must be filtered, heated, humidified and cooled. (Fig. 1), the F/A cycle on the psychrometric chart could apply to this application. All the air will be exhausted through pressure relief grilles from the Theatre and no recirculation will be permitted. Steam is available for heating and humidification.

A typical plant layout for this type of system might be as illustrated in Fig. 6. In this case the main air handling plant and refrigeration unit is located upon a flat roof approximately 11 ft. from ground level. Fig. 7 shows a closer look at the construction of the air handling unit. Air is drawn in through low velocity high efficiency filters (96% at 5 microns) pre-heated or cooled, reheated and humidified and delivered via ducting to ceiling diffusers located either side of the operating table.

It is good practice to use D.I.D.W. fans running at 900 r.p.m as this reduces the operating noise level considerably. (Two ½ duty fans or one fan with stand-by motor.) Air noise from the fan can be completely eliminated by careful design of the air handling unit and

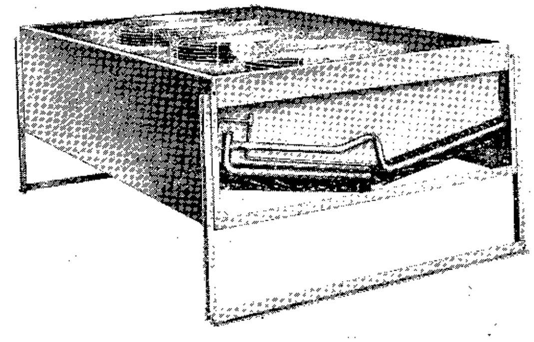

Fig. 5. An air-cooled condensing unit.

distribution ducting; usually the air velocity is arranged to be between 500 and 600 f.p.m. through the unit (300 f.p.m. through the filter), rising to 900/1,000 f.p.m. in the ducting. Air velocity at the grilles is dependent upon the position and length of throw required but is between 350 to 500 f.p.m.

The heating coils, if steam, should be of the self draining type to prevent frost damage and would normally be constructed from copper tubes expanded on to plate type aluminium fins.

The cooling coil material construction would be similar and would incorporate a drain tray to catch entrained moisture during de-humidification.

The humidifier section comprises a spray header with provision for catching and removing condensate either by reheating in the spray pipe, or by positive drain.

All the components are enclosed within an insulated cabinet which, in this case, is stove enamelled for additional weather protection.

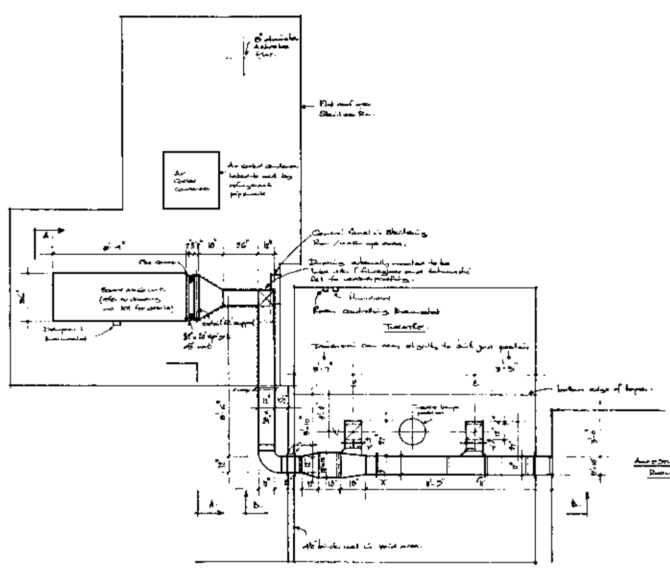

Fig. 6. Plan view of Theatre ventilation at Haslemere Hospital.

The refrigeration unit is, in this application, a single stage semi-hermetic system using an air cooled condenser similar to the previous illustration, Fig. 5.

Humidification

As humidification is required on a wide variety of projects, of which typical examples are Operating Theatres, Spinning Mills or process test rooms, it may be of interest to examine current practice in this field.

Requirements can vary considerably but are usually required between 50% RH and 70% and normally controlled, being somewhere between these two figures at a value appropriate to the process. In the case of humidity requirements in Operating Theatres, it is recommended that the humidity is not allowed to fall below 50% RH in order to reduce the risk of combustion from static electricity. It is usual in these cases to design the plant to provide 55% RH under maximum load conditions.

The amount of moisture to be added is greatest for total fresh air systems, but can be reduced if recirculation of the room air is permissible. The following chart shows design conditions and humidity requirements for a number of typical applications.

Application	*Design condition RH %*	*% Fresh air of total*	*Approximate amount of moisture lbs./hr. 100 cfm circulated*
Operating Theatre	70°F DB 55% RH ± 5%	100%	2·5
Offices	70°F DB 50% RH ± 5%	10%	2·2
Computer Rooms	70°F DB 50% RH ± 3%	10%	0·2
Standards Room	75°F DB 60% RH ± 5%	5%	0·13

The means by which moisture is added can be one of four methods currently employed.

(*a*) Indirect infusion of steam from pan type humidifier either electrically, steam or HPHW heated.

(*b*) Direct steam injection through sparge pipe into air stream.

(*c*) Saturated cold water spraying.

(*d*) Spinning disc cold water atomising type.

The type most suitable for a particular application will depend upon the heating medium available, the amount of humidification required and the application itself.

(*a*) Figure 8 shows a pan type humidifier using electric heating elements as the means of raising steam. This type of unit is ideal for general air conditioning systems where the capacity requirements are modest, say up to 24-lbs/hr. Above this rating the electricity consumption usually precludes its use. The amount of electricity required per lb. of steam, allowing for scale build-up, is about 500 watts or 1 kW. per 2-lbs. steam per hour.

This type of unit has the chief advantage of producing water vapour with little risk of contamination of the air stream with bacteria or smells.

Control is by humidistat operating the heating elements via contactors.

(*b*) Direct injection of steam into the air stream is probably the simplest means of humidification and, provided care is taken in the design of the layout to ensure proper distribution and drainage of condensate from the sparge pipe, it is perhaps preferable to other means.

However, a good supply of *clean* steam is essential.

Control is by a room air/duct mounted humidistat operating either:—

(i) Solenoid Valve.

(ii) Modulating Valve.

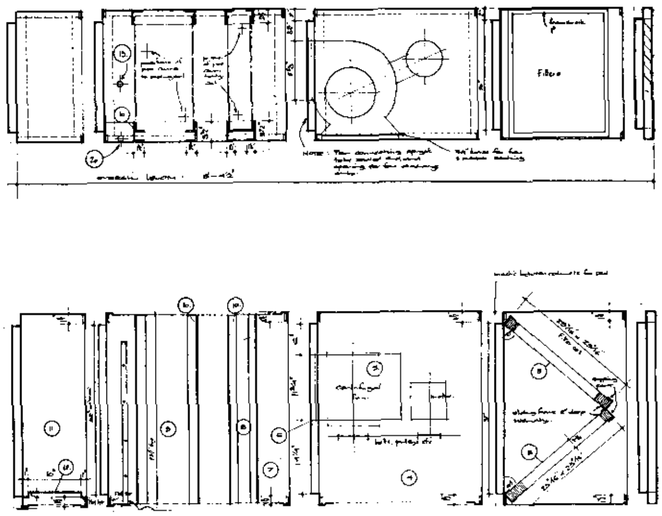

Fig. 7. Haslemere Hospital Air conditioning unit.

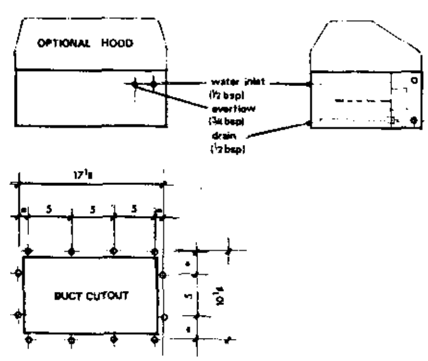

Fig. 8. A Pan humidifier.

Modulating control is preferable and essential at higher steam pressures to avoid sudden saturation of the conditioned space with steam. At lower pressure however, and where limiting control only is required, a solenoid valve is satisfactory.

(*c*) Unlike steam humidifiers which are said to humidify at constant temperature, i.e. (isothermally or vertically on the psychrometric chart). Cold water spray humidifying is carried out adiabatically, i.e. at constant total heat but varying temperature following the W.B. lines of the psychrometric chart, as shown previously, Fig. 1. With this type it is necessary to correct the temperature of the air to ensure the final supply condition is at the desired level.

The efficiency varies with design and the pressure of spray water, but is usually low between 60% and 70%, i.e. up to 35% of the water goes down the drain.

The main application for spray humidification is in systems requiring large quantities of water and where advantage can be taken of the cooling effect from the mains water which is usually at 50 to 55°F. Control is by switching on/off the circulating pump.

(*d*) In order to improve the saturation efficiency, the spinning disc type of humidifier was developed. This employs the principle of centrifugal force acting upon water which is introduced on to a motor driven spinning disc. The water is spun out to the periphery of the disc and is broken into very small particles forming a fine mist or fog.

The operating characteristics are similar to spray types but have a higher efficiency, 90% or better, and control is by shutting off the water supply via a solenoid valve.

If the water is hard or contains mineral salts, it is advisable either to treat it or to install a good after filter in the air supply duct, as the solids are held in suspension in the water vapour and may eventually be deposited on equipment or furniture in the conditioned space in the form of dust.

A brief word about the care and maintenance of humidifiers may be useful at this stage. Much time and trouble can be saved by consulting a water treatment specialist before installing the plant. If the water is then treated, preferably de-ionised rather than just softened, the plant will require inspection and cleaning at far less frequent intervals.

Refrigeration

Refrigeration is becoming increasingly an essential part of most environmental control systems as is evident in the numerous types of packaged and other equipment available.

In order to reduce the temperature of a fluid (usually air or water) it is necessary to remove heat. The greatest amount of heat is removed during an evaporation process and the basis of the refrigerant cycle is to circulate a liquid refrigerant which does this at a temperature below the level of the fluid to be cooled. Having absorbed heat, the refrigerant vaporises and then requires to be turned back into a liquid so that the process can continue.

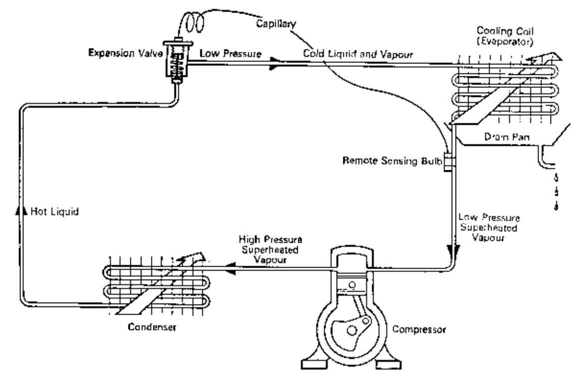

Fig. 9. A typical vapour compression cycle and major components.

Fig. 9 shows a typical vapour compression cycle and the major components which are necessary for this to operate effectively.

The cycle operates as follows:—

Liquid refrigerant under pressure is passed through an expansion valve which allows the refrigerant to pass from the high pressure side of the circuit into the cooling coil at the low pressure side. The reduction in pressure allows the liquid to expand inside the cooling coil tubes and this continues whilst absorbing heat from the air or water passing over the external side of the tubes.

The low pressure gas leaves the cooling coil and is drawn into the suction side of the compressor. The gas is compressed and cooled in a condenser where heat is given up by the refrigerant to the air or water passing over the condenser.

The gas liquefies and is ready to commence the cycle once more.

In its simplest form this refrigerant cycle is an on/off cooling device depending upon a fairly constant load in order to perform satisfactorily. There are, however, many ingenious modifications to this basic cycle that have been devised to make it more flexible. A combination of bypass valves and liquid injection is sometimes used to achieve capacity modulation or the system may be broken down into multiple units under step control.

