THE HOSPITAL ENGINEER

THE JOURNAL OF THE INSTITUTE OF HOSPITAL ENGINEERING

VOL XXIII No 9
SEPTEMBER 1969

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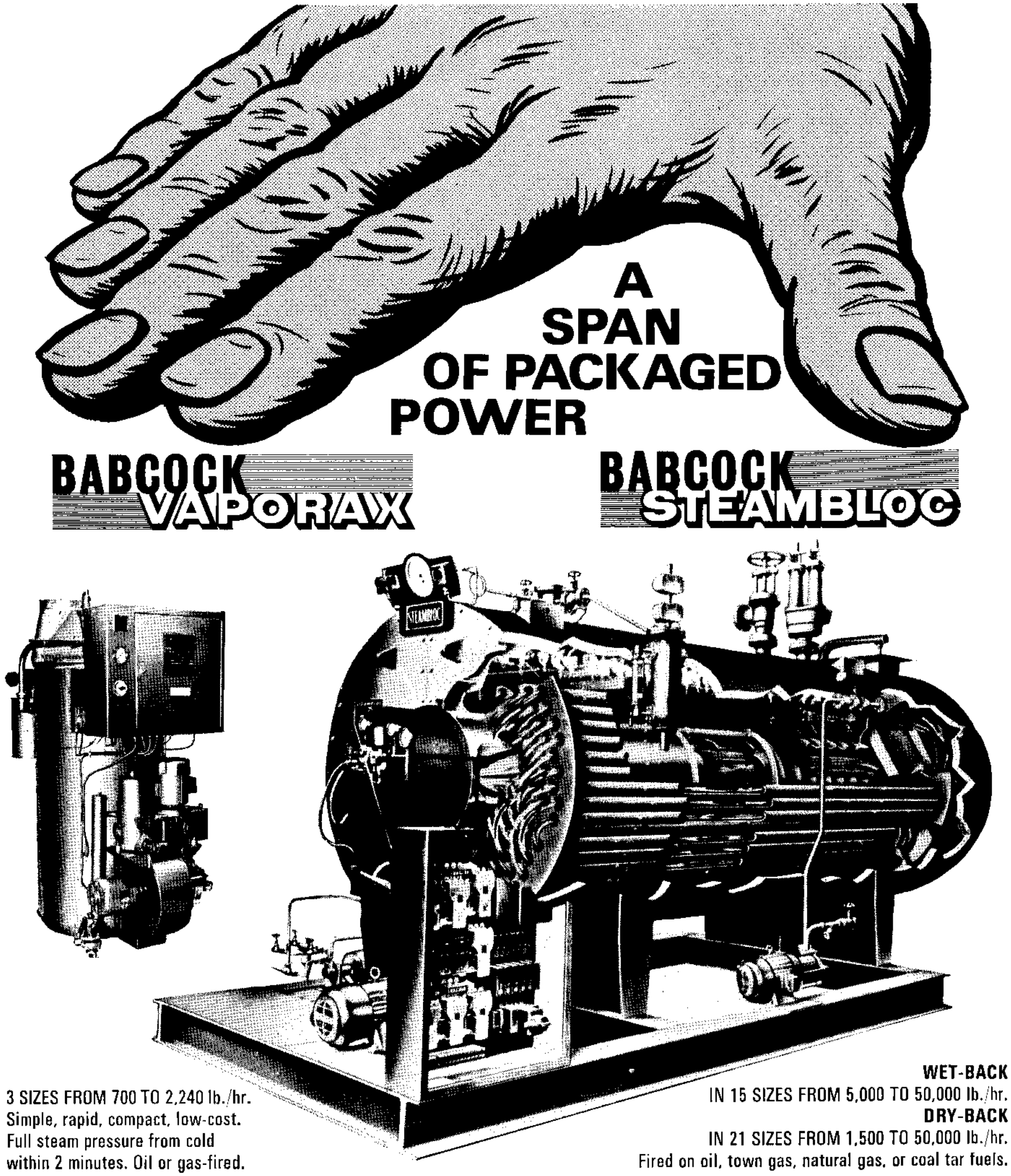

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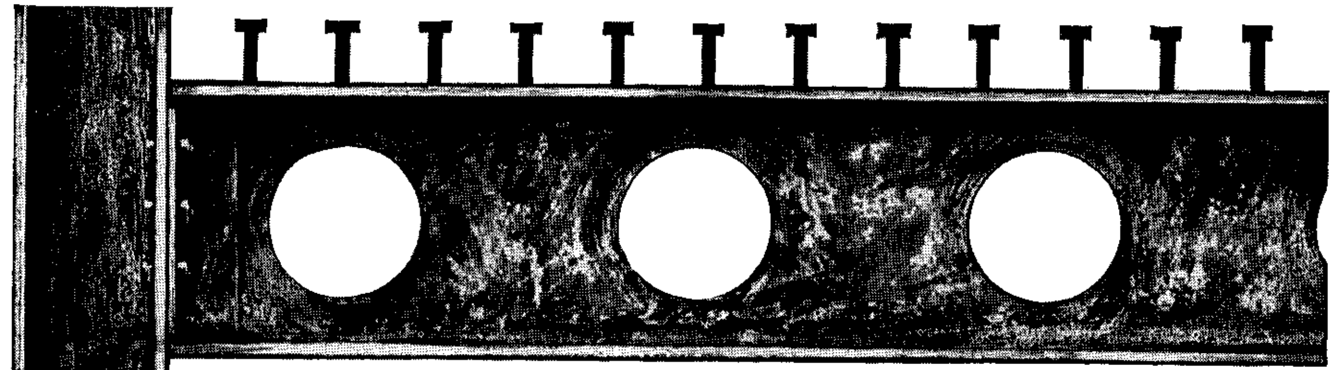

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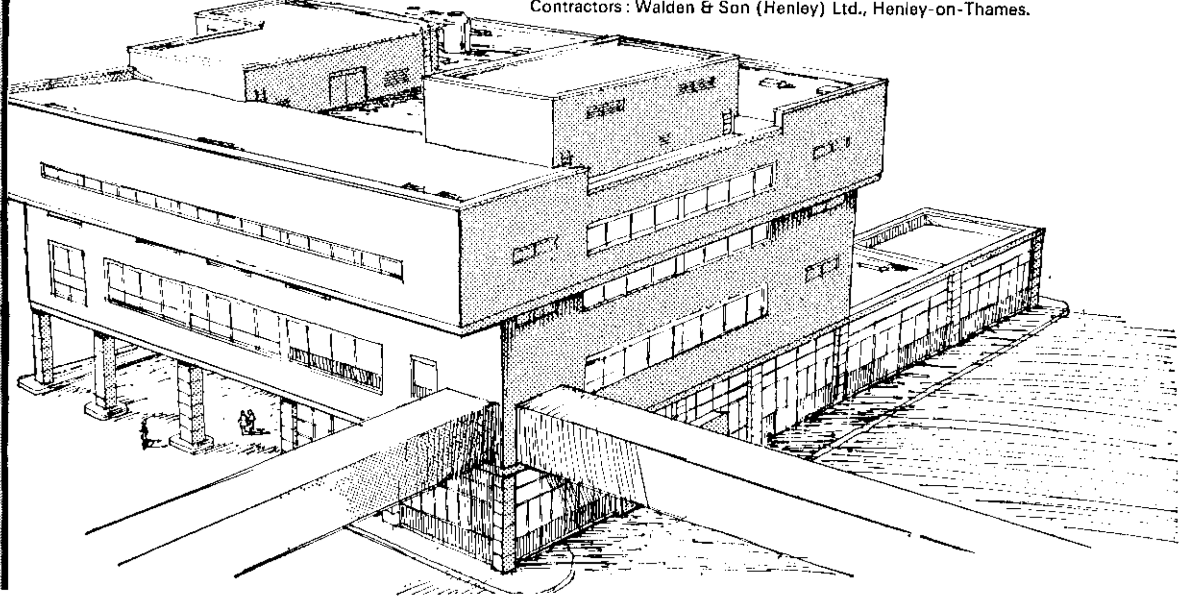

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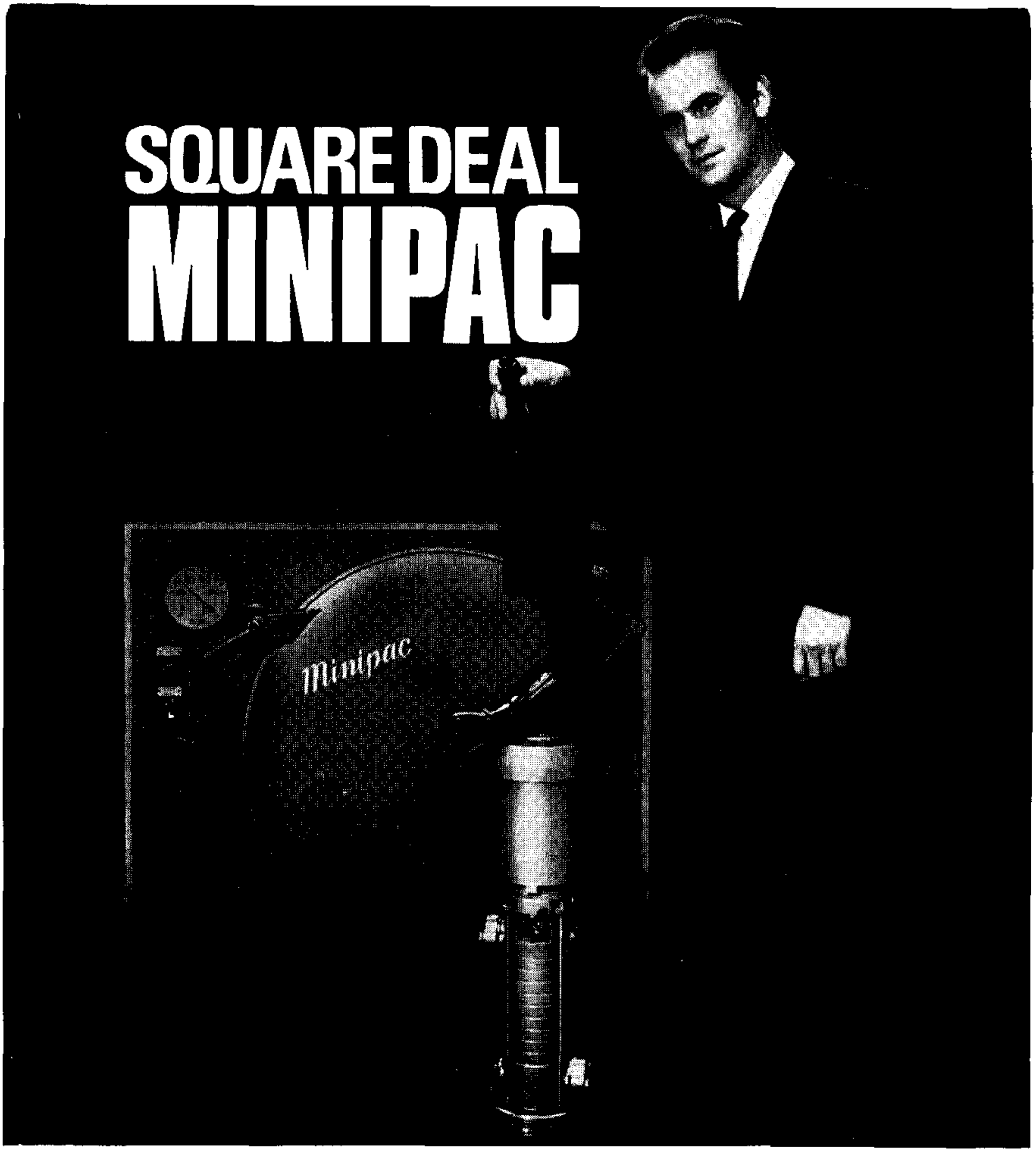
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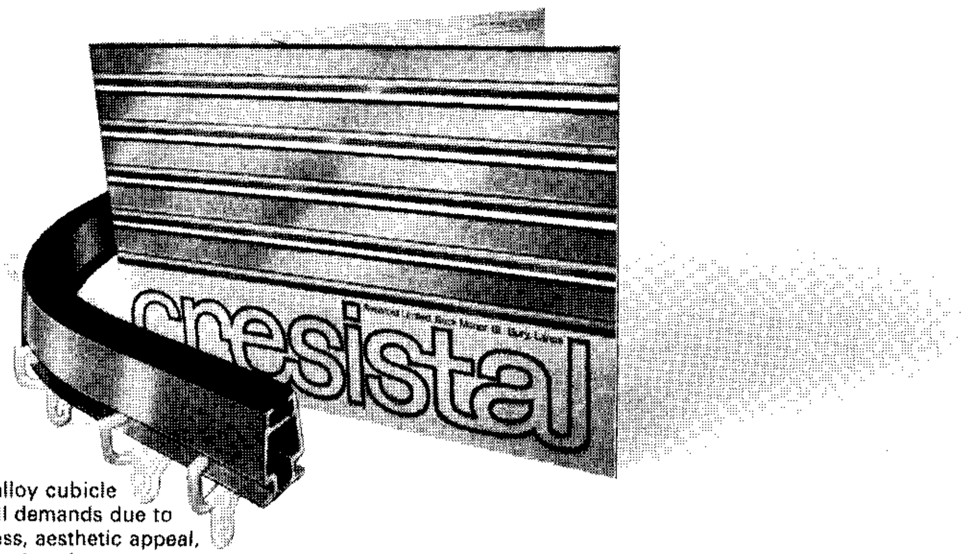

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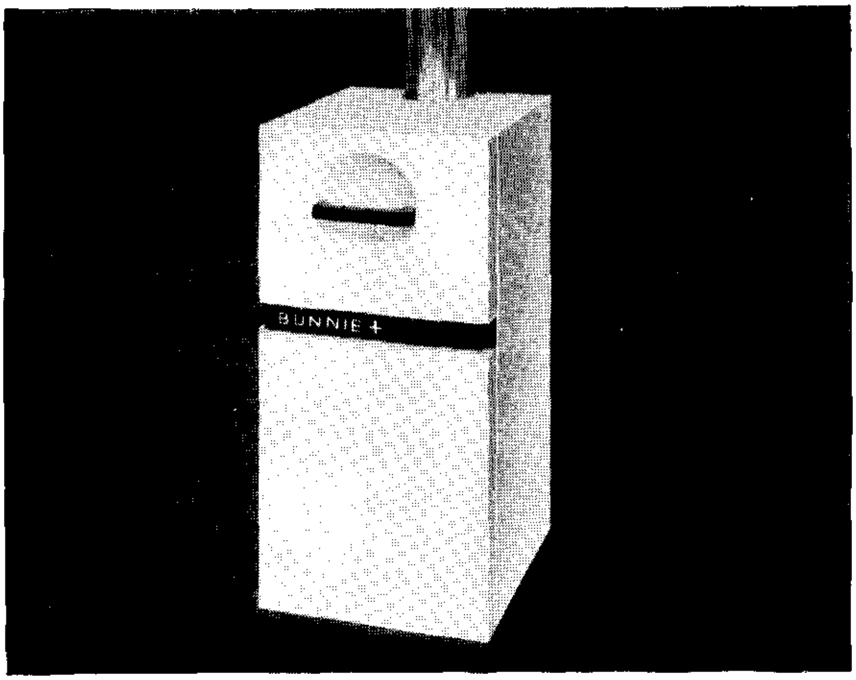

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With all this at stake... what price power cuts?
The ability to maintain an electrical supply is essential to economic viability, communications, human comforts and even life itself. For Process Plant, Communication Systems, Pumping Stations, Hospitals—in fact, any essential service—Auto Diesels Standby equipment cuts in *AUTOMATICALLY* when the main power supply fails. And not only for Standby—the equipment may be used in conjunction with, or instead of, the normal mains supply to cut down on electricity charges.
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THE HOSPITAL ENGINEER

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With all this at stake . . . what price power cuts!

By M. S. RIDOUT
Home Sales Manager,
Power Plant Division, Auto Diesels Ltd.

Introduction

IN 1964 the Ministry of Health issued a Technical Memorandum describing the various methods and applications of providing emergency supplies for electrical services in hospitals.

Until a few years ago it was general practice to provide emergency electrical supplies for lighting only, in such areas as operating theatres and delivery rooms. With the increasing dependence on electrically operated equipment, whose continuity in service is of vital importance, the facility of maintaining electrical supplies to this type of equipment can be even more important than emergency lighting. Typically, operating theatres, resuscitation rooms, intensive therapy units depend entirely on electricity for their safe and proper functioning and a failure on the mains electrical supply can seriously disrupt the work of the hospital and endanger the patient.