It is perhaps interesting to note that this basic system can be designed so that the condenser can be used as a means of preheating a fluid, the cooling side becoming of secondary importance. Where the need for heating

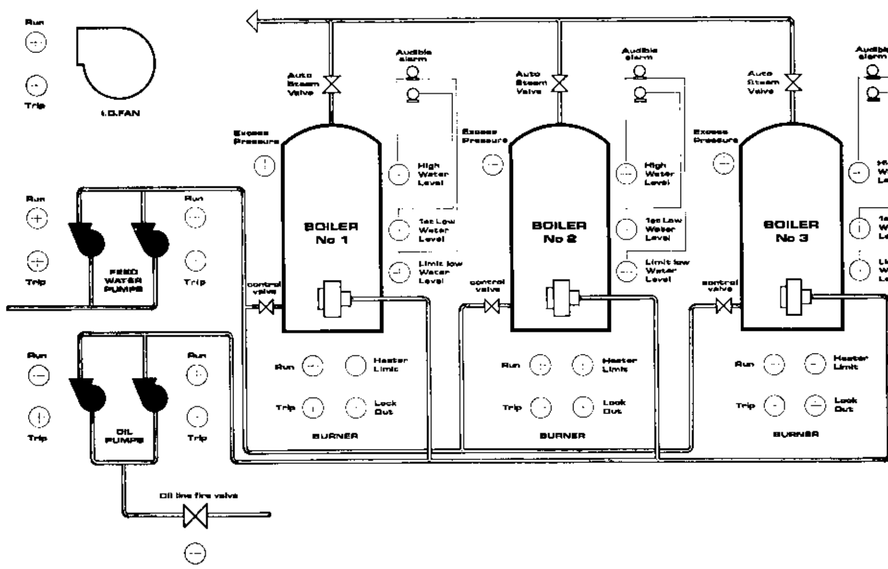

Fig. 10. Royal Sussex County Hospital: Layout of Mimic Panel for Boiler Automation scheme.

and cooling is simultaneous, the system is called a heat pump.

Applications which are ideal for employment of the heat pump principle are in breweries where large quantities of warm water are needed for washing, coinciding with air cooling in bottle stores. It has been shown that it is also practical in large office blocks which may have a cooling and heating requirement occurring together in the same building during a considerable period of the year.

The power requirement for refrigeration plant varies according to the level of cooling required but for general air conditioning applications it is approximately 1 hp per ton of refrigeration where a ton is 12,000 btu/hr per hour (based upon the heat required to melt one American short ton of ice in one hour).

The cooling load requirements likewise will vary considerably but a useful guide is 4 btu/hr per cubic feet of space to be conditioned.

Controls

No system can function satisfactorily unless provided with appropriate controls and, to a large extent, the layout of the equipment is determined by the method of control employed (returning to Fig. 6). The air handling unit is arranged so that by positioning a duct thermostat in front of the cooler and preheater a constant temperature can be maintained at this point. Another thermostat is located in the Theatre and operates the reheater which "tops up" as necessary. The humidifier is operated from a humidistat also located in the Theatre which opens the steam valve to the spray header whenever humidity is below the desired level.

It is useful to incorporate a pressure switch which illuminates a warning light whenever the filter becomes dirty and requires changing.

The amplifier unit, relays, contactors and fuses can be prewired into a control panel incorporating lights to confirm the various plant functions.

There is an increasing interest and use of control panels incorporating mimic diagrams representing in diagrammatic form a plant layout and incorporating visual indication of equipment functions. Fig. 10 shows a triple boiler plant mimic panel. In this case, indicating lights are located in appropriate positions to show normal and abnormal operations and is clearly an aid to quicker appreciation of normal or abnormal plant function.

The use of panels of this type is at present mostly confined to large installations, although there is tremendous scope for development of their use on a wide variety of projects. They are particularly advantageous where it is necessary to convey information about the plant operation to non-technical or lay personnel. An example of this situation can be found in an Operating Theatre where the Theatre Staff, although skilled, know little about air conditioning but would, at a glance, be able to advise the Engineer of any malfunction and give a fairly accurate description enabling corrective action to be taken more quickly.

Applications

Varying degrees of environmental control are illustrated by the following applications:—

Premature Baby Ward—St. Luke's Hospital, Guildford.

It was necessary to provide four areas in a premature baby unit with conditions between 70°F. DB, 50% RH and 80°F. DB, 60% RH. The building was an old building converted for the purpose. Individual units were suggested as a satisfactory and economical means of dealing with the varying conditions in each area.

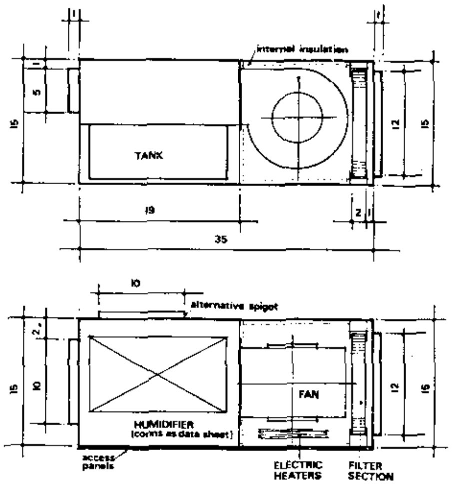

Fig. 11. Air handling unit.

Fig. 11 shows the type of unit employed. The units were fixed to the external wall of each area. Fresh air is drawn in at the rear, passed through a filter, preheated electrically and humidified and delivered to the room through a high level grille. A small switch panel in the room enables the Staff to switch on/off the unit fan and override the heater. A thermostat and humidistat control the room temperature and humidity automatically. All service functions can be carried out outside the conditioned space.

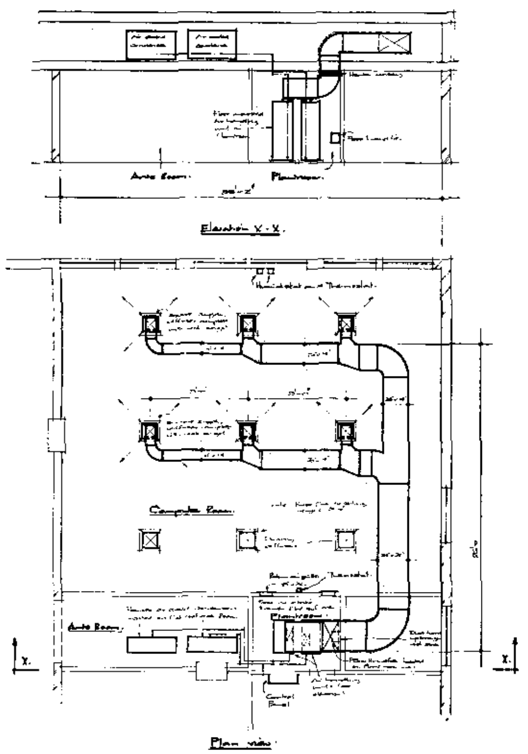

Fig. 12. General arrangement of Air conditioning scheme for Winnall Valley Road Accounting Computer.

Computer Room—S.W.M.R.H.B. Winchester

This system shown in Fig. 12 employs two Rootes Tempair 5000 air conditioning units located in a small plant room/plenum chamber adjacent to the conditioned space.

Air is drawn into the plenum through a grille in the wall adjoining the space and is filtered, cooled and/or heated, humidified and returned to the area through high level ducting and diffusers mounted in the ceiling.

Electronic controls are used to maintain 70°F. DB. ±3°F., 50% RH ±5% RH on this installation through multi-stage switching. An interesting problem encountered on this installation, after running for over 12 months, was a sudden variation in the set point of the controller. This proved to be caused by fluctuations in the voltage of the electricity supply and necessitated the fitting of voltage stabiliser; the cause of the voltage variation is unknown, although it is believed to be due to a steady increase in the demand for electricity in the area.

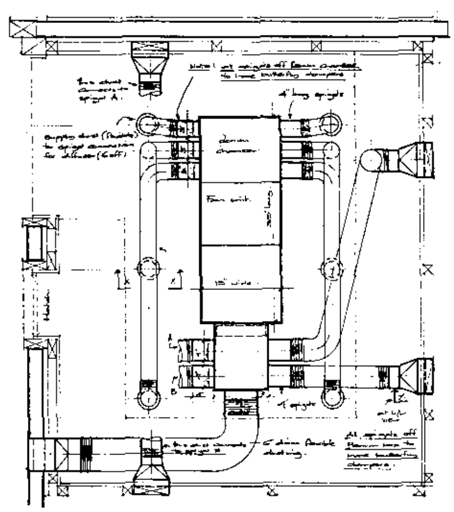

Fig. 13. Layout of proposed ventilation services for the Incubator Room, The London Hospital.

Incubation Room—The London Hospital (Fig. 13).

Part of a comprehensive air conditioning system serving the Clinical Laboratories was the inclusion of equipment to provide close temperature control to a small room used for incubation of cultures. The control requirements are 37° $\pm\frac{1}{2}$°C. with a maximum differential of 1°C. between floor and ceiling.

As the temperature in the room is higher than that normally experienced externally the surrounding rooms were air conditioned to 70°F. DB. 50% RH, cooling was not considered necessary.

A unit was designed to provide constant circulation of warm air and distributed as evenly as possible to avoid stratification. A single 2 kW. heating element was

(*Continued on page 100*)

A brief history of the Reciprocating Engine—

1ST CENTURY A.D. TO 1850

By J. DEAN (Member)

NOW that the Steam Locomotive has disappeared from the railways of this and other countries one could be forgiven for thinking that the long useful years of steam power are past, but such thoughts would not be ti ue.

In countries where coal and nuclear energy are common, steam is still the prime mover for converting heat into mechanical energy to drive electricity generators.

The steam engine liberated mankind from a tremendous amount of toil and led to large expansion of industry. When mines became deep enough for pumping to be a serious problem, pumps were for the most part worked by horses or men. In the seventeenth century, the discovery of the pressure exerted by the atmosphere opened up a new source of power.

When, at the beginning of the 18th century the first workable cylinder and piston engine was made, its use became general in the British mines but, as it relied upon the vacuum, or perhaps we should say an unbalancing of atmospheric pressure (produced by the condensation of steam), its efficiency was very low.

As the century progressed and engineers applied themselves to the designing of rotative engines with a more efficient use of the condensed steam, the steam engine became the prime supplier of power to factories, mills, railways, ships, road transport and even lawn mowers.

Now in the 20th century, the recipiocating engine has been displaced by the internal combustion engine; however, in some places, for small power purposes, the steam engine still finds work to do. Therefore, the importance of its history transcends its purely technical points, however important these may be.

It is recorded that, in the first century A.D., Hero of Alexandria described the opening of temple doors by heat. Air, when heated, drove water out of a closed tank into a bucket which descended and opened the doors. As the air cooled, it contracted and sucked the water from the bucket, whereupon the doors closed.

In 1606, Della Porta of Naples experimented with the use of steam instead of air and water, to produce the same effect. Using a flask full of steam with its neck thrust below cold water, he was able to draw water into the flask as the steam condensed. The accepted explanation of suction was that "nature abhorred a vacuum".

Many others experimented along these lines and, in 1643, Torricelli announced that the atmosphere exerted a pressure on account of its weight and that this pressure would balance a column of mercury about 30 in. in height.

This discovery prompted a burgomaster of Magdeburg, one Otto von Guericke, to make a first air pump. In 1650 he succeeded in evacuating a copper sphere which collapsed under atmospheric pressure. Later, he used this pressure with a cylinder 15 in. in diameter and an accurately fitted piston packed with hemp. By pumping the air out of the cylinder, he raised a weight of more than one ton.

In 1679 a Dutch scientist tried unsuccessfully to remove the air from a cylinder through non-return valves, by using gunpowder.

Denis Papin, 1647–1712, continued experimenting on the use of steam and in 1690 he took the important step of condensing steam to make the vacuum and suggested the use of a machine with several cylinders arranged to turn the paddles of a boat by means of ratchets. As there were difficulties in the production of large cylinders to requirements, he did not follow up his suggestion. He had, however, demonstrated principles which were later to be used by Newcomen.

In 1648, Thomas Savery, who was a military engineer, obtained a patent for ". . . Raising of Water . . . by the Impellant Force of Fire" and made a pump based on Della Porta's principles. Steam was admitted into a sealed vessel and condensed by cold water poured on the outside. The vacuum thus produced pulled water up a suction pipe through a non-return valve in the bottom of the vessel. Steam was then again admitted, driving the water through a second non-return valve and up the delivery pipe. All the valves were manually operated.

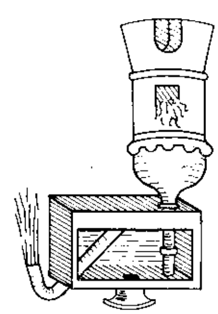

Fig. 1. Della Porta's steam pressure apparatus from his "Spiritali" —1606.