The Ministry memorandum recommends that, where it is essential that such services are maintained, an engine driven generator is the most convenient and economical method of providing the standby supply.

Applications

The application and specifications of this type of equipment can vary enormously to suit the particular requirements of an individual hospital and Auto Diesels have produced many unusual installations, some of which are detailed in the following paragraphs. However, in a great many cases it is possible to make use of manufacturers commercial standards which have the advantages of being well tried and proven units, giving the lowest price with the greatest reliability commensurate with simplicity of operation and maintenance.

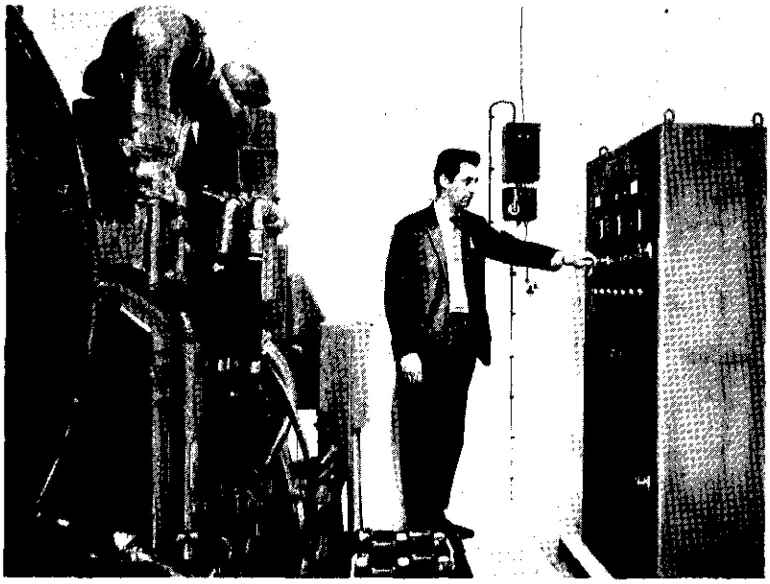
Typical of this type of equipment is a 129 kVA Auto Diesels standby generating set recently installed at Stratheden Hospital at Cupar, Fife.

Stratheden Hospital Installation

This scheme was prepared by the Stratheden and Associated Hospital Board's appointed consultants, Messrs. David Elder and partners of Dundee, who placed the order with the Company for the complete supply, installation, site testing and commissioning of the equipment.

The plant provides an output of 129 kVA at 0·8 power factor, at a voltage of 415/240 volts 3 phase, 4 wire 50 c.p.s. and is powered by a Rolls-Royce diesel engine coupled to a statically excited, self regulating alternator both of which are mounted on a common fabricated steel bed plate which is set on the foundations through anti-vibration mountings.

The installation included a daily service fuel system, ducting to take the radiator outlet air to atmosphere, an



129 kVA Auto Diesels standby generating set installed at Stratheden Hospital, Cupar, Fife. The photograph shows the floor standing control panel which incorporates the equipment instrumentation, switchgear and the automatic control circuit.

acoustic type exhaust silencer and system which is lagged with asbestos tape, and a floor mounting control cubicle which incorporates all the necessary switchgear and instrumentation.

The engine is fitted with special protection switches which will shut the engine down in the event of a fault occurring due to low lubricating oil pressure, high cooling water temperature and engine overspeed and the fuel system incorporates a level switch to give visual and audible warning of low fuel level.

Automatic Operation

As it could not be guaranteed that hospital personnel would be on hand to operate the equipment manually in the event of a mains failure, it was decided to incorporate the standard Auto Diesels automatic start and changeover system.

This incorporates sensing units to detect a drop or total failure of the mains supply on any of the mains three phases. On receipt of such a signal the mains contactor, incorporated within the control panel, is de-energized and drops out and the engine's 24 volt electric starting system is automatically initiated.

When the engine runs up to normal operating speed of 1,500 r.p.m. (this normally takes about 10 seconds) and the alternator voltage is up to nominal value, the standby contactor—which is mechanically and electrically interlocked with the mains contactor—is energised and closes, thereby switching the standby electrical supply to the load and the essential services. When the mains supply returns and is determined to be a healthy supply the set automatically shuts down and resets for the next day.

Special Mains Standby Duties

The above description relates to the Company's standard automatic mains standby equipment, but many variations are possible to comply with a user's precise need, for example: the sensing of the mains supply can be within very close limits; typically 5% of the nominal, and the circuit can also be arranged to sense variations in the mains frequency.

Additional protection features can be fitted to the diesel engine prime mover and the electrical circuit can incorporate other methods of switching which will work in conjunction with a hospital's existing distribution circuits.

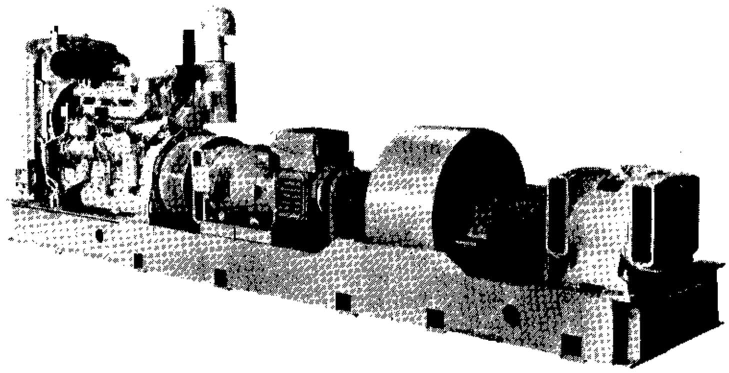
"No-Break" Systems

The above system always induces a break in the supply to the essential services whilst the engine runs up to speed and is applied to the load. Although this is only about 10 seconds, it is sometimes referred to as a "long break" unit to differentiate it from the system known as "No-Break".

Requirements for this type of equipment are rare in the U.K. but some overseas authorities prefer to maintain the supply to essential services with no break, however small, in the supply. This is normally achieved by incorporating a more complex type of unit which comprises a diesel engine prime mover with an electrically operated magnetic clutch. The secondary side of the clutch is connected to a conventional squirrel cage electric motor which is directly connected to a heavy steel flywheel which is, in turn, connected to the alternator.

Under normal conditions the motor, powered by the mains, drives the flywheel and alternator which supplies the load. The diesel engine is at rest and disconnected from the remainder of the equipment as the magnetic clutch is de-energised.

As soon as the main supply fails or varies beyond the predetermined limits, the motor will automatically disconnect from the mains and the diesel engine electric starting circuit will be initiated.



The Company's typical "No-break" set clearly showing the diesel engine, alternator, flywheel and motor. The clutch between the engine and alternator is hidden by the protective guard.

A similar unit to this was recently installed in Hospital Traumatologico, Caracas, Venezuela.

When the engine reaches normal operating speed, the magnetic clutch is energised, thus engaging the engine to the motor-flywheel-alternator assembly.

Throughout this operation, which is completed within 10 seconds, the supply is fully maintained from the alternator by the kinetic energy of the flywheel. At no time is the alternator disconnected from the load and, during changeover, the frequency will drop by only about 1 c.p.s.

From this point the engine will continue to run the complete assembly until the mains supply is restored, at which time the engine is de-clutched and the motor reconnected to the mains.

Peak Lopping Systems

A further application of conventional diesel generating sets that the Company have been particularly successful with is the system known as Peak Lopping.

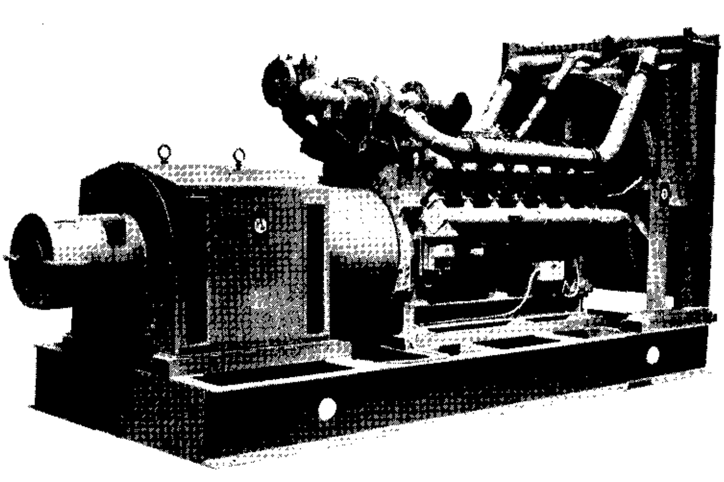
This principle is used in a number of hospitals and involves a normal diesel generating set with a special control circuit which will operate in conjunction with the mains supply, automatically starting the generating set so that it supplies the peak load demands which are evident when the hospital's demand varies.

In this way it is possible to maintain the hospital's demand from the Local Electricity Supply to a predetermined level, thus reducing the electricity maximum demand charges which are based on the highest peak load requirements during the period of a month or three months, whichever period the local supply board's maximum demand charges are based on.

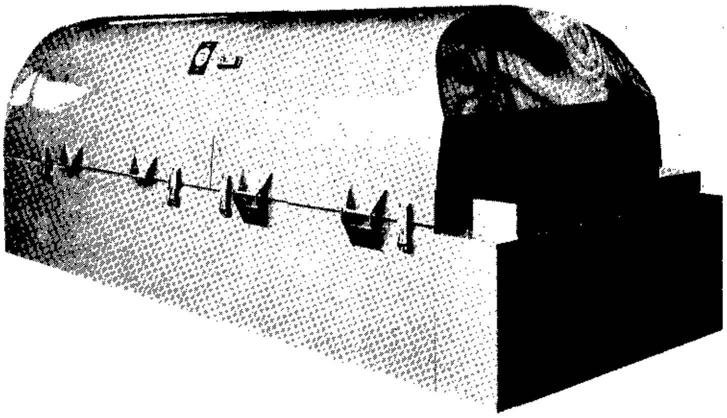
In this way electricity charges can be reduced by as much as 50%, which enables the capital cost of the equipment to be recovered in a relatively short time.

This type of application also has the advantage that the generating set can be brought in as a standby set during a mains supply failure.

The control circuits applied to this type of equipment vary considerably, ranging from a simple circuit where the set is operated manually and supplies an isolated section of the hospital load, to a fully automatic system which will automatically start the engine set on receipt of a signal that the hospital's predetermined maximum demand has been reached. The equipment will then be



The engine generator unit of a standard Auto Diesels ADQ 585. This type of unit will produce an output of 585 kVA (under N.T.P. conditions) and, with automatic starting equipment, will supply the load within 10 seconds of a failure of the mains supply.



The Company's 45 kVA silenced diesel generating set as installed at Mile End Hospital. The automatic "mains failure" circuit control panel is supplied separately but the equipment incorporates an eight hour fuel tank.

automatically paralleled and synchronized with the normal mains supply.

Silenced Diesel Generating Sets

One of the major problems with conventional diesel generating sets is the very considerable noise that the diesel engine prime mover produces. This can typically be a level of 95 to 100 decibels (on the 'A' scale) at a distance of 12 ft. and obviously has considerable nuisance value when the equipment is installed near personnel or patient areas.

Some 6 years ago, the Company produced the first ever silenced diesel generating sets in the form of a 5 kVA trailer mounted unit for military applications. Since then this range has been extended to 200 kVA and has found obvious outlets in the field of television outside broadcasting and film location work.

The majority of these units were in trailer mounted or vehicle mounted form for easy mobility to suit the application but a further progression was achieved by manufacturing these silenced units in static form for standby to mains duty, and hospital engineers and authorities were quick to appreciate these units as the solution to a noise problem normally associated with diesel engine powered standby plant.

The first Auto Diesels silenced diesel generator to be installed in a hospital was a 45 kVA unit equipped with fully automatic mains failure circuits for Mile End Hospital, and since this time a considerable number of silenced generators have been supplied for installation in hospitals in the U.K. and abroad.

The silencing of the diesel engine is achieved by a special silencing and air cooling system incorporated in a sheet steel enclosure which reduces noise levels to approximately 55 db 'A' at a distance of 12 ft. This means that the equipment is virtually inaudable, with normal background noise, at a distance of 25 ft.

An additional advantage is that, by virtue of the soundproofing enclosure, this type of unit is also completely weatherproof and can be installed out of doors, thereby obviating the necessity for a special engine room.

Mobile Power Plants

The silenced generators referred to above can also be supplied in mobile form, as can conventional diesel electric sets, to suit the application that some hospital authorities have. This is to satisfy the needs of a number of small hospitals which can suffer a mains failure for a period of, say, 30 minutes.

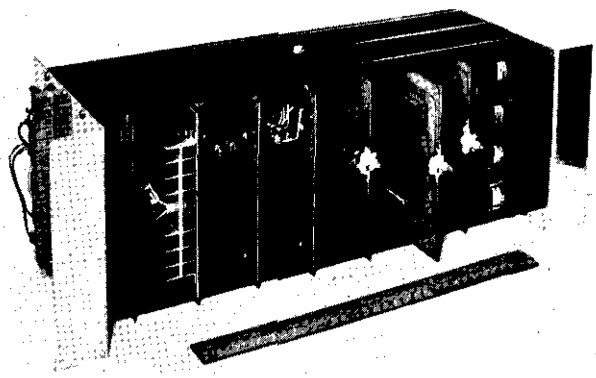
By keeping a mobile generating set at a central point, it is possible for an authority or management committee to service the requirements of several small units by transporting such equipment to the particular unit which has the requirement or power failure.

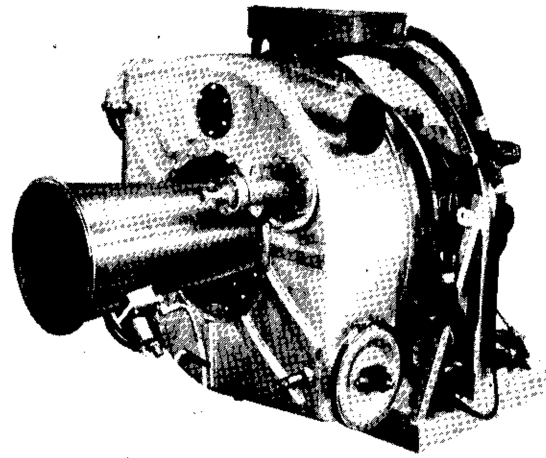
Transistorised or "Solid State" Control

The development of transistorised or "solid state" electrical circuits, as an alternative to the conventional relay type of circuit, has been very swift in the last few years, and the firm supply circuits for control of diesel generating sets in this form.

This means that, instead of the conventional bank of relays for engine control and protection circuits, these functions are performed by small "plug-in" modules in the control panel.

An Auto Diesels "Solid State" control circuit and modules. A conventional relay circuit would require two to three times the volume.





The single stage, two bearing Stad gas turbine unit, manufactured by the Company which can be utilised in industrial, shaft drive form, for electrical generation duties.

The very obvious advantages that this type of unit has is that "solid state" circuits have no moving parts and cannot therefore wear out. Maintenance is greatly simplified by the mere removal of a faulty module and insertion of a spare.

One of the disadvantages in the past with "solid state" circuits has been the higher cost of this type of equipment over the conventional relay circuit.

However, the Company are using the latest available components in their "solid state" circuits and can produce a full circuit incorporating all protection and operating functions of the equipment which is only nominally more expensive than the conventional circuit.

Future Developments

The applications of power plant for such users as hospitals is expanding rapidly, and the Company have a constant development programme in operation to ensure that the changing requirements of hospital authorities are met.

A relatively new development is the Gas Turbine, and Auto Diesels manufacture the highly successful Stad unit which will provide some 200 kVA when used as a shaft drive unit for electrical generation.

In the past Gas Turbines have had disadvantages of cost and fuel consumption against the advantages of savings in size and weight. However, improved production methods are reducing the cost of this type of plant and the advent of Natural Gas and total energy systems in the future present very interesting and viable cases.

A COMPLETE HOSPITAL SERVICE FOR THE AMAZON JUNGLES

A CONTRACT worth £3,000,000 to supply the complete infrastructure for a hospital service on a 'turnkey' basis throughout the interior of the Brazilian State of Amazonas has been won jointly by The International Professional Consortium for Health Services (I.P.C.H.S.) and Coseley Buildings Ltd., of Wolverhampton.