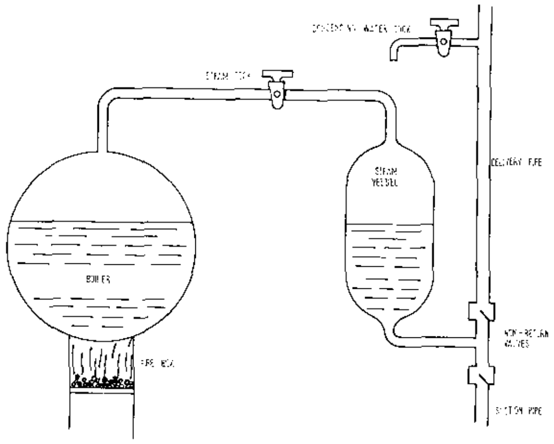

Fig. 2. Diagram of Savery's pump — circa 1698.

In 1702 he produced an improved pump using two vessels and giving a continuous flow. A pump installed by Savery near the Strand gave a lot of trouble and was eventually abandoned. He did, however, enjoy much success with the more modest requirements in the lifting of water at large private houses. Some of his pumps were still in use late in the 18th century in Manchester, despite their heavy coal consumption, for returning water to the headraces of water wheels driving cotton mills. Savery has the distinction of being the first to make a useful steam pump and to employ separate boilers. His original patent was extended to 1773.

Thomas Newcomen, 1663–1729, was an obscure ironmonger in Dartmouth and around 1697 he began to interest himself in Papin's cylinder and piston experiment and, no doubt, impelled by the pressing need of the Cornish mines, pursued his experiments for some fifteen years. In 1712 he erected his first engine, of which there is a definite record, at a colliery near Dudley Castle in Staffordshire. The cylinder of this engine measured 21 in. in diameter and was 7 ft. 10 in. high. The boiler, which resembled a brewer's copper, was 5 ft. 6 in. in diameter and just over 6 ft. high, containing 13 hogshead of water. The engine delivered at every lift 10 "English" gallons of water; the mine was 153 ft. deep.

As there was no machine which could bore cylinders truly cylindrical, they had to be lapped and fettled by hand and, in these circumstances, it was extremely difficult to have a well fitting piston. Newcomen used a leather-faced piston and a water seal on top of the piston, this water being continually topped up whilst the engine was in motion.

At first, condensation of steam in the cylinder was obtained by the use of a water-jacket, the water being drained off into the hot-well and replaced by cold on the beginning of a stroke. This method proved too slow and an improvement was made by the direct injection into the cylinder of cold water. This produced a more rapid and effective condensation and was an advance which made the engine a practicable proposition.

Newcomen did not at first appreciate that air would be carried into the cylinder with steam, and he was puzzled by the fact that his engine would lose power until it ceased to move, air having gathered to the extent that a vacuum could no longer be formed. This fault became known to enginemen as "windlogging". After finding the cause, Newcomen remedied it by fitting a small outlet pipe to the lower part of the cylinder through which the incoming steam could expel any air then present. This pipe was fitted with a non-return valve and was led into a small tank of water—because of the noise it made the valve became known as the snifting valve; "snift" at that time was equivalent to our "sniff". The tank also became known as the snifting basin.

Newcomen's engines were for some time operated by manual manipulation of the valves and were still started up by that means after self-acting gear was installed, the enginemen having complete control over the number of strokes made. Newcomen Atmospheric Engines were eventually in use in many parts of the world, the first engine on the Continent being set up in 1722. The cast brass cylinder soon gave way to cast iron ones which could be produced at one-tenth the cost. The fuel consumption remained high because the cylinder had to be heated and cooled on every stroke.

From 1772 John Smeaton, the civil engineer, designed a number of engines which gave an increased thermal efficiency, but by then the atmospheric engine was becoming obsolete, for James Watt had invented the separate condenser, the greatest single improvement ever made in the steam engine.

James Watt, the son of a shipwright at Greenock, had had training in instrument making in London. He was a craftsman with an enquiring and thoughtful mind. Late in 1763 a scale model of an atmospheric engine was brought

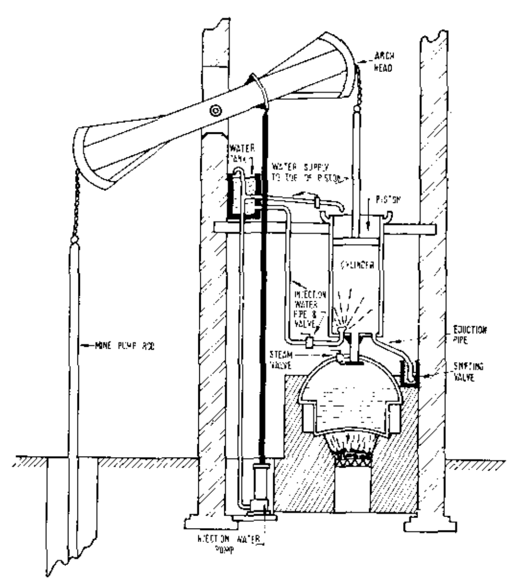

Fig. 3. Newcomen's atmospheric engine — 1712.

Classified Advertisements

SITUATIONS VACANT

BOARD OF MANAGEMENT FOR GLASGOW WESTERN AND GARTNAVEL HOSPITALS

GROUP ENGINEER

Applications are invited for the post of Group Engineer which will become vacant on 16th July, 1969, when the present holder of the post retires.

The person appointed will be responsible for the satisfactory operation, maintenance and co-ordination of all the engineering services and activities in the Group.

Candidates must have acquired wide experience in the management of modern mechanical and electrical engineering plant; in the control of staff and in the preparation of estimates and reports on maintenance and minor new engineering work.

Qualifications required are:—

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

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

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

The Salary Scale (over 72½ points) £2,050 per annum rising by five annual increments to £2,430 per annum plus an allowance of £200 per annum for special responsibilities (over 36 units).

Applications stating age and full details of experience and qualifications, together with the names of three referees, should be sent to the Secretary, Board of Management for Glasgow Western and Gartnavel Hospitals, 10 Park Circus, Glasgow, C.3, not later than 1st May, 1969.

ASSISTANT ENGINEER

required at East Birmingham Hospital to assist the Hospital Engineer in the management and organisation of engineering services, operation and maintenance. Responsibilities involve electrical and mechanical services and the control of Planned Maintenance. Applicants must possess an O.N.C. or O.N.D. in electrical or mechanical engineering or an approved equivalent qualification. Salary commencing £975 p.a. rising to £1,270 p.a. A house may be available to a married applicant at a moderate rental. Apply in writing stating age, experience and qualifications, with names and addresses of two referees, to the Group Engineer:—

EAST BIRMINGHAM HOSPITAL MANAGEMENT COMMITTEE,
Group Administrative Offices,
45, Bordesley Green East, Birmingham, 9.

WHARFEDALE HOSPITAL MANAGEMENT COMMITTEE
HIGH ROYDS HOSPITAL MANAGEMENT COMMITTEE

DEPUTY GROUP ENGINEER (JOINT APPOINTMENT)

Applications are invited for this newly created post to two adjacent Hospital Management Committees in Wharfedale, Yorkshire.

Arising from the pending retirement of the Group Engineer to the Wharfedale Group of Hospitals the High Royds H.M.C. and the Wharfedale H.M.C. are proceeding, by mutual arrangement, to a re-organisation of their respective engineering services to provide for the better use of management resources by creating APPOINTMENTS of GROUP ENGINEER and of DEPUTY GROUP ENGINEER on a JOINT basis to serve both Groups.

Building Maintenance in each Group will continue to be the responsibility of separate Building Supervisors.

The Joint Group Engineer (designate) is the present Group Engineer to the High Royds H.M.C. (Mr. H. F. Pickering, F.I.Plant.E., M.I.Hosp.E.).

The successful applicant for the post of JOINT DEPUTY GROUP ENGINEER will act for and work in close association with the Joint Group Engineer over the whole range of services for which the latter is responsible to each of the respective Groups.

Applicants MUST be qualified in accordance with the requirements approved by the Department of Health and Social Security.

A two-bedroomed cottage can be made available at High Royds Hospital at a moderate rental.

Salary Scale £1,370 to £1,605 per annum plus responsibility allowance (22 units) of £125 per annum.

Further details, job description and application forms from:—
Joint Secretaries (Deputy Group Engineer Appointments Committee), c/o High Royds Hospital, Menston, Ilkley, Yorkshire.

Closing date for receipt of applications—30th April, 1969.

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

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

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

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

Salary scale £1,270 to £1,500 plus £90 London Weighting Allowance plus £50 R.A.

Three-bedroomed house available at moderate rental.

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

LUTON AND HITCHIN GROUP H.M.C.

Applications are invited for the post of HOSPITAL ENGINEER responsible to the Group Engineer for the engineering services of St. Mary's, Grove Road Annexe and Harpenden Hospitals. Salary scale £1,270-£1,500 plus a responsibility allowance of £25 p.a. Applicants must be in possession of H.N.C. or H.N.D. in Mechanical or Electrical Engineering or an equivalent qualification approved by the Department of Health. A sound knowledge of mechanical fired steam boiler plants and experience of mechanical or electrical services required. Applications (with two referees) to be sent to Group Secretary, Luton and Hitchin Group H.M.C., St. Mary's Hospital, Luton, Beds.

WEST CORNWALL HOSPITAL MANAGEMENT COMMITTEE
GROUP ENGINEER'S DEPARTMENT

Assistant Engineer, to be based at St. Clement's Hospital, will be required for duties throughout the Group.

Applicants must have completed an apprenticeship in mechanical or electrical engineering or otherwise acquired a thorough practical Certificate in Engineering or a recognised equivalent qualification.

Commencing salary according to experience from £975 and rising to £1,270.

Applications stating age, qualifications, training and experience, with the names of two referees, to Group Secretary, West Cornwall Hospital Management Committee, 4, St. Clement Vean, Truro, Cornwall, by 30th April, 1969.

ST. GEORGE'S HOSPITAL, HORNCHURCH, ESSEX.

ASSISTANT ENGINEER

to assist the Hospital Engineer over the whole range of his duties. Responsibilities include electrical and mechanical services and the implementation of Planned Maintenance. Applicants should possess an O.N.C. or O.N.D. in Electrical or Mechanical Engineering and have served an apprenticeship or otherwise had thorough practical training. Facilities offered for continuation of studies. A house may be available on a rental basis to a married applicant.

Salary scale £1,065 per annum rising to £1,360 per annum, including London Weighting.

Application forms obtainable from the Group Secretary, Romford H.M.C., Oldchurch Hospital, Romford, to be returned by 22nd April. Quote Ref. 27/43 (HE).

SHREWSBURY GROUP HOSPITAL MANAGEMENT COMMITTEE
ASSISTANT ENGINEER

required at Copthorne Hospital to assist the Hospital Engineer in the management and organisation of engineering services, operation and maintenance. Responsibilities involve electrical and mechanical services and the control of Planned Maintenance. Applicants must possess an O.N.C. or O.N.D. in electrical or mechanical engineering or an approved equivalent qualification. Salary on scale £975 p.a. rising to £1,270 p.a.

Applications in writing, stating age, experience and qualifications and naming two referees, should be forwarded to the Group Engineer, Copthorne Hospital, Shrewsbury, not later than 14th May, 1969.

MID STAFFORDSHIRE HOSPITAL MANAGEMENT COMMITTEE

DEPUTY GROUP ENGINEER

Applications are invited for this newly created post. The person appointed will be required to deputise over the whole range of duties of the Group Engineer.
The Group Engineer is also responsible for building maintenance.
Applicants must be qualified in accordance with the requirements approved by the Department of Health and Social Security.
Housing accommodation available.
Salary scale £1370 - £1605 per annum plus special responsibility allowance of £200.

Applications stating age, experience, and qualifications together with the names of 3 referees to be sent to the Group Secretary, Mid Staffordshire H.M.C., Foregate Street, Stafford, within 14 days.

HOSPITAL MANAGEMENT COMMITTEE No. 9—

WAKEFIELD 'A' GROUP

ASSISTANT ENGINEER required to assist the Group Engineer in the operation and maintenance of the engineering services of hospitals and ancillary premises in the Group. Knowledge of principles and practice of steam and oil-fired boiler plant operation an advantage. Applicants must have completed an apprenticeship in mechanical or electrical engineering and must hold an Ordinary National Certificate in Engineering or an equivalent qualification approved by the Ministry of Health.