The contract, which allies the provision of British 'know how' with exports of goods and equipment, provides for professional and technical consultancy services, the supply and supervision of erection of prefabricated buildings, the supply of all medical equipment from X-ray and surgical equipment to bandages and cutlery, the preparation of staffing schedules and maintenance requirements and arrangements for loan finance.

This is believed to be the first contract of its type and size anywhere in the world.

The network of prefabricated health centres will comprise 7 hospital units, 24 health centres and 13 outpatients/emergency units located variously at 44 sites throughout the interior of the Amazon. Additionally, 25 houses, fully furnished and equipped, are being supplied to accommodate doctors.

With the exception of the hospitals located in and around the capital—Manaus, all other units will be situated in the depths of the Brazilian jungle, the most remote being 1,300 miles from Manaus.

The buildings for these "Planned Hospital Units" are single storey, steel framed Coseley "Paramount" design, clad in insulated aluminium sheeting. All units will be supplied complete with full medical equipment, furniture, fittings, electrical generator and water purification system. The major hospital units include operating theatre, obstetric wards, radiography, laboratories and outpatients department as well as a kitchen, staff canteen and administrative block.

Erection will be carried out by local labour under the joint supervision of I.P.C.H.S. and Coseley experts.

The contract also includes the medical equipment and engines necessary to convert twelve custom built boats into floating medical units. These will be used both as ambulances for conveying patients between various centres and also to administer medical care to the more remote areas not served by one of the health centres.

Under the terms of the contract, I.P.C.H.S. is required to provide the technical services and to survey the existing conditions and resources of each of the 44 sites, and Coseley Buildings Ltd. are responsible for the despatch of all buildings and equipment from Britain by April 1970, and to have all units in the network operational by December 1970.

The technical and professional services, for which I.P.C.H.S. is responsible, will be carried out by two of its member firms, The Oxford Architects Partnership, The Economist Intelligence Unit and by its Brazilian associate SORTEC.

Problems of Scales, Corrosion and Hydrogen Embrittlement in Boiler Plant

By E. HOULT, A.M.C.T., F.R.I.C.

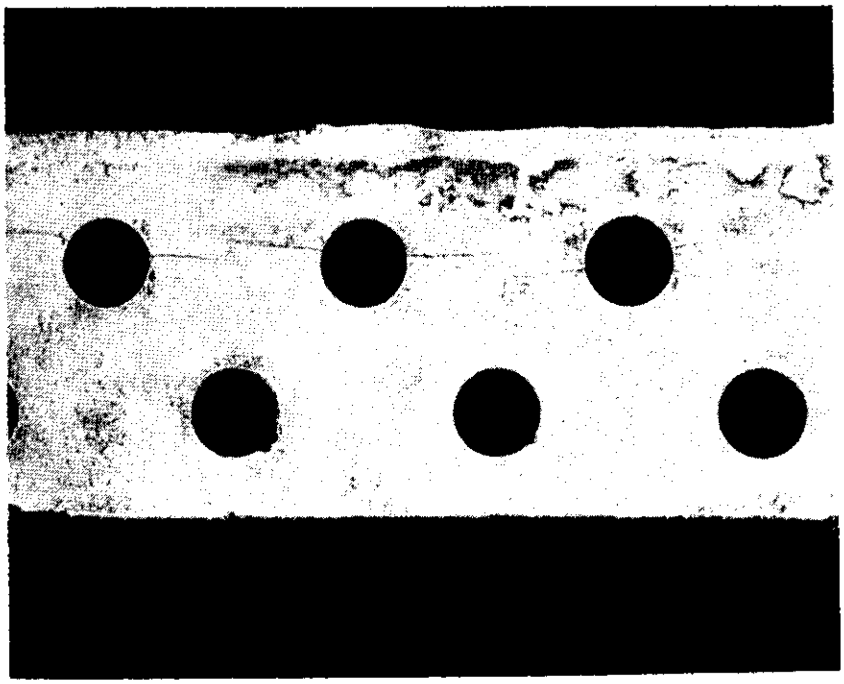


Fig. 1. A typical example of caustic cracking in the plate of a riveted shell type of boiler.

IN the first part of this century, caustic cracking was one of the most feared types of corrosion with which boiler operators were faced, and was the cause of the disastrous explosion at York in 1949.

A typical example of cracking resulting from attack by caustic soda is shown in Fig. 1. The cracks are parallel to the edge of the plate, and it can be appreciated that, should the cracks at each rivet hole have joined, the strength of the seam would have been greatly reduced and the seam would have eventually ripped apart. Fortunately, the cracks were found before this occurred.

This paper was first read by the author in London in January, 1968, and, subsequently, in Birmingham and Dundee at meetings of the Combustion Engineering Association. We are indebted to the Association and to the Editor of *Vigilance* for permission to reproduce the paper.

Mr. Hoult joined The National Boiler & General Insurance Company in 1950, many years before the formation of NV Group. As chemist to the National and later to NV Group, he has considerable experience of problems associated with the subject of this paper.

It is now generally accepted that caustic cracking can occur in boilers with drums of riveted seam construction, but the following conditions must prevail:

(1) There must be a leak of steam to atmosphere, to allow concentration of boiler water in the seam.

(2) The concentration of the caustic soda must be above the range 5% to 10%.

(3) The water must be conducive to caustic cracking.

(4) The metal must be under high tensile stress.

Few operators of boiler plant were aware of these conditions when in 1952 a symposium was arranged in London to discuss caustic cracking, and many operators, investigators, and other interested people, attended.

Consequently, much information came to light, and as this was recorded and issued in the form of a booklet, "Caustic Cracking in Steam Boilers", published by the Society of the Chemical Industry, many people were able to study the subject more closely and use the information as a guide on precautions necessary to avoid this type of cracking. The maintenance of the sodium sulphate

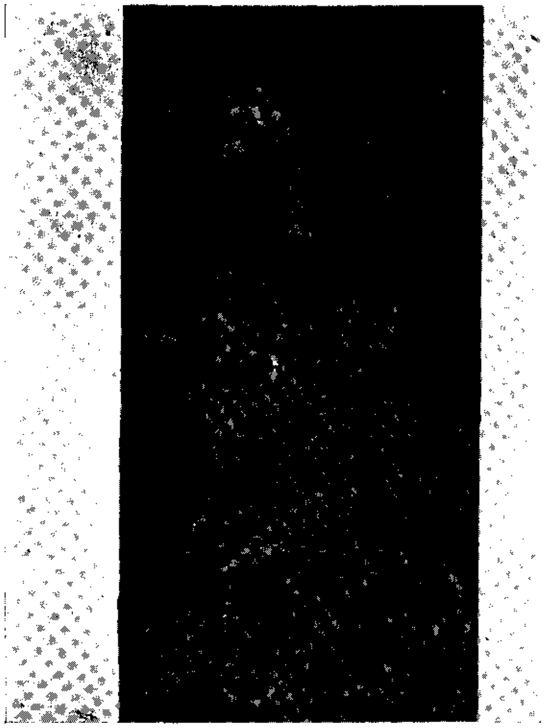


Fig. 2. Water-side gas tube, showing pitting and a perforation.

content of the boiler water at never less than 2·5 times the caustic soda content, or the sodium nitrate never less than 0·4 times the total alkali in terms of caustic soda, were the precautions taken.

Although caustic cracking has now become less of a worry to boiler operators and engineering insurance companies, it still occurs from time to time.

In the second half of the century another problem has faced producers of steam, known as "on-load" corrosion, but whereas caustic cracking is a matter concerned with low-pressure boiler operation in boilers with drums of riveted seam construction, this new source of boiler outage is confined to the higher range of pressure and in many cases the steel is said to be embrittled by the hydrogen produced in corrosion.

A symposium on hydrogen embrittlement and "on-load" corrosion has never been held in this country and few know either about it or its cause. A good deal of experiment has been carried out to determine (*a*) why steel becomes oxidised producing massive amounts of magnetic iron oxide, and (*b*) why in some cases the hydrogen evolved penetrates the steel, forming methane with the carbon, whilst in others it does not. Although some suggestions have been made as to the cause, no consensus of opinion has been reached. In some instances, research work has not simulated actual working conditions and, therefore, may not give the cause of "on-load" corrosion.

It was with a view to disseminating the experience gained over the last seven years in a plant where "on-load" corrosion and hydrogen embrittlement had occurred, and in the hope that others with similar experience might get together to discuss this problem, that the subject of today's meeting was suggested. To make the talk more complete, it is desirable to say something about scales and corrosion and finally a cause will be suggested and ways of preventing "on-load" corrosion will be put forward.

In low-pressure boilers, i.e., pressures below 250 lbs. per square inch, scales are formed as a result of either insufficient or incorrect water treatment, or no treatment at all. These scales comprise mainly calcium carbonate and sulphate, and calcium silicate. Any corrosion is mainly of a pitting nature, which is essentially due to oxygen, possibly in a water which is insufficiently alkaline. Fig. 2 is a photograph of a perforation in a tube, following corrosion.

In the medium range of boiler pressure operation—and of course there is no hard-and-fast division between low and medium—other types of scale appear, such as analcite (sodium alumino-silicate), acmite (sodium iron-silicate), silica and, again, calcium silicate. In addition to these scales, which occlude calcium phosphate where phosphate is used in conditioning the boiler water, scales form from copper and iron oxides.

TABLE I

(A) Calcium silicate scale.

Lime	as CaO	49·42%
Magnesia	as MgO	2·89%
Iron and alumina	as R_2O_3	3·17%
Silicates	as SiO_2	17·07%
Carbonates	as CO_2	13·44%
Phosphates	as P_2O_5	6·27%
Sulphates	as SO_3	1·54%
Loss on ignition		17·08%

(B) Sodium alumino-silicate-carbonate conditioning.

Sodium oxide	as Na_2O	10·71%
Lime	as CaO	21·00%
Magnesia	as MgO	0·65%
Iron oxide	as Fe_2O_3	1·60%
Alumina	as Al_2O_3	13·91%
Silicates	as SiO_2	32·68%
Sulphates	as SO_3	2·94%
Loss on ignition		12·68%

(C) Sodium alumino-silicate-phosphate conditioning.

Sodium oxide	as Na_2O	3·97%
Lime	as CaO	30·00%
Magnesia	as MgO	4·92%
Iron oxide	as Fe_2O_3	3·20%
Alumina	as Al_2O_3	6·76%
Copper oxide	as CuO	1·19%
Silicates	SiO_2	19·44%
Phosphates	as P_2O_5	22·70%
Loss on ignition		4·40%

Fig. 3. Tube interior, showing two slight bulges, with penetration through the larger one, and deposits of scale.

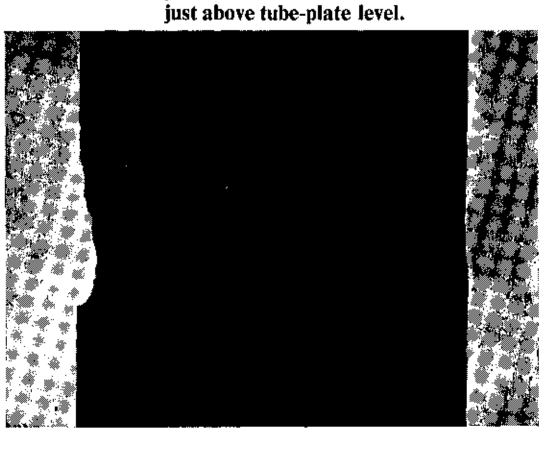
In Table I are given typical examples of (*a*) carbonate-silicate scale, (*b*) sodium alumino-silicate scale when using carbonate conditioning and (*c*) sodium alumino-silicate scale when using phosphate. The cause of all these scales was, fundamentally, owing to failure to maintain either correct conditions when softening, or the recommended compositions of the boiler waters. Our laboratories have on record, however, an example where a sodium alumino-silicate was unavoidable because alumina and silica were present naturally in the make-up water, but alumina is present in some cases because of the wrong application of aluminium salts in feed waters containing little magnesia.

It has been our experience that thin scales, for example 0·050" thick, of sodium alumino-silicate, or calcium silicate, which have low coefficients of heat transfer, cause overheating of tubes, with the result that they bulge and burst at the apex of the bulge. Fig. 3 is a photograph of a tube which has bulged in the manner described.

At the higher range pressures—and for convenience a figure of 600 p.s.i.g. is considered—water treatment is usually of such a high standard that these scales do not normally appear, and any operator of boiler plant who found a scale of this nature would be very concerned indeed and would set about its removal and prevent its formation.

"On-load" corrosion problems however, do occur, where high heat absorption takes place, even though the water is maintained in a suitable condition. Before turning to "on-load" corrosion of water walls, however, it should be mentioned that corrosion does occur also on surfaces where the temperature difference between heat source and water is not large. An example of this is shown in Fig. 4.

Fig. 4. An attemperator tube, showing waterside corrosion just above tube-plate level.



This tube was taken from an attemperator of a water tube boiler operating at 600 p.s.i.g. The raw feed water was demineralized, and demineralized water comprised approximately 25% to 30% of the feed. The feed was made suitably alkaline and mechanically and chemically deaerated. The boiler operated with a caustic alkalinity of about 150 parts per million and a phosphate reserve of about 50 parts as PO_4.

Corrosion was not occurring in the boiler itself, but it was necessary to renew the ends of the hair-pin tubes on the steam inlet side after two years. In each case there was a build-up of deposit on the tube plate and around the base of the tubes only on the side where the steam entered. Only where there was a build-up of this deposit did corrosion occur, but corrosion was sufficiently rapid to cause perforation of the tubes in two years and quite deep pits in the tube plate.

TABLE II

Attemperator deposit.

Lime	as % CaO	13·0
Magnesia	as % MgO	1·3
Iron oxide	as % Fe_2O_3	62·2
Copper oxide	as % CuO	7·9
Phosphates	as % P_2O_5	10·9
Silicates	as % SiO_2	0·6
Loss on ignition		3·0

Analysis on material dried 105°C.

In Table II is given the analysis of the deposit. It can be seen that the predominant constituent is iron oxide, and although it is here expressed as Fe_2O_3 it would be present in the attemperator as magnetic iron oxide. This deposit was hard and porous and was quite difficult to break up.

If the iron oxide is taken out of the analysis, it can be seen that the main constituents are calcium phosphate and copper oxide. These substances were brought in by the feed water, and there is little doubt that some of the iron oxide was too. This occurrence suggested that the cause of the corrosion was fundamentally the build-up of deposit in the attemperator, owing to the slowing down of the boiler water passing through, allowing the sludge to settle. By suitably arranging the blow-down so that the sludge was removed, corrosion has been prevented.

This particular incident is mentioned because it clearly indicates that corrosion can occur where a feed water is sufficiently alkaline and mechanically and chemically deaerated. This fact will be referred to later.

In 1960, a water tube boiler of M.C.R. 220,000 lbs/hour operating at a pressure of 900 p.s.i.g. with superheat temperature 900°F, was giving trouble, as the steam temperature could not be kept down to the design figure except when the sootblowers had been used. Then water appeared in the steam. The plant was about two years old. When the boiler plant was shut down, it was found that the tubes of the attemperator, again on the water side, but on the side where the steam entered, had been severely corroded and that many of the tubes were perforated. Examination of these tubes revealed they had not only been corroded, but had become embrittled. Clinging to the tubes was a deposit which was stratified with large amounts of native copper.

TABLE III

Corrosion products taken from the tubes of an attemperator.

Lime	as CaO	2·6%
Magnesia	as MgO	Trace
Iron oxide	as Fe_2O_3	60·0%
Copper	as CuO	41·7%
Nickel	as NiO	0·1%
Silicates	as SiO_2	Trace
Phosphates	as P_2O_5	3·3%

Table III gives the analysis of this clinging deposit, and Fig. 5 is a photograph showing the copper layers in the deposit. A tube, which had been severely corroded, is shown in Fig. 6, while Fig. 7 is a photomicrograph of a cross-section of the tube wall showing a deep pit and that the mild steel had been decarburised. There are numerous microcracks, suggesting hydrogen damage.

It was concluded that the attemperator, having collected a large amount of deposit, was not functioning correctly owing to the impedence of water circulation, and that concentration was occurring. Again, this shows that, where deposit is present in a boiler, corrosion can occur and hydrogen damage take place, even though the temperature at which heat is being transferred is only 900°F.

A few months later the same boiler had to be taken out of commission because of a cracked water wall tube. Again it was found that there were massive amounts of magnetic iron oxide present in the tube, together with native copper. The tube was found to be affected by hydrogen embrittlement.

Fig. 8 is a photograph of the interior of a tube showing massive scab formation, and this was typical of other tubes removed from the boiler.

It was suspected there was scale on the internal surfaces of the tubes, and closer examination of the tube, away from the corroded area, was made by testing electrically. An E.M.F. was applied through the tube wall and it was found there was a resistance of over one million ohms, between the outer and inner surfaces facing the fire, whereas on the side away from the fire the resistance was less than 40. This suggested something was present on the bore surface as the outer surface had been cleaned.

Thirty-eight tubes, which were thought to have been affected, had already been cut out of the boiler so samples of tube 6″ long were taken, three from an uncorroded tube and three from a corroded one. The three samples were taken from the top, middle and bottom of each water

Fig. 5. Deposit taken from the tube wall of an attemperator tube showing layers of native copper.

Fig. 6. Severely corroded attemperator tube.

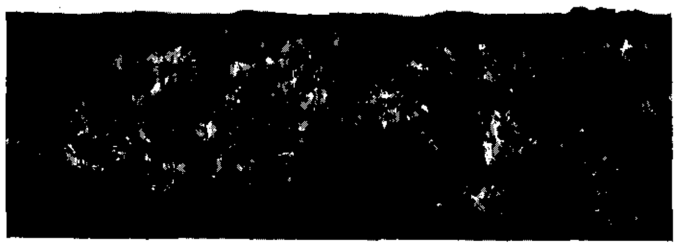


Fig. 7. Photomicrograph of a cross-section taken from the tube showing one of the deep pits, decarburisation of the steel and numerous micro-cracks.

Fig. 8. (Approx ¾ full size.) Tube interior on furnace side showing elongated corrosion area with remains of corrosion scab adhering.

wall tube in the burner zone. On receipt, the resistance of the wall of each piece was measured and then the sludge which had dried on the surface was brushed off and the specimens tested again.

Next, 1″ wide longitudinal strips were cut from each piece of tube, one from the front and one from the back and 10 resistance tests carried out on each strip, and the average recorded.

TABLE IV

Resistance to 500 Volts through wall uncorroded tube.

	*Longitudinal Section		**Strip 1″ Wide
	As Received	Sludge Removed	Sludge Removed
Top Fireside	4 megohms	2 megohms	200 ohms
Centre Fireside	0·2 megohms	0·4 megohms	4·4 megohms
Bottom Fireside	20·0 megohms	2·0 megohms	9·0 megohms
Top Back	253·0 ohms	120·0 ohms	
Centre Back	67·0 ohms	Negligible	31·0 ohms
Bottom Back	429·0 ohms	41·0 ohms	

Corroded tube.

Top Fireside	5·0 megohms	3·0 megohms	4·0 megohms
Centre Fireside	1·0 megohms	1·0 megohms	1·2 megohms
Bottom Fireside	2·0 megohms	1·5 megohms	0·6 megohms
Top Back	300·0 ohms	90·0 ohms	
Centre Back	159·0 ohms	72·0 ohms	50·0 ohms
Bottom Back	785·0 ohms	70·0 ohms	

*One test

**Average of 10 tests

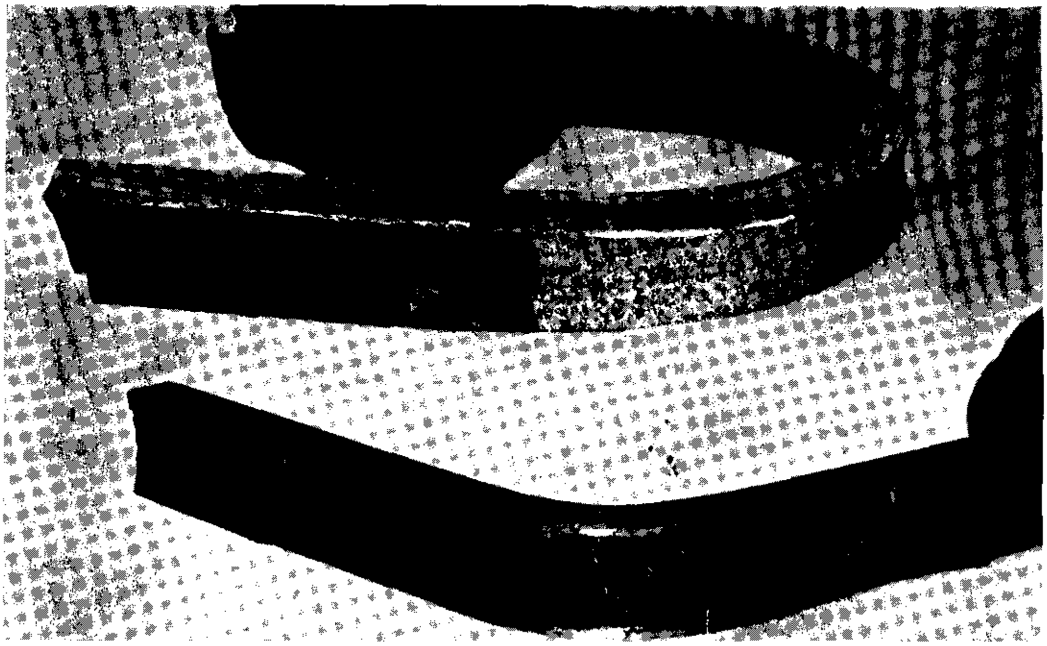


Fig. 9. Bent, cracked (embrittled) and uncracked longitudinal strips showing scale abutting the metal.

Table IV summarises the results obtained, and it can be seen at a glance that resistance is many times greater in tube walls facing the fire than in those away from it. It was desirable to find out what was impeding the current, as it was thought this would also adversely affect heat transfer. On close examination a scale was detected which on removal was found to be 0·015″ thick facing the fire and 0·001″–0·0015″ away from the fire.

Fig. 9 is a photograph of a strip from which some scale has been removed, and the scale abutting on to the bare metal is sharply defined. Analysis of this scale was revealing, and the tests showed that not only did the scale contain many of the metals which were in the system, but that only 30/40% of the material was magnetic iron oxide. The results of the analysis are given in Table V.

TABLE V

Typical composition of scale from internal surfaces towards the fire, water-wall tube.

Sodium oxide	as % Na_2O	2·5
Lime	as % CaO	3·2
Magnesia	as % MgO	1·3
Iron oxide	as % Fe_2O_3	29·6
Copper oxide	as % CuO	43·9
Zinc oxide	as % ZnO	8·1
Nickel oxide	as % NiO	0·6
Silica	as % SiO_2	0·8
Sulphate	as % SO_3	3·9
Phosphate	as % P_2O_5	5·8
Gain-on-ignition		3·2

This material could only have come from corrosion of the steam condensate feed system and from the make-up water and it was decided the boiler should be chemically cleaned. The boiler was later examined in 1964, and the scale was found to have formed again on the internal surfaces. Once more it was acid cleaned. Up to the time of this meeting, this boiler has run for seven years—more or less continuously without further trouble. (The scale was 0·009″ to 0·013″ in August, 1968, when the boiler was again cleaned.)

A second boiler, commissioned in 1955, operating at 1,500 p.s.i.g. and rated at 450,000 lbs. per hour, had to be taken off load last year due to the failure of a generating tube. A water wall tube failed a month later. Examination of the tubes showed there was a massive build-up of magnetic iron oxide, and hydrogen embrittlement had resulted in cracking. Other parts of the tube, away from the corrosion, were examined, and again scale was found on the bore surface about 0·017″ thick, in one case round the whole circumference, but only on the interior to the fireside on the other. Chemical examination of the scale revealed a large variety of corrosion products and materials from the feed and condensate system. In this case 100% condensate had been used, and the causticity of the boiler water was maintained by the use of trisodium phosphate. The boiler was acid cleaned and there was little doubt, when the cleaning was in process, the boiler contained a large amount of iron oxide and copper oxide, suggesting, if one may use the word, that, prior to cleaning, the boiler was dirty.

In a third boiler operating at 900 p.s.i.g. and rated at 90,000 lbs. per hour corrosion had occurred owing to loss of alkalinity. The boiler was opened for examination and a piece of corroded tube removed. The tube was examined for scale and it was found that there was a scale build-up, towards the fireside internally, of 0·015″–0·018″ thick.

Chemical analysis revealed that this scale again comprised iron oxide, copper oxide and other metals present

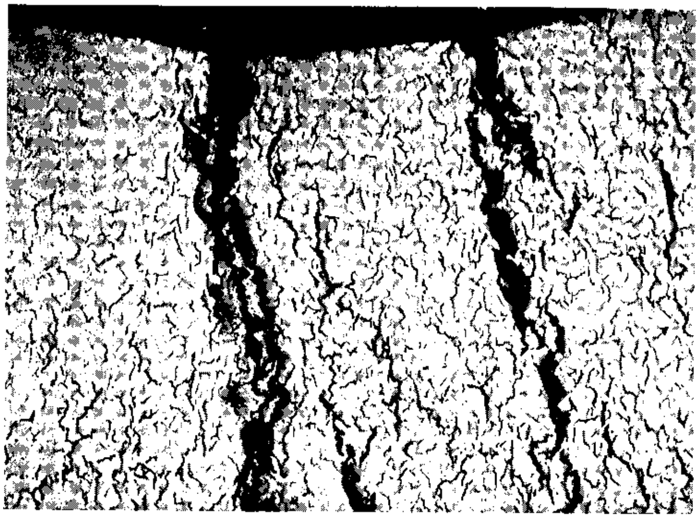


Fig. 10. Photomicrograph of a crack in a water wall tube following hydrogen embrittlement showing metallic copper plated out in the crack.

in the boiler system, in addition to small amounts of materials likely to be present in the feed water owing to condenser leakage. The feed was essentially condensate. There had, however, been occasions when leakage from condensers had resulted in the addition of calcium and magnesium salts.

In the case of a fourth boiler, which was operating at 700 p.s.i.g., a similar build-up of iron and copper oxide scale was found where corrosion and subsequent hydrogen embrittlement had occurred.

Suggested cause of "on-load" corrosion

Steel is unstable in water and corrodes. In boiler plant, a film of black magnetic oxide is formed on the metal surface, and this protects the metal. Where the condition of the boiler water is unsuitable with regard to hardness salts, scales cover this oxide. These scales are found to be thicker towards the fire than away from it, and this is considered to be due to the concentrating film of water, as a result of heat transfer. Where, however, feed water is of such quality that little sludge of a calcic nature is present, the predominant solids in the boiler will be oxides of the metals comprising the condensate feed system.

It is reasonable to suggest that these oxides will also concentrate in the film and stick to the tube wall. In the foregoing it has been shown that oxides of iron and copper have been found internally on water walls in much greater thickness towards the fire than away from it, thus supporting this view. In a generating tube the thickness of this type of scale was found to be fairly uniform around the circumference, which might be expected. It has been seen that thin calcium silicate and sodium alumino-silicate scales of 0·050″ thick have caused heating of metal to over 1,200°F. Although iron oxide and copper oxide may not have as low coefficients of heat transfer as these scales, there is little doubt that heat transfer will be impeded and the temperature of tube walls will increase, particularly if the scales are porous and allow steam to form in the interstices. It is known that steam blanketing results in corrosion.

Evidence has been given of corrosion occurring under deposits in an attemperator, even though the temperature differential between heat source and water was only a few hundred degrees Fahrenheit. Severe corrosion, resulting in hydrogen damage, was also experienced in an attemperator where concentration of deposit and boiler water was thought to have taken place. Both circumstances suggest concentration was the primary cause of the corrosion. It is known that concentrated caustic soda corrodes steel, and this probably was the corrodent.

Referring to the last sentence, it must be made quite clear that the type of corrosion mentioned is not caustic cracking, as shown previously, but chemical solution of the metal surface, leaving the metal with a gouged-out appearance.

Having again drawn attention to the main causes of corrosion, one mechanism by which "on-load" corrosion may occur can be put forward. Tests carried out on feed waters show that 0·01 part per million of iron and of copper passing to the boiler are not uncommon. Small amounts of other metals are probably also present, as may be calcium and magnesium salts. All slowly concentrate in the boiler and some are deposited in the tubes as scale.

After a period of time the thickness of these deposits becomes sufficient to have an effect on the heat transfer, and the temperature of the metal wall rises above its normal operating temperature.

In a high-pressure boiler, this increase need not be large to raise the metal temperature to a point where the normal iron-water reaction, producing the oxide, is quickened. This reaction then increases the thickness of scale by the iron oxide produced from the tube wall. If, in addition, there is concentration of salts and caustic soda, or steam is produced in porous deposits, then these conditions will assist the corrosion taking place and quicken the rate of build-up.

It may be that copper oxide dissolves in concentrating caustic soda, copper plates out and at the same time iron goes into solution, to reappear as iron oxide on dilution. Fig. 10 is a photomicrograph of cracks in the metal of a tube wall showing the deposition of copper along the length of the cracks. This lends support to the view that the copper was in solution, as solid copper oxide would have to be very finely divided and packed in preferentially to produce relatively so much copper when the oxide was reduced by the hydrogen from the corrosion process.

At first, the build-up of the scale will be slow, depending upon the entry of solids in the feed water, i.e. the pick-up of corrosion products from the feed and condensate systems. The less corrosion in these systems, the slower the process will be, but, as the scale thickens, so the pace of corrosion will accelerate. If the rate is slow, hydrogen may have time to penetrate the metal, whereas if the metal surface is continuously being removed by corrosion, hydrogen embrittlement may not be able to take place. Fast or slow, there is finally a large amount of magnetic iron oxide produced, which will result in rapid corrosion at the end. Should this oxide break loose and circulate throughout the boiler, there is also the possibility of a build-up causing over-heating elswhere.

Prevention

It has been suggested that deposition of corrosion products produced externally to the boiler is one of the primary causes of "on-load" corrosion and hydrogen embrittlement. If this be the case, the method of prevention seems simple—stop the entry of corrosion products into the boiler. In theory, this should be possible by stopping the entry of oxygen into the system, but in practice the prevention of the pick-up of iron and copper is difficult. Alternatively, perhaps they could be filtered out or removed by ion exchange resins, and in fact this is what is now being done.

However, there seems to be another way—acid clean the boiler and remove the scale before it reaches a critical thickness. In three of the cases mentioned this has been done. In one case the boiler has now run seven years without a recurrence.

Up to the present, scale thickness has been measured following the removal of a tube from the hottest part of the boiler. NV Group are now experimenting with an instrument to measure the thickness in situ, but unfortunately, at present, there must be access for the probe to pass down the tube.

Before closing I would like to thank Mr. Robey, of Bowaters, for giving permission for the experience gained in this work to be published, and to thank my colleagues for their assistance.

Productivity and Training

Productivity is a concept which is much discussed but little understood in the hospital service. The incentive schemes which are now being introduced, and the proposed interim bonus scheme, which will soon affect all hospitals, are the result of Report No. 29 of the National Board for Prices and Incomes. Initially, these schemes affect ancillary staff but their repercussions are likely to spread much more widely and to cause basic changes in the management philosophy of the service.

Productivity, therefore, raises vast training problems and in the autumn of 1968 the King's Fund made a grant to the North East Metropolitan Regional Hospital Board to enable Mr. Duncan Smith to undertakea pilot study on this subject for the Board. Mr. Smith completed the study before his recent appointment as training officer, National Health Service, and though the Department regards his report, published by the King's Fund under the title *Productivity and Training**, as a useful basis for discussion, it does not represent official policy.

The report points out that training must be based on a close analysis of the situation and the author examines the concept of productivity and the wholly novel demands which it makes on the hospital service. It also points out how vital this problem has become now that half the gross national product is spent in the public sector of the economy. Resources of so massive a kind must be used economically and it is clear that all public services must put their own houses in order before they can reasonably demand more sacrifices from the taxpayer. Work study has confirmed the charges of Report No. 29 that 'the standard of labour management is low' in hospitals and has shown that many millions of pounds a year can be saved.

The author of the report visited all the hospitals at which incentive bonus schemes were in operation and described what he found. The results appear encouraging and in several instances staff have doubled their productivity without working under strain. Consequently, they are benefiting financially as well as freeing resources for other purposes.