Salary scale £975 to £1,270. New entrants normally start at minimum of scale but up to two increments (£1,045 per annum) may be given for relevant experience.

Application form from Group Secretary, 113 Northgate, Wakefield.

MISCELLANEOUS

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

WREXHAM, POWYS AND MAWDDACH HOSPITAL MANAGEMENT COMMITTEE

HOSPITAL ENGINEER

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

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

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

Higher National Certificate or Diploma in Mechanical or Electrical Engineering with appropriate endorsements
or
City and Guilds Mechanical Engineering Technician's Full Technological Certificate (Part III).

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

Application Forms and further particulars are obtainable from The Group Secretary, Wrexham, Powys and Mawddach Hospital Management Committee, Group Offices, Maelor General Hospital, Croesnewydd Road, Wrexham, to be returned not later than 30th April, 1969.

ST. JOHN'S HOSPITAL (356 beds), ST. JOHN'S HILL, LONDON, S.W.11.

HOSPITAL ENGINEER

Applications are invited for this post which will become vacant on 19th July, 1969. Salary scale £1,270 to £1,500 plus £90 London Weighting allowance, plus £25 responsibility allowance. Applicants must hold at least the Ministry of Transport First Class Certificate of Competency (including O.N.C. or O.N.D.). Application forms and full details of acceptable qualifications from Group Secretary, Tooting Bec Hospital, Tooting Bec Road, London, S.W.17, to be returned not later than 5th May, 1969.

to Watt for repair. During the testing after repair he found that the engine would make few strokes before it exhausted the steam in the boiler. He made a number of calculations and found that at every stroke the model used as much steam as would have filled the cylinder several times. Many subsequent experiments made Watt realise that the cause of the waste of steam was the heating and cooling of the cylinder after every stroke.

Watt realised that to make the best use of steam, it was necessary that the cylinder should be as hot as the steam that entered it and that when the steam was condensed, the water of which it was composed and the injection itself, should be cooled down to 100°F, or lower, where that was possible.

In 1765 the separate condenser was invented. Watt worked on the basis of keeping the cylinder clear of water (from condensation and injection) and air (contained in the steam and from leakage) by means of a pump. The cylinder was to be kept as hot as possible by a steam jacket surrounded with an insulating substance. A further departure from past practice, was the use of steam to press the piston down instead of atmospheric pressure, the piston rod passing through a stuffing box in the cylinder cover. Watts' first model has survived but many were made before he was satisfied.

In the succeeding years James Watt worked with Dr. John Roebuck, an industrial chemist, engaged in working coal mines on the Firth of Forth. James assigned a two-third interest in his patent to the Doctor. In 1773 Watt met Matthew Boulton of Birmingham, who was a creditor of Roebuck's (he having gone bankrupt). Boulton arranged to take over the shares in payment of debt. The partnership between Boulton and Watt proved successful and they made two engines which were completed in 1776. One of these was set up at Bloomfield Colliery at Tipton in Staffordshire. It had a 50-inch cylinder. The second, a 38-inch blowing engine, was for John Wilkinson Blast Furnaces at New Willey in Shropshire.

These engines were an immediate success and consumed less than one-third of the fuel as did the old engines. The partners continued the practice of the customer paying for all materials and finding the labour for erection. They themselves provided important parts like valves, which were made at Boulton's Soho Manufactury. It was also insisted that the cylinders should be ordered from Wilkinson's in order that the performance of the engines should not be impaired by bad workmanship. Payment for the services of the partners was calculated on the basis of one-third the saving of coal over the atmospheric engine. To register the number of strokes from which the premium payments were calculated, a counter worked by a pendulum was fixed to the engine beam in a locked box.

These engines still worked on very low pressure, being loaded to 10½ lb. p.s.i. of piston and remained single acting. The expansive force of steam was still not being used to the full and not until Watts' patent of 1782 was it possible. By that time higher pressures were being used.

As early as 1769 Watt had been thinking of a rotary engine and in 1774 he built one at Soho. It seems to have worked satisfactorily but was expensive and none was made for sale. Boulton, who was farseeing, persuaded Watt to adapt the reciprocating engine to produce rotary motion and the first one was set up at Soho in 1782 and the first to be erected outside was supplied to John Wilkinson to drive a hammer. These engines were single acting and the connecting rod drove the flywheel shaft by means of a sun and planet gear instead of the simpler crank. Neither Watt nor anyone else realised how a fly-wheel in combination with a crank would regulate the stroke of the piston and carry the crank over the dead centres. Sun and planet engines were made until 1802, although the firm of Boulton and Watt had built engines with cranks before 1794.

Watt went on to produce the double-acting engine in which steam acted alternately on both sides of the piston thereby doubling the power with a consequent saving. Conical pendulum governors controlling butterfly throttle valves to admit steam to the engine were in use by now and these had the useful property of reducing the variation of speed with load, and prevented the engine from running too fast.

Boulton's foresight with reference to the demand for rotative engines was correct. They formed more than 60 p.c. of the 500 or more engines built by the firm up to the year 1800. Rotative engines were built in standard sizes up to 36 in. cylinder dia. by 7 ft. stroke and developing 50 h.p.

In the early years of the 19th century many new builders of steam engines arose, Matthew Murray (1765–1826), of Leeds, a fine craftsman excelled by none at that time; Henry Maudsley (1771–1831), and his direct-acting table engine, which was in favour for fifty years driving machinery in workshops. Around 1800, Phineas Crowther, of Newcastle-upon-Tyne, built a direct-acting vertical engine with a crankshaft over the cylinder which became the standard type of winding engine in the coalfields.

The first direct-acting horizontal engine appeared in 1801 and in 1825 Messrs. Taylor & Martineau built them for driving sugar mills. This type of engine made very little headway until after 1850. At this period, James Nasmyth introduced the inverted vertical engine with the cylinder over the crankshaft and this type has remained popular ever since. All these new type engines used high pressure steam.

We have traced the history of the reciprocating steam engine from the first century A.D. up to the year 1850. The further development of steam from that date, railway locos—great ocean liners—steam road vehicles and even attempts to fly steam-driven aeroplanes, could only be adequately dealt with in a further paper.

Problems of Planned Maintenance

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

The report of the proceedings, given below, is continued from our February issue.

A DEPARTMENTAL VIEW

By J. KNIPE, C.Eng., M.I.Mech.E., A.M.Inst.F.,
Senior Engineer, Department of Health and Social Security

Due to the rising complexity of engineering plant and equipment, effective maintenance is vital to the smooth running of a hospital.

Increased mechanisation offers advantages to staff and patients, however it also demands a high availability of plant and equipment. The penalty of breakdown can be serious for the patient.

The National Health Service in 1948 inherited a variety of types and sizes of hospital. They consisted of buildings, plant and equipment whose age, efficiency and quality differed considerably. Many of the hospitals had been built before the beginning of the century when engineering facilities were probably less than 5% of the whole cost. Now, with the changing pattern of patient care to meet the needs of the present day Hospital Service, engineering facilities can absorb 40% of the cost of a new hospital building.

It is accepted that in many of the hospitals taken over in 1948 the standard of plant and equipment was poor and expenditure on maintenance was minimal, or the previous satisfactory arrangements for the maintenance of plant and buildings, for example, by the local authority staff were no longer available.

During the first decade of the National Health Service, modernisation and the provision of new plant and buildings was inhibited by the decision to reduce to a minimum its share of the national revenue. A considerable programme of modernisation is now in hand, however the condition of plant and equipment generally could still be improved in a large number of hospitals. The following reasons may explain this position:—

(1) In hospitals there has existed in the past, and to some extent still persists, a considerable lack of adequate and up to date facilities for the carrying out of proper and systematic maintenance of plant.

(2) There are often difficulties in recruiting the right labour, especially in industrial areas where the demand for trained craftsmen is in excess of the supply.

(3) Insufficient maintenance funds are allocated.

(4) The type of maintenance frequently practised in the Health Service is "breakdown" in nature. That is "work which is carried out after a failure but for which advance provision has been made in the form of spares, materials, labour and equipment", and this policy has governed to a considerable extent the number of maintenance staff employed.

In 1961 the Chief Engineer, in the light of the need for planned preventive maintenance in the Health Service, formed a section to investigate the systems which existed in other government departments, private industry, and those hospitals already operating such schemes. The aim of this section was to produce a unified system suitable for the Health Service as a whole and to provide guidance to the hospital authorities who decided to introduce planned preventive maintenance.

Many systems were examined and it was decided that one based on a scheme operated by the Ministry of Public Building and Works would be suitable. A pilot scheme was put into operation at St. George's Hospital, London in 1962/3.

From the experience gained, the Department of Health recommended that the principles of planned maintenance should be applied to hospitals, and issued the following information:—

(*a*) Hospital Technical Memorandum No. 12 which discusses the administrative arrangement needed effectively to plan and control the maintenance of hospital buildings, plant and equipment.

(*b*) Hospital Technical Memorandum No. 13 which describes a system of planned maintenance for engineering plant and services.

(*c*) Hospital Memorandum (65) 28, which recommends the adoption of this system and gives guidance on procedure and staffing.

A planned maintenance system provides a rational basis for estimating the number and types of staff required to carry out the known volume of routine engineering maintenance work. It is not possible to state generally what staff ratios are necessary for the implementation of planned preventive maintenance because so much depends on the type, complexity and age of the plant and buildings in a particular hospital but, as an indication of extremes, it has been found that between ½ and 3½ engineering craftsmen (electricians and fitters) per 100 beds were required for engineering maintenance. Guidance on staff ratios can be obtained from the Department on request; this will generally involve a survey by a team consisting of the Department's and Hospital Management Committee's staff.

Planned preventive maintenance is one way of obtaining good management of maintenance services, enabling manpower to be deployed effectively and economically and avoiding, as far as possible, breakdowns in essential services which have to be put right at high cost.

Management consultants have found that for various reasons only 45% of craftsmen's attendance was effective working time. The Department considers that planning the maintenance programme should increase this to approximately 60%

The introduction of planned preventive maintenance can be expected to involve extra effort in the initial stages from Hospital Engineers to survey the work to be done and then implement the scheme, but, after two years, when much of the arrears revealed by regular inspection have been cleared, the maintenance work load should decrease below the previous normal level. Where full implementation is not thought feasible it is recommended that planned preventive maintenance should be introduced by stages, selecting the most vulnerable and vital parts of the building and plant first. The savings in work achieved in one section can be used to implement the scheme on succeeding sections of the hospital. This approach should avoid, in general, the demands for extra staff which are necessary when the application of planned maintenance has been proposed in a single stage. The system can be operated, in part, whatever staff are in post, provided that not all the existing staff are currently fully employed on emergency breakdown maintenance; a situation which is in any case unsatisfactory, expensive, and which no hospital authority should allow.

Thus, in general, it should be possible to carry out a planned preventive maintenance programme with the existing number of craftsmen employed in the hospital services and the increase in effectiveness of staff time finally used to improve the standard of maintenance.

It has been found desirable that planned preventive maintenance should be introduced on new installations to establish an initial standard of performance and ensure its continuance. Ideally, relevant financial and staffing requirements should be agreed in advance so that a programme is ready for action when Hospital Management Committees take control. Running and maintenance costs incurred in the operation and control of works plant and services are an irrevocable first charge on hospital expenditure.

From a total hospital spend of the order of £700 million a year, engineering expenditure is approximately £15 million on operation and maintenance, £16 million on fuels and £6 million on electricity.

It is anticipated that, if there is no improvement, maintenance costs will rise at a greater rate than new installation costs, therefore, it is obvious that there must be an immediate concentration on efficiency in the organisation and implementation of maintenance work. Hospital engineering maintenance can be improved, and save the Health Service considerable funds by reducing the frequency at which plant is replaced and installations renewed. This saving, of course, will be on the capital programme.

There is now another reason why breakdown maintenance should be superseded by planned preventive maintenance and it is one which is attracting the attention of all trade unions. Productivity agreements as recommended by the National Board for Prices and Income cannot be based on breakdown maintenance, but they can, to a limited extent, be based on planned preventive maintenance.

Circular H.M. (68) 80, which covers the Code of Requirements prepared by the Ancillary Staffs Whitley Council, and which hospital authorities should observe in preparing incentive bonus payment schemes, has linked planned preventive maintenance with productivity agreements.