So far, however, the process has barely begun. Many more work study officers have to be recruited and trained, and management has to be taught to use them. The co-operation of the staff has to be secured at every hospital in the country and new relationships with the unions have to be developed. All this involves a new form of participative management and the problem is thus linked with that posed in another recent King's Fund publication *Joint Consultation—Defeat or Opportunity?*

The author has made a number of suggestions about the forms of training which are necessary to take full advantage of the investment which the service is making in recruiting 800 work study officers.

He points out that training cannot get fully into gear until management decisions about the strategy of the productivity drive have been taken. Various alternatives are examined in simple language which avoids the work study jargon that sometimes clouds discussion of this subject. The conclusion is that this is a problem of the utmost urgency and one which could vitally affect relationships in the service.

The subject under discussion

In association with the King's Fund College of Hospital Management, the Hospital Centre has arranged a series of conferences at which various aspects of hospital management, and especially personnel management, have been discussed. The fifth conference was held at the Centre on 24th June on the subject of Productivity and Training.

A selection of the principal papers given on this occasion are summarised below.

(*See page 202*)

*King Edward's Hospital Fund for London, *Productivity and Training* 1969, price 8s 6d, post free in the U.K.

PRODUCTIVITY—THE ROLE OF THE DEPARTMENT OF HEALTH

by L. G. S. MASON, O.B.E., F.C.I.S., F.B.I.M., Assistant Secretary, Department of Health

The stimulus to the development of productivity schemes in the Health Service stems from Report No. 29 of the National Board for Prices and Incomes, although a limited number of schemes had been launched by the Department of Health before this Report was issued. The Report within its terms of reference is primarily concerned with matters affecting the pay of manual workers in local government, the National Health Service and Gas and Water Supply. In the process of doing this it criticises the National Health Service for not being geared to obtain value for money spent and for deficiencies in the use of modern labour techniques. It recommends in the field of manual work with which it is concerned, management improvements, including the fuller use of work study, which apart from achieving substantial savings will make it possible for manual workers to earn more by providing them with the opportunity to do so—to earn more as the result of working harder and more effectively.

The National Health Service is the sixth largest industry in the country and employs some 203,000 manual workers and including some 29,000 workers on hospital building and engineering maintenance. The wage bill of this staff is about 33·1/3% of the total wages cost of the Hospital Service, totalling £523m. p.a. The Report says that productivity schemes in local government are producing a rate of saving in labour costs and on-costs in the range of £100–£300 a year for each operative employed after taking account of the costs of devising and administering a scheme. Whether savings of this order can be achieved in the N.H.S. remains to be seen but, with the scale of expenditure in the N.H.S., the challenge is clear.

Productivity

By itself the word Productivity means very little. It becomes active and meaningful when it is compared with some other level of achievement, e.g. relative productivity or increased productivity means a more effective use of resources. Specifically, it can be described as the ratio between input and output. An increase in productivity means a better output for present labour cost or the maintenance of the present level of output at a lower labour cost.

These improvements can be achieved by better management which includes improved control (the process of setting objectives and standards and reviewing achievement), the introduction of more efficient methods and the avoidance of waste. On the part of the staff, increased productivity means greater effort and willingness to adopt *different methods of work.*

Increased productivity is by no means limited to improvements in the field of manual work. It can take different forms, in different fields of activity. In recent years there has been an increasing volume of advice, reports and information on many aspects of hospital work, on medical organisation, nursing organisation, supplies work and, in the field of O & M and Work Study, reports on laundry management and the management of portering services and developments of the technique of Management Survey and other methods of assessing administrative efficiency. In the Part IV Services studies are well advanced to transfer much of the work of the Dental Estimates Board to a computer, and the feasibility of handling the routine work of Executive Councils by computer is being examined too.

This description illustrates to some extent the role of the Department of Health in relation to productivity generally, but the subject of this Conference relates only to the role of the Department in introducing and supporting productivity schemes.

In this field the role of the Department is very clear, not only because of the general demand from hospital authorities that it should take all practicable steps to co-ordinate action, to avoid waste of effort and delay in the construction and design of productivity schemes which could result if every hospital authority worked on its own without reference to the achievements of others, but also to take all steps which will on the one hand stimulate and encourage development of schemes and on the other to keep the process of approval of schemes through the Whitley machinery, or otherwise, as simple and as effective as possible.

Action being taken by the Department

Time does not permit me to give any more than a brief sketch of some of the main actions being taken by the Department to assist the development of productivity schemes in the Hospital Services. Broadly speaking, these are methods of encouragement, approval and development.

In the first of these categories, action to encourage the development of productivity schemes and to achieve a better understanding of the meaning and value of increased productivity, the Department organised a conference in June, 1968, attended by some 200 representatives of the Hospital Service, and since then has participated in a number of conferences organised by Regional Hospital Boards in England and Scotland. Within the limits of its staff resources the Department will be happy to help hospital authorities in this way in the future. Apart from this, and with the assistance of the Central Office of Information, the Department is producing a colour film which aims to illustrate the scope for increased productivity in all branches of hospital activity, but with particular reference to the implementation of the recommendations of Report No. 29 of the National Board for Prices and Incomes. This will be supported by a booklet which is being specially written on the same subject and which will be given wide distribution throughout the Hospital Service. Later on, perhaps in the Spring of 1970, a Newsletter will be published regularly recording the results achieved from productivity schemes introduced by different hospital authorities and containing other material designed to encourage and help the fuller development of productivity schemes throughout the Hospital Service. The success of this last venture will, of course, depend on material supplied by hospital authorities, but the idea could eventually develop into a Newspaper on the lines of "Target" for the Hospital Service.

The next category, the approval of productivity schemes, has as its basis the need for schemes to be soundly based in a way which will produce benefits both for hospital authorities and for their staffs which are reasonably comparable throughout the country. For example, if in one place increased productivity was obtained by management improvements, including capital expenditure but without any material increased effort on the part of the employees, and if this increased productivity were then to be shared with the employees, this would be manifestly unfair by comparison with another hospital where, in the terms of N.B.P.I. Report No. 29, the increased reward for the employees was based primarily on their own increased efforts. If the design of productivity schemes were left entirely to the initiative of individual authorities it is obvious that the different schemes would vary as substantially as the number of authorities—and there are over 2,000 hospitals.

However, if all schemes had to be sent to the centre for approval either by the Department or by the Ancillary Staffs Whitley Council there would be so much congestion at the centre that nothing would be approved at all. With these points in mind it is the aim of the Department and the Whitley Council so to arrange matters that hospital authorities will be free to introduce schemes provided that they conform to certain agreed principles.

With this end in view the Department has already issued a Code of Requirements governing the design, negotiation and implementation of the Variable Type Incentive Bonus Payment Schemes. In some respects this Code is already in advance of anything of like kind which has been introduced elsewhere. A similar Code for Measured Day Work Schemes will be introduced as soon as sufficient experience of this type of scheme has been obtained, but the bulk of productivity schemes are likely to be of the kind described as Productivity Agreements.

With this in mind, the Department has set up a working group of chief O & M and Work Study Officers, later to include a number of Hospital Administrators, first to examine a number of outline productivity agreements designed by the Department and develop them into schemes for practical application, and also to take account of schemes being developed with the Hospital Service of a similar kind. Once it has been demonstrated that any of these schemes are capable of general and fair application the descriptions of the schemes will be published and any hospital authority will then be free to design such a scheme adapted to meet its own local requirements. All these schemes will be based on detailed work study examinations as recommended by the N.B.P.I. and it is worth noting that there is no short cut to the design and implementation of effective productivity schemes if they are to be fair in the first place and, in later years, to maintain the rewards both to employers and employees which are promised when they are started.

The third category of help which the Department offers to hospital authorities is that of development. In many ways this is the most important. At the moment it seems to embody information and publicity, technical assistance in the sense that I have already described and also in the bringing together of technical knowledge gained from practical experience for the benefit of all, and training.

It would obviously be absurd if every hospital authority had to seek knowledge about the development of productivity schemes on its own without being able to draw on the experience of others or to learn from others about the pitfalls which may be peculiar to the development of productivity schemes in the Hospital Service. It will be the aim of the Department to act as a focal point to collect and to disseminate information of this kind. It is likely that the volume of information and its variety will be such that it can be handled effectively only by use of a computer and while, initially, information is being collected and recorded in a less exciting way steps are at the same time being taken to develop programmes for more advanced methods of storing and retrieving information.

Practical experience in the design and development of productivity schemes will rest with individual hospital authorities aided by the work study teams of the Boards of Governors and Regional Hospital Boards. It would be presumptious for the Department to endeavour to tell any of these organisations how best they might be able to conduct their affairs but, apart from the design of acceptable productivity schemes which I have talked about earlier, there is a substantial area which can be tackled best by a central authority. This is the bringing together and eventual promulgation of "standard data" relating to the measurement of work and the design of the more simple procedures. This sort of information can be built up only on the basis of practical experience gained in the field, but the Department has already set up a team recruited from the Hospital Service to develop synthetic data which it is hoped will eventually enable hospital authorities to obtain standard times and details of the most efficient procedures by reference to published manuals instead of by the use of stop watch timings and ad hoc judgments. In this exercise the central team is already in close contact with local government, the Local Authorities Management Services and Computers Unit, with industry, with the Defence Departments, the Home Office and with National Undertakings all concerned with building up similar data banks for the same sort of purposes in their respective fields. It is quite likely that with the wide range of activity encompassed by hospital work that the data bank for the National Health Service will eventually be one of the most comprehensive in the country, but it will depend on its compilation and for its success on the contributions made by the work study officers in the Hospital Service.

The third category, that of training, has two main aspects. The first and most immediate is the training of the work study force needed to implement the recommendations of Report No. 29 N.B.P.I. This entails the recruitment and to some extent the training of 800 additional staff. There has existed for some years a training centre at Leicester College of Technology which has provided Management Services courses for Hospital O & M and Work Study staff. In addition the Slough College has organised special training courses for the Hospital Service in work study related to pay/productivity. So far these training resources have been adequate to cope with the substantial increase in work study staff which has already taken place and which is planned for the immediate future. Plans are in hand to set up a central work study training centre which will augment these courses and which will provide a continuing centre for the substantial O & M Work Study force which will from now on exist in the Hospital Service a force of at least 1,300 officers. Whether this training centre operates on its own or as a part of a larger scale management training centre is something which has to be considered as the pattern of events develops.

The second aspect of training, apart from other aspects of training which will be discussed later in this Conference, is that related to the interchange of technical experience gained in the design and introduction of productivity schemes. To assist this the Department has made arrangements to organise a number of Seminars which will be attended by the work study staff of hospital authorities which will provide a venue both for the interchange of experience and also the importation of ideas and experience from industry and elsewhere on particular aspects of productivity schemes. The first of these is taking place today elsewhere in London on the subject of "Standard Data" to which I have referred earlier. The Training Centres also have plans to bring back their students to exchange ideas and experience and to keep them up to date with current developments and also to enliven future training courses with experience gained from the practical application of measures of all kinds designed to improve productivity.

Although it is not directly connected with the design and introduction of productivity schemes in the full sense of this term, I must refer to the decision to introduce an interim scheme to bridge the gap to some extent between the present time and the period, some years hence, when full scale incentive schemes and productivity agreements based on work study are introduced generally. The Department has designed, on the advice of Chief O & M and Work Study Officers of Regional Hospital Boards, a system of, as it were, "photographing" existing methods and procedures (or any new method which can be evolved after examining existing arrangements) so that any hospital authority may, in appropriate circumstances, seek with the support and ideas of its staff, to save money on existing manual activities so making it possible to augment the pay of the staff out of achieved savings. Schemes on these lines have been made the subject of experiment and the Department will shortly be publishing details to enable all hospital authorities to introduce such arrangements where appropriate; it is hoped that the arrangements can be extended to include building and engineering maintenance staffs.

To conclude I cannot do better than repeat my concluding remarks at the Department's conference on productivity in June 1968 where I said:

"The Department will do everything it can to help hospital authorities to make a success of this substantial venture and, in particular, to provide centralised information services which will enable hospital authorities to save time in the setting of work standards and to make use of the accumulating knowledge and experience which will develop throughout the hospital service as these revolutionary changes get under way."

PRODUCTIVITY SCHEMES IN HOSPITALS

by S. E. HARRISON, D.F.C., D.F.M., A.M.B.I.M., F.I.W.S.P., Management Services Officer
North East Metropolitan R.H.B.

Introduction

It is now firm government policy that the pay of ancillary staff in hospitals shall be linked to their productivity. Our problem is to determine how best to achieve this without prejudicing the standards of patient-care, increasing costs or causing unnecessary stresses and strains amongst staff generally.

There is, of course, a long history of applying incentive schemes in industry. All too often, however, these schemes have degenerated into blatant power struggles between employer and employee for the lion's share of the profit "cake". Neither side seems to have grasped the elementary fact that, in the ultimate, pay and profits must depend on productivity, and that maximum productivity is unlikely to be achieved unless management and labour sink their differences and combine their knowledge, their energies and power, firstly to agree on, and then to attain, the goal of the organisation.

This concept of using productivity schemes as a long-term means of drastically improving management/staff relations is one which we must grasp firmly or risk serious labour troubles. It is, therefore, vital that we understand the nature of productivity schemes and the roles of management and staff in developing and operating them.

Types of Scheme

The first and basic principle is that all incentive and other forms of productivity scheme are bargains, entered into willingly, between management and staff. It follows that they must meet certain criteria: they must manifestly be fair and relate as directly and simply as possible the amount and quality of work done to the reward: they must be easy to understand and operate; and they must be tailor-made to fit exactly the circumstances prevailing from day to day, so that, for example, a worker who is prepared to put in the effort can always earn a bonus.

There are three main types of scheme:

1. *Variable.* The classic industrial type scheme in which the output of each worker, or small group of workers, is accurately measured, compared with a standard performance for the work and a bonus paid in direct proportion to the amount of output in relation to the standard.

   "Standard Performance" and the method of measuring output are determined by experienced Work Study Officers, who first study the work content, streamline the working method, measure each task, and then agree their findings with the worker representatives.

   These schemes require that the output shall be identifiable, measurable and freely available, within very wide limits, so that the worker can largely determine how much he does and thus how much he earns.

   There is only a limited field for this type of scheme in hospitals, e.g. in laundries, C.S.S.D.'s and works maintenance, and they are rather expensive to maintain. However, they can be very profitable to both staff and management, are easily understandable, not difficult usually to negotiate, and in many ways are ideal "starters" to give management and unions some experience in this new field of industrial relations.

2. *Measured Day Work.* When the amount of work to be done is fixed, or for some other reason is not under the control of the workers, a measured day work scheme may be more appropriate. Essentially, standards of output or performance are agreed between management and workers, and, when they are achieved, the workers receive a fixed bonus.

   This system is particularly appropriate to catering staff, whose work is predictable within fairly close limits, but who have no control over the number of meals served, dishes to clean and so on. Transport drivers, domestic staff and porters could also be so covered.

   Measured day work schemes are in some ways easier to manage than variable schemes, but it is important that the work is first properly studied, defined and measured, otherwise they can easily degenerate into lightly disguised pay increases.

3. *Productivity Bargains.* This is a relatively new technique and, to be successful, demands a high level of co-operation between management and staff and considerable skill in negotiation. In effect, the two sides agree on changes in working methods, flexibility between trades and grades, reorganisation of shifts and so on, leading to a reduction in the numbers of staff required to give a defined service (e.g. the domestic work in a ward block, or the internal transport of patients and materials). In exchange for an assurance from the workers that they will operate the proposed system, management promise that a fixed bonus will be payable.

   Method study and work measurement are again necessary prerequisites, but participation by the workers in preparing the scheme is important and their goodwill is essential to its success.

   Productivity bargains can be applied to any manual work but tend to be less profitable than various schemes and more open to abuse.

Conclusions

Productivity schemes are with us to stay and indeed will undoubtedly be extended in time to A & C and P & T staffs. We must learn how to negotiate them and manage them. Above all, we must bring our workers into full partnership so as to gain maximum benefit from this opportunity to ensure "a fair day's pay for a fair day's work".

PRODUCTIVITY—A MANAGER'S POINT OF VIEW

by P. M. COOKE, Secretary, West Suffolk H.M.C.