The Government had asked the National Board for Prices and Incomes to examine productivity agreements generally. The Board concluded that there was a strong case for encouraging the spread of productivity agreements which conform to the requirements of prices and incomes policy. Such agreements promote higher productivity and help stabilise or reduce prices. In their report No. 29, the National Board for Prices and Incomes recommended that the pay of ancillary staff should be related to productivity. The Department has advised that, where a system of payment by results is to include engineering craftsmen, a planned preventive maintenance scheme should have been fully operational for at least a year.

The introduction of planned preventive maintenance to hospitals is continuing at a steady rate, 400 schemes are in operation and a further 350 are being prepared. Approximately 50% of the schemes in operation cover the whole of the hospital and from this it has been calculated that nearly 15% of all engineering work in the Health Service is now maintained on a planned basis.

The system of planned preventive maintenance, where adopted, has clearly demonstrated that maintenance staff have been more effectively employed with the result that breakdowns have been reduced and plant is operating more efficiently. It has also shown that it is possible at least to contain the maintenance costs at their existing level and at the same time give a more efficient service.

It may be worth while reminding the Technical and Administrative staff of Hospital Authorities that they are solely responsible for the safety and proper care of all within the hospital complex, and for the proper use of the facilities and resources placed at their disposal. This does mean that they must be able to show that their arrangements to this end are adequate and satisfactory. How else can this be done than by showing that the problems of allocation of men and of work have been properly considered and a plan evolved and put into execution.

PLANNED MAINTENANCE — DOES IT WORK?

By Miss E. G. CRANE, S.R.N.
Theatre Sister, Bromsgrove General Hospital

I am a theatre superintendent, so my remarks are based entirely on planned maintenance in relation to an operating theatre suite over a period of four years. The answer to the question is that planned maintenance does work, and work well, and for the successful uninterrupted function of present day operating theatres, I would say it was essential.

There are many reasons why planned maintenance has become essential, and most of them are plain common sense. There are far more patients passing through theatre per week now than ten years ago, and the whole tempo of work has speeded up. Operations have gradually become more complex and require more complex apparatus, which, in turn, requires more maintenance. A four hundred bedded general hospital does not take in patients for very specialised work, as for example do Thoracic Units. Nevertheless, the work still covers every aspect of surgery seven days a week because of emergency admissions.

Whenever more work has to be done in more or less the same number of hours, accidents are liable to occur because of the increased tempo. Fortunately, such accidents as the performing of incorrect operations on the wrong patients are remarkably few, thanks to the work of the Royal College of Nursing. There are other types of accident due to equipment becoming faulty through over-use and insufficient maintenance. A simple example is the burn of the skin due to a faulty earth connection of the diathermy apparatus. Then, of course, there are the periodic explosions due to an inflammable anaesthetic agent being sparked off by an excessive build-up of static electricity. Any accident these days has a good chance of becoming a court case, and the resulting litigation is a most upsetting and sleep preventing occurrence. I think it would be fair to say that my theatres have so far avoided any such contretemps, thanks to planned maintenance and engineering co-operation.

Having decided in one's own mind that regular planned maintenance was necessary, the next step was to set about arranging it. The group engineer and his hospital engineering staff were delighted to co-operate on a programme, and we were in complete agreement that a certain period of time should be set aside each week. This period should be long enough for a major job to be undertaken with no disturbances. The period allocated should be during normal working hours, so that the day theatre staff could be present when any job was being carried out, and could liaise with the engineers over any problems. The question of paying overtime because of work being done out of normal hours also came into the matter.

As far as the operating theatres are concerned, the Maintenance Manuals, both electrical and engineering, as issued by the Ministry of Health, are very good. The work is set out in sections of weekly, three weekly, and quarterly maintenance. Obviously, some of the quarterly jobs are pretty large, and on discussion it was thought that a weekly period of around two hours, and more if required, would cover the maintenance syllabus. On some weeks there would be insufficient weekly jobs, but part of the larger jobs could be started. This then would ensure that everything was attended to properly and in an unhurried manner. So far then, we have complete agreement between theatre staff and engineers, to have a regular weekly session of planned maintenance during normal working hours.

The real problem now makes its debut. There are generally too many surgeons competing with their colleagues for too little theatre time and, if the surgeons had their way, theatres would work non stop. Faced with a complete stoppage of work due to an autoclave breakdown or gas gangrene infection, the surgeons are stumped. To give up some operating time to avoid a mechanical breakdown is quite another matter. To find and make a small session for the engineers needs an examination of personalities, and a little help from those who are realistic enough to see the wood for the trees. As far as realists are concerned, I had help from the anaesthetists, without whom surgeons cannot work. We picked on a Tuesday afternoon and with ear, nose and throat co-operation, the engineers "operate" at 4.0 p.m. and they wear overshoes like anyone else crossing the theatre threshold.

So far I have stated why I think planned maintenance is necessary and how it was brought into being in Bromsgrove General Hospital. There now remains the reasons why I stated originally that planned maintenance does work, and these reasons are the benefits which have been derived.

Firstly, requisitions to the hospital secretary for engineering repairs are no longer necessary. Any odd repair can be dealt with in the weekly visit. Secondly, the engineers, from the gaffer down to the newest recruit, know their way about the theatre. Both the theatre staff and the engineering staff understand each others problems, and can achieve the maximum benefits to both with the minimum waste of time. Thirdly and lastly, I will quote from the the maintenance manual paragraph four, on safety. "Maintenance and safety are two closely related subjects, general safety being largely dependent on adequate standards of maintenance. The patients are safer and they, after all, are what hospitals are really for! The theatre staff are in much less danger and know they have friends in time of trouble. The benefits eventually even pass upwards to the Regional Hospital Boards, because they will have fewer stoppages of work, less accidents, and less litigation.

Looking into the future, we will become more and more clever and progressive, so that there will be more and more complicated and expensive equipment. Planned regular maintenance of at least a half session a week is unnecessary now. In due course surgeons are going to have to accept longer periods of planned maintenance.

(*To be concluded*)

(*Continued from page 91*)

need for service zones of three feet between floor and ceiling, posed no problem for the system.

The overall design was for a four-storey building with a 40-ft. clear span so that each floor was completely free of obstructions.

The project is being carried out under the control of Mr. E. B. Glass, the Chief Engineer to the Board of Governors, Hammersmith Hospital; architects are Farms and Partners; consulting engineers (for foundations) are Kenchington, Little and Partners, and the main contractors are William Moss and Sons Ltd.

Kingsworthy contruction is by Conder (Southern) Ltd., a member of the Conder Group of companies which has factories at Winchester, Burton-on-Trent, Darlington and Cumbernauld, Scotland.

Success story

The five-year development by Conder of the Kingsworthy Mk. 2 industrialised building system is a current success story. Since it was launched last summer, orders received and projects being processed amount to about £1·5 million.

It is claimed as a revolutionary system, designed for communal type buildings such as hospitals, clinics, schools, canteens and office blocks.

It is revolutionary, say Conder, because it is at least twice as fast as traditional methods of construction; a weather-tight shell or "dry envelope" is provided within weeks, or even days, from the start of operations, enabling interior work to continue without interruption.

Conder also claim that it is revolutionary because it can result in substantial savings in construction costs—it takes less time—and because it does not produce stereotyped buildings, but provides full scope to architects for the expression of individual taste.

Hammersmith is the first Kingsworthy hospital building.

Completing the "dry envelope" for Hammersmith Hospital's new four-storey Multiple Department . . . In only 30 days—steel structure erected and fully enclosed, by the Conder Kingsworthy Mk. 2 building system. This rapid "dry envelope" construction enables work to proceed inside, unhampered by weather conditions.
The Conder Group, which recently introduced the Kingsworthy system after five years' intensive research and development work, has factories at Winchester, Burton-on-Trent, Darlington and Cumbernauld, Scotland.

HAMMERSMITH HOSPITAL — "DRY ENVELOPE" AIDS RAPID CONSTRUCTION

HOSPITAL building on a very large scale is necessary throughout Britain not only to cope with the population increase but to replace the great number of obsolescent buildings.

Not all new hospital buildings can be on ideal sites with unlimited development potential. Many have to be close to existing hospital buildings which, invariably, are in use 24 hours a day.

Cramped and restricted sites pose special building problems. Hammersmith Hospital is a classic example.

"We believe that Kingsworthy is the complete answer to Britain's urgent hospital building problem—by this system we will have erected and fully enclosed this four-storey structure in the phenomenal time of five weeks. Conventional methods would have needed 13 weeks at least."

This claim was made by Mr. Robin Cole, Chairman of the Conder Group, of the Kingsworthy Mk. 2 building system, during a visit by journalists to Hammersmith Hospital's new Multiple Department building.

The visitors toured the four-storey "dry envelope" which is taking only 30 working days to erect, and enables work to proceed unhampered by weather conditions.

"This is a timely illustration of how the vast and urgent hospital building programme for England and Wales—£1,000 million over ten years—can be helped by this new time-saving construction technique. Without such help we are bound to fall behind," Mr. Cole said.

"Kingsworthy can halve the construction time for a hospital block.

A 'Shot in the Arm'

"Architects and others involved in hospital planning are doing a magnificent job, with the construction industry absorbing something like £100 million a year. But if they are to cope with the situation as outlined by the Government—including a higher-than-expected rise in population to 54·2 million by 1981—they will need all the help they can get. And Kingsworthy can give this.

"As the original hospital building programmes were based upon population projections which are now admitted to have been under-estimated, it is not surprising that the task of providing the planned network of district general hospitals at the rate originally programmed has become more and more difficult.

"The Kingsworthy system could be a real 'shot in the arm' by cutting construction time substantially."

Speed in erection of hospital buildings was often important for another reason, Mr. Cole added. Obsolescent buildings were being retained longer than originally envisaged, and new buildings often had to be built nearby. It was therefore important to minimise noise and disturbance by enclosing and completing building operations as quickly as possible.

Rapid construction of the Multiple Department at Hammersmith Hospital is particularly important. The site is right in the middle of existing hospital buildings—these surround it closely on four sides—and prolonged building operations would be a serious handicap to staff and patients.

Restricted site

The only access to the Hammersmith site is a seven-foot-wide way, necessitating much of the material being hoisted by tower crane over an adjacent two-storey block.

The floor loading overall is 100 lb. per sq. ft., with special reinforcement in local areas to accommodate a 300 lb. per sq. ft. loading. This arises from the need to accommodate in the diagnostic area a movable gamma camera, a scanning couch and other equipment. This factor, and the

(*Continued on the previous page*)

MOTHER AND BABY UNIT — ST. JOHN'S HOSPITAL, LINCOLN

The Reasons for the new Unit

SOME 35 years ago the late Professor Spence of Newcastle-upon-Tyne drew attention to the principle that young children should not be separated from their mothers for any length of time if this could possibly be avoided. He had in mind children who were themselves ill, and who require hospitalisation. Up to that time such young patients had usually been admitted to a Children's Hospital, and only saw their mothers infrequently at the permitted visiting times. He opened the first Children's Unit in which mothers were allowed to live in the Unit and help in the care of their children.

A natural extension of this idea has been its adaptation to treatment of cases of psychiatric illness in the mother. At St. John's hospital in Lincoln, babies have been admitted with their mothers since 1963. This arrangement is desirable when the mother, although suffering from some nervous or mental trouble, is, by and large, able to care for her child, particularly as regards feeding, nursing, washing and entertaining, etc. It is particularly useful in cases of puerperal mental illness, when there is often severe emotional disturbance. Sometimes a mother lacks confidence in her ability to care for her child, and in a Unit of this kind she can be taught to do so while herself receiving treatment.

During the first year this system was adopted, 22 mothers were admitted with their babies, and in the following years the figures were: 1964—36; 1965—33; 1966—38; 1967—31; 1968—51. (The reduction in 1967 was due to the closure of Outlook House Female Ward temporarily for rewiring.) There has, therefore, been a fairly steady increase in the figures since the inception (apart from 1967). The average length of stay has been six weeks.

Outlook House was not constructed with this idea in mind and there have been no proper facilities for the babies and toddlers that have been admitted. Among other deficiencies, there has been no nursery, no playroom, no kitchen, no separate washing or sanitary facilities, and no storage space for children's prams, toys, or other requisites. The babies and toddlers have had to use accommodation intended only for adults, and by their very presence they have increased the overcrowding problems. Often there has been insufficient room to admit deserving cases.

The new Unit will provide for 10 mothers with their babies, and facilities will provide opportunities for excellent care of both mother and child.

There is now no doubt of the therapeutic value of this scheme, and it is one which is being pursued in many other parts of the country.

It is, in fact, a further extension of the principle of providing psychiatric care for those who require it, under the most beneficial surroundings, and with the minimum possible disturbance of family life.

General Construction of the new Unit

The building is in traditional construction in that the walls consist of an outer skin of facing brickwork and the inner skin of 4-in. foamed slag blocks plastered finish, there being a 2-in. air cavity between the skins. The whole of the floors are concrete finished with asphalt and linoleum or Vinyl tiles. The roof construction is timber joists with woodwool slabs, a light weight screed and an impervious roof finish. The ceilings include insulation with a plaster finish and vapour barrier to limit the passage of condensation. The unit is sited over an existing sub-way housing mains services from which a branch duct runs the full length of the new building below the corridor floor. The position of the building in relation to the main ward being Outlook House, affords a pleasant area surrounded on three sides by buildings, giving a sun trap play area for the children and also use of the existing verandah by babies in prams during inclement weather. All patient areas have been planned to take advantage of the southerly aspect, the Day Room being so positioned to give a view of the play area and verandah.

Electrical Services

Wiring throughout is contained in conduits concealed in the fabric of the building, feeding services for lighting, power, patients' call system, fire alarm, electric clocks, etc. Facilities are provided for G.P.O. telephone services and television. Each bed is provided with a head light and a group service box comprising 13 amp switch socket, switch for bed head light, fixed call button for patients' call, extension push for patients' call and reassurance light; corridor signals are provided on the patients' call system.

Mechanical Engineering Services

Heating is by means of pumped low pressure hot water serving convectors, the whole being automatically controlled according to atmospheric temperature. Domestic hot water is provided at a constant 110°F. to serve patients' wash basins and baths and boosted via local booster heaters to 160°F. in the sluice room and kitchen.

The Architect was Philip R. Needham, A.R.I.B.A., in association with W. J. Jobson, E.R.D., F.R.I.B.A., F.I.Arb., Architect to the Regional Hospital Board.

The Consulting Engineer for the Mechanical and Hot Water Services was Percy A. Moore, Assoc. I.E.E., in association with W. C. Jeffries, C.Eng., F.I.Mech.E., M.I.H.V.E., F.I.Plant.E., Regional Engineer.

The Main Contractor was Frank R. Eccleshare Ltd., of Lincoln.

Contract Values

Building	£20,174 16s. 2d.
Engineering	£9,440 0s. 0d.
Furniture and Furnishings	£2,965 0s. 0d.

Nominated Sub-Contractors

Mechanical Engineering Installation	G. N. Haden & Sons Ltd.
Electrical Installation ...	Harry Carr Ltd.
Cubicle Curtain Rails ...	Bintay Equipment Ltd.
Flexible Doors	Simmons of Nottingham Ltd.

Messrs. Eccleshare's own Sub-Contractors

Lino Floor	Smeetons Flooring Service Ltd.
Acoustic Ceiling Tiles ...	Arthur Sydall (Grantham) Ltd.
Floor and Wall Tiling ...	Tayside Floor Coverings Ltd.
Glazing	Lincoln Glazing Co. Ltd.

BOILER EXPLOSION REPORT

THE EXPLOSION occurred on 6 September, 1967 in the South Boiler House at the works of GKN Screws and Fasteners Ltd, Smethwick, Worcestershire.

Persons killed or injured

Two boiler operators were killed; Graham James Ferris (22) was dead on admission to hospital; his father, Arthur James Ferris (46) died on 9 September, 1967 from injuries received.

Description and principal dimensions of the boiler

The boiler was an all welded oil fired, GWB model 700 Powermaster, about 22 feet long, with an internal shell diameter of 8 feet 3 inches; it was a horizontal dry back boiler with a central furnace and two passes of smoke tubes; the first pass of 151 tubes returned below the furnace; the second pass, from front to back of the boiler, consisted of a total of 118 tubes, 59 on each side of the furnace. The boiler design pressure was 270 pounds per square inch; the working pressure was 260 pounds per square inch; the boiler was usually steamed at about 230 pounds per square inch. Superheater tubes were looped into the back smoke box, giving a steam outlet temperature of about 470° fahrenheit.

The furnace was 18 feet $4\frac{5}{8}$ inches long and 3 feet $8\frac{7}{8}$ inches outside diameter over the Fox type corrugations; plate thickness was $\frac{21}{32}$ inches; it was rolled, longitudinally welded, and corrugated in two sections which were finally joined by a circumferential weld at the mid-length of the furnace.

The scantlings of the boiler were sufficient for its intended purpose.

The boiler was fitted with Elcontrol combustion control equipment; this equipment sensed the boiler water level through two Mobrey-Trist float controls mounted on each side of the boiler at the front, or firing end. Both controls operated a low water alarm and boiler oil fuel cut out and one control also governed the stop/start operation of the boiler water feed pump.

The steam connections to the float chambers of the Mobrey-Trist controls came from a common stand pipe on top of the boiler; the water connections came from two shell mountings on the centre line of the boiler. The stand pipe on top of the boiler was also used as a connection for an air vent and the instruments used for measuring, recording, and controlling the steam pressure.

A conventional gauge glass with steam, water and drain cocks was mounted on the float chamber of each Mobrey-Trist control.

The boiler was fitted with recorders which continuously logged the following data: (*a*) steam pressure; (*b*) steam flow; (*c*) feed water temperature; (*d*) flue gas temperature; (*e*) saturated steam temperature, and (*f*) superheated steam temperature.

The boiler was completed in 1966 and had been in service for about five weeks prior to the explosion.

Particulars and dates of repairs

None.

Nature of the explosion

The explosion was of a violent nature; the furnace collapsed and ruptured in way of the circumferential weld for approximately half of its perimeter. The boiler (which weighed about 32 tons) was projected about 34 feet through the boiler house wall. Consequential damage was severe and extensive.

Cause of the explosion

The primary cause of the explosion was overheating due to shortage of water; the poor quality of the centre circumferential weld in the furnace may have initiated the rupture and increased its extent.

General remarks

This boiler was No. 3 in a group of three installed in what was known as the South Boiler House; Nos. 1 and 2 were Thompson Boilers. South Boiler House was normally used as a stand-by for the main, or North Boiler House; at the time of the explosion North Boiler House was shut down for routine maintenance, and so the South Boiler House was in continuous use; No. 3 boiler was usually steamed continuously, augmented by No. 1 or No. 2 boiler as required.

On 2 September, 1967 No. 3 boiler was shut down for cleaning and minor adjustments; it was returned to service on 3 September, 1967: satisfactory steaming trials were carried out on 4 and 5 September, 1967.

From evidence available (including charts recovered from the recorders) and statements made, the sequence of events leading to the explosion appears to have been as follows:

0945 a.m.—*5.9.67:* Control columns blown and operation of low water alarm and cut-out tested by Peter Adams, the boiler house charge hand. On load steaming trials were started and continued satisfactorily until about

0420 p.m.—*5.9.67:* Adams left the boiler house in charge of the boiler operators on duty, P. Trotter and A. E. Bennett: Nos. 2 and 3 boilers were on line.

0905 p.m.—*5.9.67:* A. J. Ferris and G. J. Ferris arrived to relieve Trotter and Bennett; Trotter went off-duty, Bennett stayed to explain the fuel oil position to the Ferrises. About 9.25 pm as Bennett was preparing to leave he heard the low water alarm ringing on No. 3 boiler: the charts from the recorders confirm that No. 3 boiler cut out about this time. Bennett returned to No. 3 boiler and noticed that the water level was below the normal working level and that the boiler water feed pump was running. The cause of this drop in water level has not been definitely established but a fine wire mesh filter in the feed suction line was found partially choked and may have reduced the feed water flow to the feed pump. The elder Ferris switched the feed pump to manual control and Bennett left the boiler house.

0955 p.m.—*5.9.67:* No. 3 boiler flashed up and steamed until:

1040 p.m.—*5.9.67:* No. 3 boiler shut down: steam pressure drops from 215 to 120 pounds per square inch.

1140 p.m.—*5.9.67:* G. J. Ferris phoned Adams reporting that the boiler had cut out on failure and that he (Ferris) was experiencing trouble in relighting the boiler; Ferris suggested cleaning the ignition probe and Adams agreed.

Midnight: G. J. Ferris phoned Adams and reported that the ignition circuit was now alive but could not flash up the main burner; Adams suggested that Ferris should check the oil filter and oil pressure at the burner head.

0025 a.m.—*6.9.67:* No. 3 boiler flashed up.

0035 a.m.—*6.9.67:* Works policeman checked boiler house and saw nothing unusual; steam pressure rising.

0055 a.m.—*6.9.67:* Boiler steaming on almost full load; steam pressure 230 pounds per square inch.

0110 a.m.—*6.9.67:* Feed, flue gas, saturated and superheated steam temperatures commenced rising sharply.

0120 a.m.—*6.9.67:* G. J. Ferris phoned the main gatehouse and told the works policeman to phone Adams, and to ask Adams to come to the factory as they (the Ferrises) were having trouble with the boiler water.

0135 a.m.—*6.9.67:* No. 3 boiler exploded.

I examined the boiler about twelve hours after the explosion and found the front half of the furnace almost completely collapsed and distorted into the classic shape of an overheated furnace; the furnace had failed in way of the defective circumferential weld described in detail later in this report. The boiler mountings were found in normal steaming positions except both the lower isolating valves for the water columns; both these valves were found closed. These valves being closed would have given a false, high reading in both gauge glasses and would also have indicated to the feed pump controller and to both the low water alarms that there was sufficient water in the boiler when, in fact, there was not.

All boiler mountings were in a satisfactory condition.

The boiler control panel switches were found in the following positions:

Damper control	...	Automatic
Oil heater ...	...	Automatic
Atomising air compressor	...	Automatic
Burner switch	...	Off
Feed water pump	...	Pointer missing, but it was determined later that this switch was in the automatic position

The ignition probe and the photo electric cell were both detached from the furnace front: it is possible that the operators had realised too late that the furnace was overheating and had switched off the boiler immediately prior to the explosion, anh dad then removed the ignition probe and the photo electric cell to examine better the interior of the furnace.

The float controls were examined; both low water alarm float switches worked satisfactorily: the feed pump control relay was jammed in the "off" or high water position: this was considered to be a consequential derangement caused when the boiler passed through the boiler house wall.

The safety valves and feed pump were tested and were found satisfactory.

There was no evidence of excessive scale or any other contamination of the boiler water which might have caused overheating.

Examination of the furnace circumferential weld which failed showed lack of penetration and fusion. Tensile tests taken across the weld gave UTS of 21·6 (weld ground flush) and 24·4 (as welded) tons per square inch; similar tests on the furnace plate gave 30·3 (furnace bottom) and 31·5 (furnace top) tons per square inch.

Bend tests taken across the weld failed at 28° (fire side in compression plates 4A and 4B) and 80° (fire side in tension).

The furnace plate was not thinned appreciably; the distortion was accommodated by the corrugations flattening.

The firm which made the furnace have radiographed the welds on all furnaces at present in stock but have found no similar defective welding; the firm is instigating a radiographic check on all future furnace welds.

The boiler owners intend to fit an additional independent, low water alarm and cut out to each of their boilers.

The boiler concerned will probably be repaired and put back into service.

It is difficult to avoid the conclusion that the water column isolating valves were closed, or inadvertently left closed, by the deceased, but it is, however, considered that the basic system design philosophy could be improved insofar as that the four factors concerned with ensuring a safe working water level (i.e. feed pump control, low water alarms, fuel oil cut-outs and gauge glasses) were so interdependent and could all be made inoperative by closing two valves, especially so when under these conditions the system failed to danger.

Comments of the Engineer Surveyor-in-Chief

This violent explosion from the furnace of a horizontal multitubular boiler was caused by overheating due to shortage of water.

The shortage of water was apparently due to the closing of the lower isolating valves of two water gauge columns. The closing of these valves rendered inoperative the glass water gauges, the feed pump control, the low level alarms and the safety fuel cut outs.

Where boiler level indicating arrangements, automatic controls, alarms and safety cut outs are so grouped together and arranged so that all can be rendered inoperative and false and dangerous indications can be given by the closing of one or two valves, consideration might be given to improving the operational safety of such arrangements.

Examination of the ruptured furnace revealed that the standard of workmanship of the central circumferential weld in the furnace was well below that normally expected for such important components and resulted in a weld which did not give proper penetration through the plate thickness as had been intended by the designers. This may have enhanced the degree of rupture of the furnace.