Introduction—Use of Resources

The Hospital Manager today bears a heavy responsibility in the course of his everyday work for the use he makes of the resources at his disposal. These may be resources of different kinds—resources of money, of manpower, of building or equipment. On the one hand, he must consider whether a building is being used to its best advantage – could an Out-patient Department perhaps be used for some other extra and related purpose during the evening?—or, on the other hand, is expensive machinery being left idle for considerable periods of time, could its lifetime be more profitably exploited by bringing more labour to bear; whatever it is, he has consciously—and with some measure of dedication—to wring the last drop of advantage out of limited, available funds and more especially he has to use costly man- and woman-power in the best possible way to achieve the objects of the Organisation. Whatever may be our views on the proportion of the Gross National Product devoted to the Health field, or about the level and quality of service we would like to see, it is patently obvious that there are—and will continue to be—restrictions on what is available in terms of financial and other resources and in this situation it is incumbent on Management that we do the very best we can with what we've got.

Using resources to best advantage, examining performance in various fields of activity are essential ingredients in the exercise of improving productivity and are matters of concern whether we are Managers, whether we are Union Officers, Supervisors or Operatives.

Use Of Manpower Resources

Allan Fisher—in one of the many fine addresses he has given at Productivity Conferences, this time to the One-Day National Conference on N.B.P.I. Report No. 29 as far back as June 1968, referred to the Hospital Service as "labour-intensive" and this is particularly true when we recognise that salaries and wages account for some 70% of the total Hospital expenditure. Today labour is a resource or commodity which is difficult to come by, easy to lose, hard to train and expensive to employ. Yet it is the resource with the greatest potential in the Organisation. Sir Leslie Rowan entitled a speech he gave a year or two back "Investment in People" and we in the Health Service need to invest "in people" in a far more effective way if we're ever to achieve the best return on this very extensive outlay on labour. First of all—we need better personnel policies so that we recruit better and retain staff. Then we need to train staff for the job they have to do and for the responsibilities they have to bear. As soon as a man ceases to work by himself and is promoted to be in charge of and organising the work of others he requires training for a new type of job, involving new and different responsibilities. We need to be a lot clearer about job content and specifying work to be done. We need to be able to inculcate "interest" in work, satisfaction if you like, and we need to remember to pat people on the back when they've done well, just as much as lambaste them when they've fallen from grace. Mr. Bonham-Carter at a Conference held here recently on "Developing the Individual" said, "People are happiest, and so give their best, when they are really interested in what they're doing and when they are stretched to the limit of their ability or very near it." Again, we need to apply incentives of all sorts to motivate staff at all levels to achieve high performance and we need to achieve a new relationship between Management and Workers—a concept which throws overboard the failures of joint consultation and harnesses the potential of "joint participation" (Duncan Smith) and the possibilities of co-operative working, sharing out the benefits in achieving common goals (J. J. Jehring). It is fast being realised that management in a truly modern environment can only be practised with the consent of organised non-managerial employees. This means that, in order to be free to use his resources to the best advantage, the modern manager must be especially wise in the management of one of these resources, his manpower. It means, in effect, that his mandate to manage comes principally from his subordinates. Only if they co-operate or at least acquiesce, will he achieve his purpose. Consent to manage in this way has to be sought (G. Cattell).

Now to be wise in the management of the manpower resource implies a clear acceptance that the seven-year-old philosophy set out by the Advisory Council for Management Efficiency has been struck a fatal blow by Prices and Incomes Board Report No. 29. The previous heavy doubts about the possibility of introducing productivity arrangements into the Hospital Service, have been set aside in the face of an assumption by the Prices and Incomes Board that wherever work is done it can be measured, valued and added rewards given to those who carry it out in the most efficient and effective manner. With the new philosophy comes the new opportunity to extricate ourselves from the straightjacket situation imposed by the traditional wage and conditions of service structure in the Hospital Service. Our present systems provide some strange anomalies and oddly inverted bases of payment. At the worker's level we have rigidly named grades with pay rates attached to them based merely on nomenclature which means that the same amount of money is paid whether the worker is being effectively employed for the whole of his time, for three-quarters of that time or only half of it.

At the Middle Manager's level you will often find Supervisors taking home less pay at the end of the week than the staff they supervise. A Domestic Superintendent is paid on the basis of the number of staff she controls—for her there's every incentive to have more staff, rather than less.

At the level of top management you have the pointage system for designated grades—the Hospital Managers, based on the number of beds and Units in a Group—not on the use to which the resources are put—to be more efficient the Hospital Manager cuts his own throat! And I'm sure many more examples can be found—but the new philosophy offers opportunity for the exercise of discretion to reward achievement where it takes place, to hasten the much-needed changes, and to provide a challenge to the thinking of both Management and Unions. Some of the results are interesting—take the effect upon Supervisors—painters to achieve good bonus levels require all materials at hand so that they can keep going, so they badger the Supervisor to have the raw materials ready for them. Previously, before bonus introduction, it was the opposite—the Supervisor continually having to goad his men along—like Stevenson's Donkey in the Cevennes to keep them up to the mark. This sort of reversal of the role of Supervisor and his work-force is just one part of a whole new psychology of staff reaction being freed once the straightjackets are removed, the restrictions eased and the taste of bonus savoured—and we have only just begun to realize the full potential of a released and participating labour/management association.

Management's Performance

"What is not yet fully appreciated, however, is that productivity is a measurement of management's performance, of management's skill in the manipulation of all the resources at its disposal—not just manpower" (G. Cattell). What we are seeing in the Hospital Service in the '60's are the first faltering steps towards what Taylor in the '30's called "scientific management". The Institute of Work Study Practitioners in a Memorandum of Evidence to the Prices and Incomes Board on Payment by Results stated: "We would suggest that the fundamental purpose in introducing Work Study and payment by results systems should be to mould the attitudes of management and men in the direction of accepting change. We assert a belief in the fundamental necessity to change and to move from hit-and-miss methods to systematic management control made possible by Work Study and other techniques." One of the by-products of the variable incentive Bonus Scheme operating in the Group Laundry at Bury St. Edmunds has been a master control sheet indicating the performance achieved in each section of the Laundry week by week. Examination of the detail on this control sheet enables Management to make certain adjustments to the process work where required and draws attention to the performance levels attained. For the first time we have readily available detailed performance information in this sector enabling trends to be traced over a wider period and in greater depth and permitting better decision making than was posssible before in the much more hit-and-miss type situation which existed then. Now we are beginning to have the chance of "monitoring" performance in a new way. Management involvement in the development of productivity schemes in Hospitals is very considerable indeed let there be no mistake—but involvement throughout, which will include participation in performance analysis, simulation exercises, machine utilization reviews, queueing problems etc.—is a salutary exercise for management. Perhaps the same concept of performance assessment can be transferred to other areas of Hospital Activity to permit improvements in other ways.

At Bury St. Edmunds, in conjunction with the Department of Health and in advance of the "Best Buy" Hospital to be built there over the next three years, we are attempting to improve productivity within the West Suffolk General Hospital itself. We are doing so within a community health pattern involving close co-operation with Local Health Authority and General Practitioner services in the area and assisted by Hospital Activity Analysis providing computer feed-back on performance in all specialties to the Hospital Consultants themselves. Remarkable improvements in performance within the Hospital are beginning to take place and patient throughput is increasing, maximising the use of expensive Hospital In-patient facilities. With a little extra added to the resources, a great deal more work is being put through, and the Cost per Case—in a year of rising costs—has fallen.

Hospital Activity Analysis is only another form of management information and just part—an important part admittedly. Costing is another part, resource usage and planning is another—just a part of a composite and total information system designed to enable management to realize its full potential in the important task of using resources to the best advantage.

Conclusion

Implicit in all this is—a far greater concentration of attention on "reducing UNIT COSTS"—so rightly pointed out by Prices and Incomes Board Report No. 29—as opposed to "keeping within budgets".

—a much greater concern for the *use* we make of resources, rather than the extent of them—resulting, it is to be hoped, in the achievement of some form of productivity index or yardstick for the Hospital and Health Services against which improvements in our use of resources can properly be measured.

—a bold attempt to harness the potential of "joint-participation".

—and finally, a realization that, in the comparatively near future, we will need to compass the total information system for the whole of a modern District General Hospital within an on-line, real time multi-access Computer Installation.

I finish with a sentence from Duncan Smith's excellent work "Productivity and Training":

"To obtain improved productivity will not be easy; otherwise it would have been done already. That it can be achieved has been proved. That it must be done is now clear if the Service is to make ends meet and to meet its national obligations".

PRODUCTIVITY AND TRAINING

Synopsis of a talk by DUNCAN SMITH, Training Officer, National Health Service

Most aspects of productivity will have been covered by previous speakers; but they have been speaking to a handful. How do we convey the message of this conference to the thousands of senior and middle managers, to the scores of thousands of supervisors and to the hundreds of thousands of employees who will be affected?

This is a daunting problem in the time span which we have available. This problem has been recognised by the Department and, when decisions about the Interim Bonus Scheme were imminent in May, a small working party of Regional Training Officers was appointed to consider possible action.

The working party had reservations about the scheme but, since it has been decided to launch it, they considered how training could best support it.

It was soon apparent that any addition to the existing training load in regions (which is very heavy) would require extra resources and the Department agreed to recommend to the Regional Hospital Boards that an extra training officer should be appointed in each region to deal with productivity and the training of ancillary staff, whose contribution to the success of the scheme would be vital.

Next it was clear that there must be appreciation courses for the top management of Hospital Authorities, and here some doubt arose. It is not for training officers to act as missionaries for causes to which top management is not wholly committed. Regional Training Officers are in the service of their Regional Boards and need a clear mandate before they take action. We, therefore, discussed the matter with the Regional Hospital Boards' Secretaries. At the meeting some reservations were expressed until a more extensive knowledge of the Interim Scheme was available and it was clear that all doubts will have to be resolved if the scheme is to be a success.

Next it was agreed that training will have to be provided for Implementation Officers. Implementation Officers are key people and it has been suggested that they may well be the Hospital Secretary or his assistant. In any case, whoever is chosen should be given full and clearly defined responsibility for his task. His duties will depend on how great a part a Group Secretary wishes to play, but it will be broadly as follows:

1. Agree constitution of bonus groups with Unions and staff
2. Agree order of priority as between groups
3. Select and agree reference period for cost comparison
4. Supervise completion of work specification and arrange with Treasurer's Department for extraction of staffing figures and labour costs for reference period
5. Agree methods of consultation and organise communications generally
6. Chair discussions about possible methods changes and other ways of reducing labour costs, and about ways of reducing staff number (and timing)
7. Ensure the agreement is fully recorded and record accepted by all concerned
8. Supervise implementation of changes and arrange bonus payments as savings are made
9. Arrange all necessary notifications and certificates
10. Assist in periodic reviews of schemes and negotiate any necessary adjustments.

In addition to these specific duties the Implementation Officer in co-operation with the Group Secretary is faced with the even more important task of creating an atmosphere in which the Interim Bonus Scheme can succeed. As pointed out by previous speakers, this scheme introduces a wholly novel concept to hospital management and, for the first time, negotiations on questions of pay will take place inside the hospital. It is essential that this process should have in mind, first and foremost, the well being of the patients and the efficiency of the service.

It is felt in the Department that this goal will not be achieved unless Implementation Officers are given some help in carrying out their difficult job. Since Work Study Officers will not normally be concerned with the Interim Scheme there are so few people conversant with the details that problems would arise if special courses were to be organised in the regions. Hence the Department has welcomed the offer by the Staff College of the Institute of Work Study Practitioners which is attached to Loughborough University to run courses on a national basis. The Staff College staff have had unusual experience in training work study officers and the facilities available at the University are good. Courses at the College have, therefore, been recommended to Regional Hospital Boards Secretaries and starting from August it is hoped to arrange a series of 2½ day courses which, if Regions are willing, can cater for some hundreds of Implementation Officers at relatively small cost. If this scheme succeeds this is probably the first occasion on which a large scale development has been launched by a series of crash courses on a national basis.

It will be the job of the Implementation Officer to explain the scheme to the staff of their hospitals, but the role of the local union representatives will be almost equally vital in securing co-operation and a constructive atmosphere. Hence discussions have been taking place with the unions to ensure that their local representatives can attend short courses at appropriate colleges to learn about the scheme and to pave the way to further incentive schemes. It is hoped that the unions will bear the modest cost of the courses and that the Hospital Management Committee will agree to release the employees who are nominated for them.

So far I have been dealing with the Interim Bonus Scheme, but this is intended to lead on to the variable Incentive Schemes of the kind described in "Productivity and Training". These schemes present a larger problem which must be dealt with at several levels. Courses regarding the techniques and concepts of work study will have to be arranged for senior officers and members of the Hospital Management Committee and it will be desirable for trade union officials to play a part in these.

The Middle Managers will need to be instructed in greater depth in the technicalities of Incentive Schemes and this had already been done in one or two Regions with marked success.

There is no doubt that such schemes will also throw a greater responsibility on supervisors and existing schemes have already exposed the inadequacy of the supervisory system in departments where such schemes have been introduced. It is, therefore, a matter of urgency to step up supervisory training and this priority ties in with the recommendations of the Advisory Committee on Ancillary Staff Training.

Finally, all productivity schemes can only succeed in an atmosphere where there is real participation. There is thus a major training task in developing the kind of "Productivity Groups" to which Mr. Llewellyn Jones has referred and I personally believe that this could form the basis of a new and more effective form of joint consultation.

How do we do all this?

We must convince top management and we must step up training for middle management and for supervisory staff. Training of this kind is, however, geared to a very uncertain time scale. How fast will Incentive Schemes get going? Will the example of the Manchester Regional Board, in selecting particular groups for treatment over the whole ancillary front, be followed? If so, will other Regions follow the Manchester lead in appointing a Personnel/Training Officer in each group which has been covered by Incentive Schemes?

At present, Hospital Management as a whole is very uncertain about the general strategy on incentives and in "Productivity and Training" (page 57) it was suggested that it would be useful to hold a national conference to plan strategy. One Regional Secretary has urged such a conference should be held. I have likened the introduction of Incentive Schemes to "Pandora's Box" which can produce either good or evil. The likelihood of evil seems much greater if the authorities concerned are not clear about their goals, and this scheme seems to me to be far too important to be allowed to drift.

Is it possible for us all to agree to a concerted approach so that training officers throughout the service can collaborate with management in preparing for this leap into the unknown?

NEW MATERNITY UNIT AT CHICHESTER BEING BUILT BY McALPINE

Sir Robert McAlpine & Sons have begun the construction of a new Maternity Unit at St. Richard's Hospital, Chichester, for the South West Metropolitan Regional Hospital Board.

Designed by the Architect to the Board, B. W. East, F.R.I.B.A., this four storey 80 ft. high extension to the Hospital, providing 132 beds, will measure 160 ft. by 150 ft. on plan and have a floor area of approximately 6,800 sq. yds. Of reinforced concrete frame construction, it will involve the use of 3,500 cu. yds. of concrete and 200 tons of steel reinforcement. Four lifts will be installed and the extension will be centrally heated and partially air conditioned.

The Consulting Engineers are the McAlpine Design Group in association with the Engineer to the Board, K. J. Fatwell, C.Eng., M.I.Mech.E., M.I.H.V.E., and the Quantity Surveyors, J. B. Marks & Partners, Guildford. McAlpine are scheduled to complete the project early in 1971.

BRITISH HAEMODIALYSIS SYSTEM USED FOR FIRST KIDNEY TRANSPLANT IN PORTUGAL

Portugal's first renal transplant was successfully completed by Professor Alexandre Minhores Furtado, operating at the University Hospital, Coimbra. A 44-year old man received a kidney from his 40-year old sister.

Pre-operative treatment was carried out using a Lucas single patient proportionating and monitoring haemodialysis unit. The units are manufactured and marketed by G. & E. Bradley Ltd., a member of the Lucas Group and are supplied in Portugal through Conde Barao, Lisbon. Designed for use either in renal units or by the patient at home, the Lucas equipment is widely applied in the UK and overseas.

Heat recovery at new Fulham Hospital

MORE than 20 calorifiers and condense cooler units are being manufactured by Heat Transfer Limited, Gloucester Road, Cheltenham—a member company of the Spirax Sarco Group—for Phase I of the new Teaching Hospital now under construction at Fulham for Charing Cross Hospital Group.

Heat Transfer units have been chosen for their modern compact design and proven reliability. The calorifiers will convert the high pressure steam from the boilerhouse into low pressure hot water for circulation through the heating and service systems at a temperature of 180°F. The calorifiers and condense coolers will be interconnected on site to operate on the principles of the well-known Heat Transfer 'Cotswold' packaged units, a concept which the company pioneered.

Ranging in size from 1½ to 10m Btu/hr and for pressures up to 120 lb/sq. in, a further consideration which influenced the choice of these calorifiers and coolers was the need for gravity condensate drainage due to the general plant arrangement.