But for the shortage of water, however, the welded seam may not have failed and the poor standard of workmanship might never have been discovered during the working life of the boiler.

WIDNES CONTRACT

The Liverpool Office of Brightside Heating & Engineering Company Ltd., has received an order worth over £27,000 for mechanical services at Crow Wood Hospital, Widnes.

The services consist of a new calorifier plant, kitchen equipment, kitchen ventilation, external distribution mains, and underfloor heating.

Abstract of Reports

YORK "B" GROUP H.M.C.

This summary covers the years 1966 and 1967.

The York "B" Hospital Management Committee is now responsible for the care and treatment of 1,800 patients in four major hospitals and five smaller units. This number is equally divided between those who are patients in psychiatric hospitals and those who are clinically described as "sub-normal" patients. The increase in sub-normal patients is due to the fact that the Regional Hospital Board, on re-organisation of certain Hospital Management Committees, handed over Rawcliffe Hall, and this brought an additional 165 women and children to look after.

Finance

During the last two years, in accordance with the general trend, the cost of running the nine hospitals in the Group has continued to rise, mainly due, of course, to wage awards and price increases, in spite of the restraint imposed by the Prices and Incomes Board. Much careful thought is needed to decide the allocation which can be made for the large repair and improvement schemes to be placed out to contract.

Rawcliffe Hall Hospital was incorporated into the Group on the 1st April, 1966, and the accounts suggest that the merger has, at least financially, been to the advantage of that hospital.

Decoration and Repairs

Internal redecoration and external painting of the wards and ancillary departments throughout the Group has continued more or less in accordance with the Committee's programme. Improvements were made to the main entrance to Rawcliffe Hall and a new roadway laid, and repairs were carried out to other roads and paths at the various hospitals.

Minor improvements have been carried out to several of the staff houses, and in addition to normal repairs, rewiring and external painting, new sink units, back boilers and fireplaces have been installed. Further lock-up garages have also been provided at some of the houses.

At Claypenny Hospital, partitions in the dayrooms on two wards have facilitated the segregation and treatment of patients; a new reception office has been built in the entrance hall, and improvements carried out to the dental surgery. The scheme for increasing and modernising the lavatory accommodation at this hospital and providing additional storage space for patients' clothing has also been completed.

On the engineering side, the renewal of the domestic hot water mains at Clifton has been carried out, and a coal elevator replaced. The heating on Ward 5 at Whixley and in the dayroom at Tadcaster Hostel has been improved and at Rawcliffe Hall a new oil-fired steam boiler has been installed in the laundry. At Claypenny, the main boilers have been converted to oil-firing and the removal of the old boiler house and chimney has greatly improved the appearance of that part of the hospital. It was hoped before the end of 1968 that the whole of this hospital would have oil-fired heating and H.W. services.

Structural Additions and Improvements

During the last two years, several capital works have been concluded.

At Clifton Hospital the 12-bedded unit for adolescents at "Southfield" was opened in January, 1967. The men's central bathroom has been converted into additional accommodation for occupational therapy, and other alterations and extensions have provided workshops for the very active industrial therapy unit. After some delay, the improvements to the lavatories in the Villa were achieved, and it is hoped that the new treatment unit, at present being built as an extension to this ward at a cost of £52,500, will be ready for occupation by the middle of 1968.

At Claypenny Hospital, a pair of semi-detached houses have been built on the edge of the estate as a home for student nurses, but it is likely that further accommodation will be required for this purpose in the near future. Modernisation was also carried out to the kitchen of Avondale, which is another residence for nurses. The construction of an additional villa at an estimated cost of £77,810, is in progress which will be used partly to reduce overcrowding on other wards. Work on the new spastic unit as an extension to Rowan Villa is nearing completion and the old unit will then be used to house the looms and other large items of equipment of the occupational therapy department. A further addition was a wheel chair store built by the Works Department at Lime Villa, and an extension to the main kitchen is under way to provide a wash-up bay for food trolleys, at present being cleaned on the wards. A scheme is also being prepared for converting the old laundry premises into a staff dining room.

At Rawcliffe Hall, the new children's unit and lift were brought into use at the end of 1966. A scheme of various other improvements is being prepared and work should commence during 1968.

Work is in progress at Whixley Hospital on schemes for the modernisation of the kitchen, providing additional bathing facilities on the wards and converting the men's general bathroom into a tailor's workshop.

Laundry Services

Since the last report, the laundry at Claypenny Hospital has been closed, some of the machinery has been transferred for use at other hospitals, and the washing is now being processed at Clifton, with the exception of approximately 1,500 pieces per week which are being dealt with at Whixley. The dry cleaning unit at Whixley employing many patients, continues to provide excellent service for hospitals in the Group.

In the last two years, additional and replacement equipment at Clifton Hospital has included a Manlove three-roll calender, "Easi-Prep" sheet preparer, folding and cross folding machines, two washing machines and a drying tumbler, at a total cost of approximately £13,700.

MEDWAY HOSPITAL TO GET NEW TELEPHONE SYSTEM

A new telephone system designed to improve communications at Medway Hospital will also speed communications to other hospitals in the Chatham area.

The order, for a 220-line PABX (Private Automatic Branch Telephone Exchange) worth £15,000, has been awarded to Telephone Rentals Ltd., and will include private wires to St. Bart's Hospital, Chatham, All Saints' Hospital, Star Hill and the Teaching Unit at Medway Hospital. These will enable Medway Hospital staff to make calls direct to the other hospitals without seeking the assistance of the hospital's switchboard operator.

£2 MILLION READING HOSPITAL EXTENSION TO BE UNDERTAKEN BY COSTAIN

A MEDICAL complex, with all wards and associated departments contained in a large single-storey building covering four acres, is the main feature of a £2 million contract to be undertaken by Costain Construction Ltd. for the Oxford Regional Hospital Board.

With a 217-bed capacity, the building is the first phase of the redevelopment of Battle Hospital, Reading. Costain's contract also includes the construction of staff flats and an industrial zone containing Group workshops and garages, a boiler house, and a Group laundry.

The medical complex will be built in the Oxford Method of industrialised construction pioneered by the Oxford Regional Hospital Board and now being adopted elsewhere. It involves the use of a structural steel frame with precast concrete floors over a services undercroft. The roof is of steel decking covered with insulation board and felt.

The cladding components will consist of plastic-coated steel sandwich panels incorporating aluminium windows delivered to the site ready for erection.

The building will contain operating theatres, wards, X-ray, outpatient departments, short-stay and intensive care units. A two-storey kitchen and staff dining block of similar construction will be linked to it.

Parallel working has been adopted between the design team, Costain Construction Ltd. and the principal sub-contractors to facilitate effective co-ordination of information requirements, programming and cost planning.

The three-storey residential building will be of cavity load-bearing brickwork with in situ reinforced concrete floor slabs. Windows will be timber framed. The flats are linked together in groups with access staircases forming three sides of a quadrangle.

Work on the contract was due to start on 31st March, and the staff flats and boiler houses are due to be completed in 21 months. The medical zone and remaining buildings are scheduled for completion in 27 months.

The architects are Yorke Rosenberg Mardall and the consulting engineers Felix J. Samuely and Partners. The mechanical and electrical consultants are R. W. Gregory and Partners, the quantity surveyors Monk and Dunstone, and Messrs. L. A. Edwards and Partners are the laundry consultants.

On the Market

A review of new equipment and materials and their development

STOREY'S NEW FLAME RESISTANT PANELLING

The **Merchant Trading Co. Ltd.,** of Adrienne Avenue, Southall, Middlesex, is now marketing Storeybord G1—vinyl faced panelling tested to class 1 spread of flame specifications.

Storeybord G1 is a new development in the Storeybord range of wall panelling and it is available in bleached oak, English oak, olive ash, dark ash, natural cherry, dark cherry or crown teak. All panels are pre-finished in 8 ft. × 4 ft. standard sizes, quarter inch thick.

The natural wood finishes are obtained by a photographic reproduction process which is claimed to produce a more realistic effect than any board of its type available. A hard, translucent vinyl film protects the surface to provide a durable and hard wearing panel capable of being washed and scrubbed.

Further details and literature on Storeybord G1 are available on request.

BOILER WATER TREATMENT REMOTE CONTROL

Water treatment for boilers can now be controlled from the boiler instrument panel, using one of the new series of Nalfloc chemical pumps.

A new design of control unit, incorporating a solid-state electronic timer, permits remote control of the output of the chemical pump. It is therefore possible to site the pump itself in the most suitable position—for example, on the boiler chassis—but to mount the control unit adjacent to, or as part of, the main instrument panel. Output is continuously variable throughout the range of the pump.

Nalfloc has also developed automatic intermittent blow-down valves with similar remote-control facilities, and a wide range of other feeding devices and test kits is available.

Nalfloc Ltd. is a subsidiary company of ICI and associated with Nalco Chemical Company.

MAGNETIC DOORSTOPS ON THE QE2

Do you want to keep an open door? Then use magnets.

Arelec magnetic doorstops have been fitted to the cabin doors on the new Cunarder, the QE2, replacing the traditional cabin hooks. These doorstops have many advantages. Apart from being easy to fix, neat, efficient and reliable, they will hold a heavy door open against considerable force and yet release it with the minimum of effort. The neoprene casing acts as a shock absorber, so there is no noise or damage to the door.

Although developed especially for marine use, they are particularly suitable in indoor and outdoor situations.

Also available is a wide range of magnets to hold doors closed. In fact, doors of all sizes and shapes can be held securely either open or closed by magnets.

Write for details to **Magnet Applications Ltd.,** 323 City Road, London, E.C.1.

NEW VAPOUR AND DUST PROOF LIGHTING FITTINGS

For situations where vapour or dust are commonly present a new range of fluorescent lighting fittings has been designed to withstand extreme conditions.

The new fittings—known as the PP range—are made by **Industrolite Ltd.,** Radiant Works, Imperial Way, Croydon Airport, Croydon. The totally enclosed interior is protected from the ingress of dust or moisture and is sealed by a neoprene gasket. A feature of the design is simplicity of installation. The reflector and control gear tray are combined into a single unit and can be removed together. A slip-plug connection is provided for mains connection.

The canopy unit is of zinc-coated steel with welded seams. The finish is a PVC coating of high quality. The base is covered by a simply styled opal diffuser of moulded plastic. Alternative models are available with single and twin 5 ft. tubes.

"WIDER STILL AND WIDER"

W. B. Bawn & Co. Ltd., who have always claimed to manufacture Britain's widest range of Steel Clothes Lockers have now added two further wider sizes to their "Helmsman" Vedette series.

The new units are both 70 in. high, and 15 in. wide and with a choice of either 18 in. or 21 in. in depth and are available in a choice of 5 locking arrangements and 5 standard colours. The lockers can be obtained as singles, or in nests of 2 and 3.

There is now a choice of 7 full length single compartment lockers in the range, all of which are supplied with fixed hat-shelves, name cardholder, 2 coat hooks, (and except for 12 in. deep unit) a coat-hanger rail.

NEW HIGH POWER EMERGENCY LIGHT

The Bardic TL52 high power emergency lighting unit is ideal for public premises. The twin 25 watt filament projectors provide powerful penetrating beams of light which can be trained upon particular hazards or used to define clearly available escape routes.

Upon failure of the mains supply the unit is automatically illuminated by the sealed "Alcad" nickel cadmium batteries giving 2 hours emergency light. The batteries are re-charged automatically upon renewal of the mains electricity supply. A third lamp can be added for remote mounting or all lamps can be remotely mounted. Power consumption is 70 watts maximum.

Further details from **Alkaline Batteries Ltd.,** P.O. Box 4, Redditch, Worcs.

SPRING COILS OF NYLON TUBE

The range of helical spring coils of nylon tube available from **Enots Ltd.,** Aston Brook Street, Birmingham 6, has been extended recently. These coils are now supplied in five tube sizes, namely 3/16, 1/4, 5/16, 3/8 and 1/2 O.D.

To ensure that they are suitable for a wide range of fluid transmission installations the coils are made from a special hard grey coloured nylon having good mechanical strength, and chemical resistance to most common fluids.

The coils can be extended up to a maximum length of 25 ft. yet they have closed lengths of from 8 to $12\frac{3}{4}$ in. depending on the tube size. Each coil has a straight leader 6 in. long at each end.

Since the maximum working pressure assigned to these spring coils is 400 lbf/in.^{2} (250 lbf/in.^{2} for coils made from $\frac{1}{2}$ in. diameter tube), suitable applications include connections to portable pneumatic equipment and to sliding or swing tables where there are large relative movements between components.