Phase I of the new hospital will occupy part of the old Fulham Hospital site. The site proper covers a restricted area bounded by Fulham Palace Road, St. Dunstan's Road, Margravine Road and Aspinlea Road. The new hospital residential accommodation and School of Nursing are being built on the Claybrook Road/Lurgan Avenue part of the site.

Phase I of the development comprises a laboratory ward block, an X-ray block and a clinic block. A recently completed predevelopment pilot building will be integrated with Phase I and modified at a later stage in the development of this project. The laboratory block and the ward block together form a homogeneous 19 storey cruciform tower block, with the X-ray block, clinic block and pilot building forming a two and three storey podium at the front of the tower.

When completed, Phase I will accommodate approximately 640 in-patients, and include 250,000 sq. ft. of laboratory space, a number of out-patient clinic suites, eleven X-ray radiographic rooms, 10 operating theatres, a central sterile supply department and an 1,100 meals central kitchen. It will also house a new central 70,000 lb/hr boilerhouse, 1,800 ton refrigeration plant, 1,500 kVA standby generator plant, a PABX 3 telephone installation, 23 lifts, 2 hoists and 2 escalators, and 2 large H.V. transformer sub-stations.

The main industrial plant will be located on the lower ground and ground floors of the laboratory block, secondary plant areas being located on the 5th, 11th, 15th, 16th and 17th floors of the laboratory block and in the lower ground 2nd, 12th, 13th, 16th and 17th floors of the ward block. The lower ground floor of the pilot building is being utilised for the main site water storage tanks and boosting plant. A sewage pumping plant for the lower floors of the development is sited beneath the clinic block.

The construction of all the buildings is of reinforced concrete with hollow pot floors, and the services distribution is carried out primarily via a system of vertical builderswork ducts and horizontal ceiling voids. A primary services engineering walk-way will be situated at lower ground floor level to link all of the blocks throughout the development.

The new boilerhouse, which houses two 25,000 and one 20,000 lb/hr Ruston Thermax boilers, is situated in the laboratory block at lower ground floor level. It will service not only the contract works but, also, the existing hospital and the two new residential blocks and a school of nursing which are now being built under a separate contract and also the stages of the hospital, to be built in the future. Steam is piped from the boilers at up to 120 lb/sq. in and is circulated through a 12" perimeter ring main with principal take offs rising through the buildings to serve numerous calorifier stations and steam using equipment.

There is no pressure reduction prior to the calorifier stations, and the use of steam as generated necessitates flash steam recovery which could otherwise lead to wastage of steam as high as 6 to 8%. This flash steam is condensed and the condensate subcooled by the Heat Transfer condense coolers, resulting in substantial improvements in the overall efficiency of this system. It also enables a higher rate of condensate to be recovered which lessens water treatment and blowdown problems on the boilers. The tower block presented a problem inasmuch as a shell side pressure of up to 180 ft. head has to be met. This can adequately be taken by the standard range of Heat Transfer units. Being multi-storey, this block is fully air-conditioned. It is served by three 600 ton refrigeration plants and a single duct high velocity terminal re-heat system.

As previously stated, Heat Transfer are a member of the Spirax Sarco Group and this project highlights the service available to the heating industry by integrating the services offered and use of equipment manufactured by companies within this Group.

Steam mains will be drained by Spirax Thermodynamic (TD) Traps suitable for pressures ranging from 8 psig to 350 psig. These compact units incorporate their own strainer and are extremely efficient and simple in operation, having only one moving part—a stainless steel disc.

Condensate is discharged either direct to the hotwell or to receivers and pumps, thereby avoiding the problems associated with condensate discharged directly into flooded pumped return lines.

Rapid air removal is achieved by the use of Spirax Air Vents of the liquid expansion type. These open to discharge air or an air/steam mixture and close in the presence of live steam. Known as Spirax "Fig. 3." Air Vents, they are robust enough to withstand waterhammer and superheat.

Condensate from Calorifiers and Heater Batteries will be drained through ball float type traps with inbuilt thermostatic air vents (T.V.) These traps are able to discharge condensate as quickly as it forms and work equally well on heavy or light loads. Added to this, the T.V. will ensure that air does not reduce the heat transfer rate by remaining in the batteries.

Where condensate cannot drain by gravity back to the hotwell, Ogden Automatic Pumps will be used, so eliminating any back pressure from the plant.

To exclude dirt from the traps and to facilitate maintenance and trouble tracing, trap sets will be equipped with strainers (except for the Thermodynamic type) and sight glasses. Where possible, the new Spirax/Hills Sight Check will be used. This is a single unit with sight glass and non-return valve facilities.

Phase I of the project is due for completion in 1972. Included in future plans are an animal house, maternity, paediatric, geriatric and radiotherapy ward units, a medical school, pharmacy, renal department, chapel and stores.

Mechanical contractors for Phase 1 are Rosser and Russell, while A. G. Manly are the contractors for the residential blocks and school of nursing. The Architect is Ralph Tubbs, O.B.E., F.R.I.B.A. and Dolnad Smith, Seymour and Rooley are the consulting engineers responsible for all the building services.

IMPORTANT NEW DEVELOPMENT IN STANDBY POWER EQUIPMENT

In response to requests from hospitals in Britain and Scandinavia, Erskine Laboratories of Scarborough, Yorks. have developed a medical bedside power supply trolley to ensure a continuous and simultaneous supply of power to items of essential equipment as used in I.T.U.'s and coronary care wards.

Whilst the majority of hospitals have their own generating equipment to guard against power cuts, the changeover time on a standby set from the moment of interruption to standby power being available can vary from 10 to 15 seconds, under the best circumstances. This delay can extend to as much as 30 minutes when, for example, in such a situation where it would be necessary to switch off sufficient non-essential load to reduce the demand to within the capacity of the standby generating set output.

Constantly linking items such as cardiac defibrillators, ventilators, electro cardiographs and other vital equipment to the mains the Erskine Trolley will, in the event of a mains failure, ensure a continuous supply of power without any apparent break in continuity for periods of one to two hours. On restoration of the mains the trolley automatically reverts to recharge. The power lost during standby action is restored in 2 to 3 times the period of the mains break.

The trolley, being mobile, is also able to cover journeys to and from the ward and operating theatre, when it might be necessary to accompany the patient with other equipment which must be in continuous use, or ready for immediate application.

Erskine manufacture eight models of the trolley with a choice of outputs and capacities, either 350 watts or 500 watts, suitable for sine or square wave and with durations of one or two hours capacity. The design, development and manufacture of the medical bedside power supply trolley has been carried out by Erskine Laboratories, a member of the Dale Group of Companies of Filey, Yorkshire.

£450,000 HOSPITAL CONTRACT FOR ANDREWS-WEATHERFOIL

A £450,000 contract has been awarded to Andrews-Weatherfoil, part of the Powell Duffryn Group, by the Oxford Regional Hospital Board, to provide full mechanical services for the first phase of rebuilding at Battle Hospital, Reading.

Services provided will include low pressure hot water heating, steam services, ordinary hot and cold water services with cold water booster and softener, natural gas boilers adaptable to oil in emergencies, a refrigerated mortuary chamber and a laundry.

Mechanical ventilation will be supplied to all wards, and full air conditioning to the four operating theatres, maternity unit and special care unit to provide a dust-free and almost sterile environment with closely-controlled humidity limits.

Building, by main contractors Costain Construction, is scheduled for completion in June, 1971. Architects are Yorke & Rosenberg & Mardall, and consulting engineers are R. W. Gregory & Partners.

NEW NNHT HOME FOR PLYMOUTH

Work on a new Nuffield Nursing Home, at Plymouth, is to begin shortly. A four-acre site at Derriford has been bought, and tenders are to be invited so that work can start early in September.

A local appeal committee has raised £175,000 towards the estimated £275,000 cost of the project, and Nuffield Nursing Homes Trust is to contribute £100,000.

The two-storey nursing home will initially cater for 20 patients, but a ten-bed extension will be available for use when necessary.

All rooms in the new home will be equipped with their own toilet and washing facilities, beside telephone and television. A modern operating theatre and diagnostic X-ray department, which are standard in Nuffield Nursing Homes, will be provided.

The Plymouth project will, when completed, be the eighteenth "mini-hospital" run by Nuffield Nursing Homes Trust. At present fourteen are completed, and three more units are being built at Brentwood, Huddersfield and Leicester.

The Trust was set up as a charity in 1957 by BUPA, in recognition of the need for substantial additions to the facilities available for private practice.

LEEDS GERIATRIC HOSPITAL CONTRACT

Shepherd Construction Ltd. have been awarded the contract valued at approximately £734,000 covering Phase Two of the major redevelopment at St. James's Hospital, Leeds. Work started on 18th August.

The contract involves provision of geriatric wards and day hospital and consist of two main blocks of five and four stories respectively with two storey and single storey wings incorporating treatment, diagnostic and ancillary services.

The buildings consist of a reinforced concrete frame, floors and roof with brick cladding. The contract is scheduled for completion in 22 months.

The architects are Messrs. J. G. L. Poulson of Pontefract in association with Leeds Regional Hospital Board.

CARTER PLANT AT GARTNAVEL HOSPITAL

Carter Refrigeration & Air Conditioning Ltd., one of the Carter Thermal Industries Group of Companies, at Redhill Road, Birmingham 25, have been awarded a contract worth £37,000 to supply and install air conditioning plant to the £7m. Gartnavel Hospital development which is to be commissioned in 1972.

For the main contractor John Laing Construction Ltd., C.R.A.C. will install air-conditioning plant and equipment in seven operating theatres, an intensive care unit and in reception areas at the new hospital which will have a total of 576 beds and will be the first of a number of district hospitals to be built in the West of Scotland.

Architects: Keppie, Henderson & Partners, Glasgow, in association with T. D. W. Astorga, D.A. Dip. T.A. A.R.I.B.A., Regional Architect, Scottish Western Regional Hospital.

MOORWOOD-VULCAN AT LIVERPOOL

Moorwood-Vulcan Limited, of Sheffield (a member of the Brightside Group of Companies) has received an order worth £50,000 for the supply and installation of gas, steam and electrically operated kitchen equipment for the new General Teaching Hospital, Liverpool.

The kitchen equipment includes ranges, roasting ovens, steamers, tilting kettles, fryers, grills, hot cupboards and many labour saving items of machinery.

The Consulting Engineers are: R. W. Gregory & Partners.

On the Market

A review of new equipment and materials and their development

MEDICAL DIAGNOSTIC SOUNDER

A new ultrasonic instrument for the visualization of internal body structures is announced by **Hewlett-Packard Ltd.**

Since it is intended for clinical use, it is designed for A-scan applications only. All three scans of standard midline determinations (right-to-left, left-to-right, and through scans) can be displayed simultaneously, and they can be photographed during a single exposure.

Depth is read directly from the dial's digital readout, with a resolution of better than 5 mm. over a range of 5 mm. to 30 cm.

The design includes a time-gain compensation system to offset the increasing attenuation of sound with depth.

Average transmission power is 2 m. W/c m.^{2}, much below the level which could cause internal heat generation. The type number of the instrument is 7215A.

The diagnostic sounding technique involves the transmission of a beam of ultrasonic energy of low power into the body. The beam is reflected back from tissue boundaries inside the body. These reflections are then displayed on the diagnostic sounder instrument's oscilloscope screen as a moving spot in the vertical axis; at the same time, the spot moves horizontally with time, at uniform rate. The total elasped time from skin surface to reflection, and back, is proportional to the horizontal distance along the oscilloscope trace to the spot mentioned above. This total time can then be translated into distance (or depth) from the skin surface to the tissue of interest.

The principal application is the determination of the position of the brain's midline structure; any displacement indicated the presence of tumours or other intracranial lesions.

The technique is also employed for the measurement of kidney and liver diameter, the location of stones and foreign bodies (in particular, those which do not show up in X-ray examination), and also in pregnancy for the measurement of biparietal diameter of the foetal head.

A.C. TO D.C. CONVERTER MARKETED BY OERLIKON ELECTRODES

Oerlikon Electrodes Ltd., Unidare House, Hayes End Road, Hayes, Middlesex, announce that they are marketing a 250A a.c. to d.c. converter which may be used in conjunction with any make of a.c. welding transformer of similar performance ratings and also with the Oerlikon type EFS 250 elevated frequency welding alternator.

This conversion of the welding transformer's output from a.c. to d.c. not only facilitates the tungsten inert gas welding of stainless steel, but also enables d.c. welding of both ferrous and non ferrous metals to be carried out with the use of ordinary stick type electrodes.

The Oerlikon converter, which may be applied to continuous production duties, offers considerable savings on high quality T.I.G. or d.c. arc welding processes. It is rated at 250A maximum with a 70% duty cycle and when connected to an a.c. welder of lower putput, its own output is proportionately reduced, its striking voltage also corresponding to that of the a.c. welder.

Further details, including price and delivery, are available on request to Oerlikon Electrodes Ltd.

ZEISS DEVELOP VERTICAL FUNDUS CAMERA ON MOTORISED ROLLABLE STAND

A new version of the Fundus Camera has been developed by **Carl Zeiss** of West Germany specially for photography of recumbent patients. The camera is mounted vertically on a fully motorised stand which allows remote control of coarse and fine focusing.

Developed from the original Zeiss design, this equipment is built onto its own instrument table for free manoeuvring over the patient. Photographs, taken on 35 mm. colour or black and white film, produce an image of the fundus enlarged two and a half times. Polaroid or other camera bodies of larger format can also be attached. The intensity of electronic flash illumination makes it possible to photograph even very dark fundi with an exposure fast enough to freeze any eye movements and give a perfectly sharp image. There is also sufficient light reserve to permit use of smaller apertures. Picture contrast can be considerably enhanced by oblique illumination of the fundus. A fluorescence attachment is also manufactured.

Accurate measurement of fundus lesions is possible because the angle of view on the patient's retina always corresponds to a certain section on the film.

A perfectly flat edge-to-edge image is produced by the highly corrected optical system of the Fundus Camera. Also the chromatic aberration of the human eye is optically compensated. As a result the resolving power of the optics being so high all details which, according to optical law are possible to resolve, can be photographed. A combination of cylindrical lenses may be placed in the fluorescence light beam to correct up to twenty dioptres of astigmatism at any axis.

Marking of the portion of the retina used for fixation is simple with the integral fixation target. During observation, or in a photograph it is seen as an indicator arrow. A magnification accessory can double the overall magnification to 5X which enlarges the retina to fill the entire 24 mm. × 36mm. film format.

British agents for equipment made by Carl Zeiss of West Germany are **Degenhardt & Co. Ltd.,** Carl Zeiss House, 31-36 Foley Street, London, W1P 8AP.

HARVEY-TECHNOBEL PACKAGE AIR CONDITIONERS

A recent addition to the Harvey-Technobel range of packaged air conditioners is the CA. 15 split air cooled unit. Its capacity under U.K. conditions is 60,000 BTU/hr.

The CA. 15 features a unique facility whereby the complete refrigeration system can be removed from the cabinet and replaced with a similar module, thus eliminating the need for extensive service being carried out on site. Directional plenum or ducted discharge can be arranged with fresh air make up access to the rear of the unit.

Remote air cooled condensers are arranged for either horizontal or vertical discharge depending upon site conditions. All starters and controls are housed within the evaporative section minimising on site installation. Heating mediums can be hot water, steam or electric, giving complete flexibility to the application engineer. The evaporative section and its remote condenser are finished in an attractive "hammer blue" acrylic paint.

The Harvey-Technobel range of equipment which consists of over 42 models giving cooling capacities from 6,000-136,000 BTU/hr. is distributed by a network of selected agents. Full details and area agents' locations are available direct from **Harvey Fabrication Ltd.,** Harvey-Technobel Division, Woolwich Road, London, S.E.7.

NEW BALL-TYPE CASTOR

An entirely new type of ball-type castor, the Duet, has been developed by **Homa Engineering Ltd.** It can be used on furniture of all kinds in hospitals, catering establishments, offices, etc.

Its twin airfoil design wheels, with a differential action, give complete manoeuvrability. Wheel fixing is positive. Made from Homalon plastic, the Duet is completely silent in operation, corrosion-resistant and needs no maintenance. It will carry a load up to 1 cwt.

NEW FLUE GAS ANALYSER

SK Instruments Ltd. announce a *new* flue gas analysis equipment—the Mark 4—which provides continuous, accurate measurement of flue gases.