THE NEW COMPLETE FUEL OIL TREATMENT

Applied Chemicals, of Industrial Estate, Uxbridge, Middlesex, have recently introduced a product which is a complete Fuel Oil Treatment in itself. Known as Kleen-Flame, it breaks down sludge, thus enabling emulsified water in the oil to be separated before burning. It modifies the ash in the fireboxes so that it does not fuse to glass-like slags, and minimises the deposition of sulphuric acid on the stacks, thus helping to overcome corrosion problems.

The process is economical—3 pints of Kleen-Flame to 1,000 gallons of fuel oil are effective for most fuels.

NEW RADIATOR VALVE

Kay & Company (Engineers) Ltd., of Bolton have designed a new radiator valve of extremely neat and smart appearance for use with small bore or gravity central heating.

The valve is available in wheelhead and lockshield versions and both types can be supplied with plain brass or matt chromium plated bodies. Both versions employ the Kontite compression principle on inlet and outlet ends.

These compression joints comply with B.S. 864 (Type A), and are suitable for copper tubes to B.S. 659 and tubes of equivalent outside diameter which are to other British Standards and are approved for use with B.S. 864 Type A joints.

By use of a specially designed union coupling, the Kay valve can be fitted with the headwork vertically or horizontally according to layout requirements. These unions are manufactured with taper male threads for leak-free connection to radiators.

The handwheels or lockshields of the valves are made of white plastic.

CROMPTON PARKINSON TO MARKET DOUBLE-LIFE LAMP

A lamp with a guaranteed life of 2,000 hours, double the life of the normal domestic lamp, is to be marketed by **Crompton Parkinson Ltd.** It will be known as the Crompton Double-Life Lamp and will be generally available. It is being produced in a range covering all domestic and industrial requirements from 40 to 1,500 watts.

The principal difference between the Double-Life Lamps and standard 1,000 hour lamps lies in the use of a special filament. In addition, the manufacturing process is carried out to extremely tight tolerance and involves the application of strict quality control techniques in order to achieve the life of 2,000 hours coupled with an acceptable light output.

Notes for Members

THE NORTHCROFT SILVER MEDAL

The first Medal to be awarded under this Papers Competition goes to Mr. K. H. Bourne for his Paper entitled "Environmental Controls." This Paper appears in this issue of the Journal.

In the course of judging the eligible Papers, Mr. D. T. Helm was commended for his Paper (Materials in Medicine) which appeared in the issue of the Journal for July, 1968.

It is hoped to make the presentation to Mr. Bourne at the special Conference Dinner to be held at the Rembrandt Hotel, Thurloe Place, London, on 3rd June, 1969.

THE OXFORD FIVE-BRANCH MEETING

We would again remind readers of the annual Five-Branch Meeting which will be held at the Radcliffe Infirmary, Oxford as usual and, this year, on 3rd May next. Coffee will be served at 11.00 a.m. and the meeting will begin at 11.30 a.m. with a film. Two Papers will follow in the afternoon and full details of the day's programme are given below.

11.00-11.30 a.m.	Coffee.
11.30-12.15 p.m.	Film: "A Home of your Own."
12.15- 1.45 p.m.	Lunch.
1.45- 2.15 p.m.	An introduction to the lecture theatre at Radcliffe Infirmary.
2.15- 3.30 p.m.	Lecture: "The Anatomy of Storage Heater Design" by C. S. Whitby, Chief Heating Engineer, Electrolux Ltd.
3.30- 5.00 p.m.	Lecture: "The Shree Sayaji General Hospital" by Donald A. Goldfinch.
5.00 p.m.	Tea.

NORTH EAST BRANCH

The Annual General Meeting of the North East Branch took place at the Royal Victoria Infirmary, Newcastle upon Tyne on Wednesday, 12th March, with Mr. G. C. Elliott in the Chair. The meeting was attended by Mr. J. E. Furness, Secretary to the Institute, and Mr. D. H. Mellows, Area Member of Council.

Mr. Furness talked to the meeting of the achievements and progress of the Institute since Incorporation and spoke, too, of certain forthcoming events. Mr. Mellows told the meeting of the current activities of the King's Fund College of Hospital Management "Engineering Panel," of which he is a member.

The list of Branch Officers for the North East for the coming year will be published in the Journal together with those of other Branches.

The Secretary and Mr. Mellows were most grateful for the warm welcome which was extended to them.

EAST ANGLIAN BRANCH

The Annual General Meeting of the East Anglian Branch was held at St. Andrew's Hospital, Thorpe, Norwich, on Saturday, 8th March. The Chairman, in his Report, spoke of how the Branch, still a young one, had made steady progress during the year.

After the formal business, Mr. R. G. Freestone who is the Branch Secretary, gave a talk on the implication of 11,000 volt distribution systems which are now going into hospitals and gave details of the Code of Practice and Safety Rule Book which a Department of Health Working Party has just drawn up.

A provisional programme for the future was arranged as below:--

Date of meeting	*Venue*	*Subject of Paper to be given*
May 3rd 1969 ...	Cambridge ...	Metrication
July 5th 1969 ...	Yarmouth ...	Laundries
September 6th 1969	Peterborough...	To be arranged
November 1st 1969	Cambridge ...	H.V. Electrics
February 1st 1970...	Bury St. Emunds	To be arranged

MIDLANDS BRANCH

Over 30 members and visitors attended a paper given before the Branch Annual General Meeting at East Birmingham Hospital on Saturday, 1st March.

The paper entitled "Gas from the Desert and North Sea" was very ably presented by D. Scott Wilson, M.B.E., A.R.I.C., C.Eng., M.I.Gas.E., Scientific Information Officer from the Gas Council. Mr. Scott Wilson outlined the history of gas production and gave some extremely useful information about the developments made by the Gas Council in constructing special tankers to import natural gas from the desert, and later expanded on the development which led to obtaining gas from the North Sea. The paper was followed by a most useful discussion.

Following the paper, members only remained and attended the Annual General Meeting.

A most enjoyable evening was spent by sixty-six members and visitors at a Cheese and Wine party and film held at Barnsley Hall Staff and Social Club, Bromsgrove, on 14th March.

SOUTHERN BRANCH

A Southern Branch Meeting was held at Southampton General Hospital, on 11th January, 1969.

The Chairman opened the proceedings by briefly explaining that two films were to be shown which would give the reasons and advantages of "Critical Path Analysis" Charts.

The first film showed the build up of a "Critical Path" in relation to the construction of a small petrol filling station, and how the time for the various aspects of the job such as site planning, layout and levelling, foundations, building construction, followed by the installation of pumps, tanks and other essentials, were all carefully built up. Delays in delivery of items beyond promised delivery dates were coped with by allowances that could be made and which would not affect the overall time for the job as planned through the "Critical Path."

Large projects, with a planning team working out the "Critical Path," were then shown. Heads of different sections working in conjunction with sub-contractors went stage by stage into all the possibilities of the job and dovetailed the working of each section until a complete working programme was evolved.

It was explained how sub-contractors, producing items in their own factory as part of the main scheme, could have their own "Critical Path" for their own small part and yet it could still be integral with the Master Plan.

Again, it was shown how "Floating time" could be gained and made to play a useful part when delays occurred.

The films showed how a "Critical Path Analysis" chart could be made out for most jobs and could be made to help everyone by giving a clear picture of the job from start to finish; it also assisted by denoting at any time the state of progress.

WELSH BRANCH

A meeting of the Welsh Branch was held at The Dental Hospital, Cardiff on 11th January, 1969.

A Paper, Automation in Boiler Plant Control, was read by Mr. R. Hussey of Elliott Process Automation Ltd.

Mr. C. R. Davies introduced Mr. Hussey of Elliott Process Automation Limited. In his opening remarks, Mr. R. Hussey explained that there was a severe shortage of Control Engineers and the paper he was about to read had actually been written by Mr. Crocker who had subsequently left Elliott Process Automation Ltd.

In order to justify both the capital cost and the subsequent running and maintenance costs it is of paramount importance that the user obtains the maximum efficiency from any modern boiler plant. It has become increasingly obvious that it is physically impossible for human operators to manually control the many variables associated with boiler plant consistent with a high degree of efficiency.

It should be borne in mind that having set up automatic controls correctly they can only reproduce the highest possible plant performance obtainable under manual control. The advantage of automatic control is the fact that the high performance can be maintained under varying load conditions.

Mr. Hussey then went on to deal with the various requirements, that should be considered at design stage. He also described the methods of achieving automatic control using both pneumatic and electrically powered controls.

Mr. Hussey concluded his lecture by showing a series of slides illustrating the various control equipment.

It is hoped to publish the complete paper in THE HOSPITAL ENGINEER.

A session on business matters followed at the conclusion of the Paper.

NORTH EASTERN BRANCH

A meeting of the North Eastern Branch on 12th February, 1969 took the form of a visit to the works of Winthrop Laboratories, the pharmaceutical manufacturing company which has recently become an Affiliate of the Institute.

The members were welcomed by Mr. J. T. Rees, Director and General Manager, before touring the plant in company with Mr. A. P. Ward, Chief Engineer, Mr. R. H. Condliffe, Chief Electrical Engineer, and Mr. E. A. Stanley, Services Engineer. Time did not permit a full tour of the production plant, but some time was spent inspecting the new Sterile Products Department, which was described by its manager Mr. G. Percival. Members were most impressed by the stringent precautions taken to preserve sterility and product security (i.e. correct identification and freedom from contamination). The repercussions of these precautions upon planned and breakdown maintenance were discussed.

The Boiler House, Electrical Switchroom, Services Areas and Works Department were also visited.

Because of the large proportion of the plant not visited due to lack of time, Mr. Ward said that he would be pleased to arrange for a further visit at a later date.

CORRESPONDENCE

18th March, 1969.

THE EDITOR.

Dear Sir,

As many of your readers may know, the Architectura Association, now in its 122nd year, is actively engaged in revising its present and future policy. These revisions coincide with the impending move of the A.A. School of Architecture from Bedford Square to Imperial College where the School and the Association will be housed in the same building. In this new building, for which we are appealing for money and for which a competition has been announced, the Association will provide a common meeting ground for all those who are interested in people and buildings.

Already, however, the A.A. is taking a number of steps to prepare itself for this change. By setting up C.A.S.E. (Centre for Advanced Studies in Environment) the Association has provided a useful series of courses in mid-career training, open to architects, planners, engineers, surveyors and others concerned with the construction industry. Additionally the A.A.'s annual programme of events has been put on a broader basis, and the current over-subscribed series, "Man and His Environment", augurs well for the future.

It may not be widely known to your readers that the Council of the A.A. has recently rescinded all previous resolutions restricting the number of non-architect members of the Association and it is intended that under the guidance of its new Director, Lord Cunliffe, the A.A. will expand its role as the only organisation in which all concerned with the built environment can participate.

All of these plans, of course, depend on the success of the current Appeal that the A.A. has launched for funds with which to provide itself a new building in South Kensington, for the U.G.C. has stated that if the A.A. can finance the building it will provide for the recurrent expenditure of the School. I am very pleased that at the time of writing this Appeal has reached over £162,000. I hope that some of your readers will be prepared at this crucial moment to support the Appeal, details of which are easily obtained from the Appeal Secretary, 36 Bedford Square, London, W.C.1.

Yours faithfully,

FRANCIS BADEN-POWELL,

President, The Architectural Association.

(*Continued from page 84*)

used in the heater, and control was by two averaging thermostats in the room actuating an amplifier. This, in turn, drives a motorised variac which alters the voltage to the heater and thus the heat input to the room.

Fig. 13 shows the general arrangement of the plant located above the Incubator Room.

Acknowledgements

I would like to thank P. C. Vedast, M.I.Hosp.E., for his assistance in preparing this Paper and K. J. Eatwell, C.Eng., F.I.Mech.E., M.I.H.V.E., M.I.Hosp.E., Regional Engineer, S.W. Metropolitan R.H.B., J. W. Parsons, M.I.Hosp.E., M.I.J.E., Group Engineer, Guildford and Godalming H.M.C., D. L. Davies, M.I.Mech.E., Group Engineer, The London Hospital, and M. Crowley Harding McDermott and Partners for the use of contract material; also Rootes Tempair Ltd. for use of photographs.

The Author is the senior partner in Bourne and Partners, Guildford, Surrey.

Index to Advertisers

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