The basic analyser operates on the thermal conductivity principle, and it is available with single or twin measuring chambers for application to one or two measuring points.

The transmitter unit contains a solid-state power unit, measuring chambers, electrical bridge circuits, and aspirator pump. Indicators, calibrated in percentage CO_2, can be incorporated in the door panel.

The power unit has printed circuitry and provides a high degree of stability and reliability. For $\pm 10\%$ change in mains voltage, or in load, the variation in bridge current is less than 1%. This stability is maintained over the temperature range of operation 0 to 38°C.

Bubbler units which wash the gas sample prior to analysis are supplied, and multi-way inlet valves with Zero and Orsat positions are fitted inside the case. All internal gas connections are of plastic tubing. A comprehensive range of ancillary units is available.

NEW FABRIC FILTERS FROM DAVIDSON'S

Two new series of fabric filter have been added to their range of Sirocco dust control equipment by **Davidson and Co. Ltd.,** Sirocco Engineering Works, Belfast.

Marketed as the Series HM (for hand or mechanical cleaning) and Series A (for automatic self-cleaning during operation) the units give an efficiency of 99·8% and are available with filter bags in a variety of natural and synthetic materials to suit a wide range of conditions, including high temperature and abnormal acid or alkali content.

Designed as free standing units, the cabinets are constructed from galvanised steel sections, complete with access doors and outlets. Standardised parts are used throughout the range and large installations can be built up readily and economically from stock items. Capacities range from 2,000 c.f.m. to 50,000 c.f.m. for the Series HM, and from 2,000 c.f.m. to 14,000 c.f.m. for the Series A.

NEW DEMINERALISED WATER PLANTS FROM PERMUTIT

The Permutit Company Ltd., Pemberton House, 632-652 London Road, Isleworth, Middx., announce new improved versions of their types MB6 and MB9 packaged "Deminrolit" water treatment plants.

The plants, which are of the mixed bed type, are designed to convert mains quality raw water into very pure demineralised water conforming to the British Pharmacopoeia Standard for purified water. The MB6 plant has a maximum flow rate of 60 gal/h (270 litres/h) whilst the MB9 has an output of up to 135 gal/h (610 lit/h). Both plants have a maximum working pressure of 50 lb/in² and operate from a 200/250V single phase a.c. mains supply.

Each plant consists basically of a welded sheet steel cabinet housing a plastic dipped steel pressure vessel containing a mixed bed of "Zeo-Karb" 225 cation exchange resin and "De-Acidite" FFIP anion exchange material. Regeneration is carried out in situ using commercial hydrochloric acid and caustic soda provided in a separate regenerant container of high density polythene. The air compressor, flow indicator and all necessary control valves for regeneration are built into the cabinet. A conductivity meter/controller gives continuous indication of demineralised water quality and operates an alarm bell when regeneration is necessary. The capacity between regeneration is dependent on the raw water quality.

TOTAL ENERGY AND THE NEW DISTRICT HOSPITAL

A leaflet sets out the case for providing all the energy requirements—electricity, hot water, steam and refrigeration—for one of the new district hospitals, or any similar size unit, by Blackstone diesel generating equipment.

Readers who would like copies can obtain them from: **Mirrlees Blackstone Ltd.,** Sales Division, Dursley, Gloucestershire, GL11 4HS, telephone Dursley 2981.

Mirrlees Blackstone Ltd. was formed on June 1 from the merger of Mirrlees National Ltd. and Blackstone & Co. Ltd., companies within the Hawker Siddeley Group.

OIL-CONVERSION CHIMNEY LINERS

A new leaflet issued by **W. E. Rodell and Son Ltd.,** Eggington, Leighton Buzzard, Beds, describes their service for the manufacture and installation of insulated chimney liners. When steam boilers are converted to oil firing, insulated liners prevent the emission of smuts by maintaining flue-gas temperature above 300 deg. F. dewpoint.

The company offer a four-six week service to hospitals and other installations where boiler conversions are made.

Notes for Members

"Au Revoir"

Naturally, it is not without great regret, after almost seventeen years as Editor, that I have to tell Members that this issue of the Journal will be the last to be published under my guidance. However, present-day conditions, coupled with the prolonged effect of a serious accident in 1966, have led to a situation no longer practical and I have therefore felt obliged to relinquish this particular responsibility.

Throughout this time I have made many friends, both within and without the Institute, and I have enjoyed much kindness and support, both as Editor and, formerly, as Secretary of the Institute. I am indeed most grateful for everything and it will not be forgotten.

The heading to these few words was chosen deliberately; as a member of the Institute I shall continue to receive news of its progress and that of Members.

I have much enjoyed my long and close association with the organisation, and it only remains for me to thank everyone concerned. My best wishes to the Institute for the future and to the new publishers.

M. J. M. BOSLEY.

MIDLANDS BRANCH

There have been vast changes in technical education for engineers and technicians working in various fields associated with the hospital service and many sections of hospital staff may not be clear about the education facilities available to them.

Dr. E. Tidd, B.Sc., Ph.D., A.R.I.C., Principal of the new North Birmingham Technical College, Perry Barr, will explain the development of technical education in Birmingham in recent years and the intention to provide national courses suitable for hospital engineers and medical technicians in the future.

This meeting will be of particular interest to:

Hospital Engineers, professional and technical
Medical Laboratory Technicians
Medical Physics Technicians
Cardiological Technicians
Cardio-Pulmonary Technicians
Electro-Physiological Technicians
Dental Technicians
Surgical Technicians
Radiological Technicians
and clinicians and scientists employing professional and technical staff.

(*Continued on page 212*)

The Institute of Hospital Engineering has co-operated with the various Societies and Institutions covering the activities of the above technicians in arranging this meeting at The Alexandre McGregor Lecture Theatre, in the Dental Hospital, Steelhouse Lane, Birmingham, on Wednesday, 8th October, 1969, at 6.30 p.m. Admission is free and visitors are welcome.

Tickets are obtainable from the Secretary of the Midlands Branch, H. R. Martin, 3 Churchill Road, Hasbury, Halesowen, or from the Secretaries of the appropriate professional bodies of the groups listed above.

THE SEVENTH SCOTTISH WEEKEND CONFERENCE

It has been arranged that the Weekend Conference this year will be held in Aberdeen, and the Board of Management for Aberdeen General Hospitals are providing facilities for the Conference.

The Chairman, Professor R. D. Ireland, Q.C., M.A., LL.B., will open the Conference, and the Board of Management have further extended their hospitality by way of morning coffee and afternoon tea on each day of the Conference.

The President, G. A. Rooley, C.Eng., M.I.C.E., F.I.Mech.E., along with the Secretary, J. E. Furness, are to attend, and it is hoped that the Conference will be well supported. All sessions will be open to visitors at no charge. Visitors may attend independently or as guests of members. No special tickets will be required.

Members are requested, when forwarding their attendance fee, to indicate if their wives will be accompanying them and if guests are being invited.

Members are reminded that they may be granted Conference leave and expenses by their respective Boards of Management and Regional Boards (Circular H.M. (56) 32).

PROGRAMME

Thursday, October 16th — Coffee 9.30 a.m.

The official opening of the Conference and welcome by the Chairman of the Board of Management for Aberdeen General Hospitals, Professor R. D. Ireland, Q.C., M.A., LL.B. — 10 a.m.

Session 1: — *10.15 a.m.*

Chairman: G. A. Rooley, C.Eng., M.I.C.E., F.I.Mech.E., President of the Institute.

Modern Heat Exchangers—by F. Hicks, M.Inst. British Eng., Technical Adviser, and D. Seaton, Assistant Technical Adviser, British Steam Specialities, Ltd.

Session 2: — 2 p.m.

Chairman: K. W. Wilson, C.Eng., F.I.Mech.E., M.I.H.V.E., Regional Engineer, Western R.H.B.

Internal Automated Transportation in Hospitals by G. J. Belt, Drayton Castle Ltd.;

Bio Engineering by John Hughes, B.Sc., C.Eng., M.I.M.C.H., University of Strathclyde. — 3.30 p.m.

Friday, October 17th — Coffee 9.30 a.m.

Session 3: — 10 a.m.

Chairman: E. L. Taylor, M.I.H.V.E., A.M.Inst.F., Regional Engineer, Eastern R.H.B.

Development of a Hospital Site by C. W. King, Hospital Secretary, Aberdeen Royal Infirmary;

followed by a film on Finessa Food Distribution Systems in Hospitals.

Session 4: — 2 p.m.

Visit to new Laundry and C.S.S.D. on Foresterhill Site.

Visit to Phase I Development, Aberdeen Royal Infirmary. — 3.45 p.m.

Saturday, October 18th — Coffee 9.30 a.m.

Session 5: — 10 a.m.

Chairman: C. H. Harris, C.Eng., F.I.Mech.E., M.I.E.E., M.I.Prod.E., A.M.I.H.V.E., Regional Engineer, North Eastern R.H.B.

"Open Forum".

If sufficient numbers of those attending wish it, an informal social evening might be arranged on the Friday evening.

Index to Advertisers

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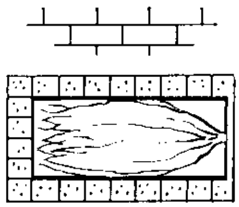

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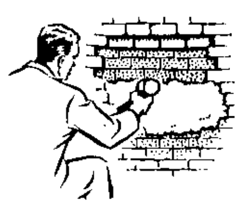

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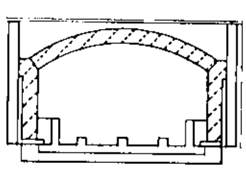

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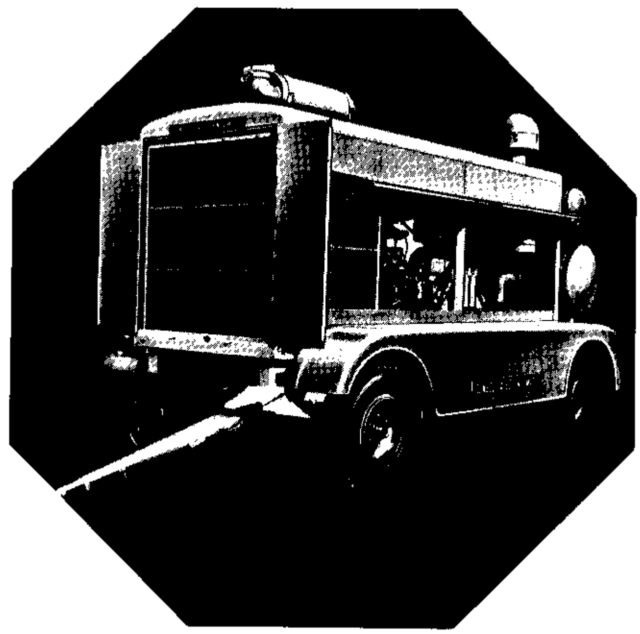

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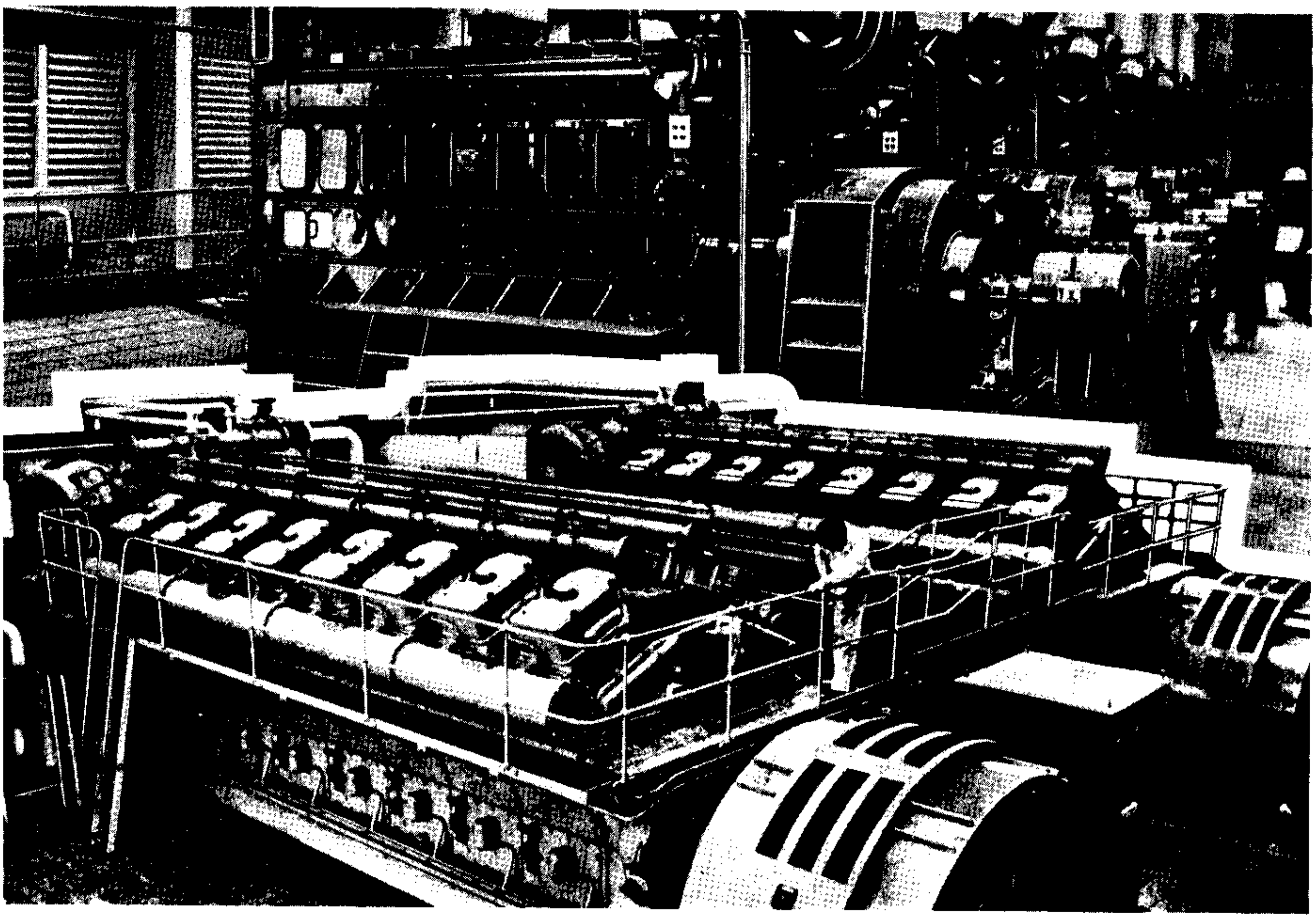

The two great leaders in the field of diesel engine manufacture have come together to form the new Company Mirrlees Blackstone Ltd. This amalgamation now offers the widest range of power units, from 100 B.H.P. to 8,500 B.H.P., for electric generation and direct mechanical drive.
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CHANGE OF PUBLISHER

Please note that, following the publication of this issue, there will be a change of Publisher for "The Hospital Engineer".

The responsibility for publishing this Journal, for the October issue and subsequently until further notice, will be assumed by Peter Peregrinus Ltd.

Communications, in the future, should be addressed to Peter Peregrinus Ltd., P.O. Box 8, Southgate House, Stevenage, Herts. (Tel: Stevenage 3311)

or, if more appropriate, to
The Secretary, Institute of Hospital Engineering, 20 Landport Terrace, Southsea, PO1 2RG. (Tel: Portsmouth 23186).

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Information available from Hospital Secretary. Applications giving full details of training, qualifications and experience, naming two referees, to Hospital Secretary, Dulwich Hospital, London, S.E.22.

HOSPITAL ENGINEER required for Cuckfield, Haywards Heath and Goddards Green Hospitals. Points range up to 24. Salary £1,270-£1,500 per annum plus £25 per annum unit allowance for special responsibilities. Qualifications and conditions of service as laid down in appropriate Whitley Circulars. Application forms and job description obtainable from Group Secretary, Mid-Sussex Hospital Management Committee, Cuckfield Hospital, Cuckfield, Sussex. Last date for receipt of applications 7th October, 1969.

BOARD OF MANAGEMENT FOR GLASGOW ROYAL INFIRMARY AND ASSOCIATED HOSPITALS

HOSPITAL ENGINEER

Based at Eastern District Hospital, Duke Street, Glasgow, E.1, to be directly responsible to the Group Engineer.

Applicants must have had a thorough practical training and hold one of the following qualifications or an equivalent qualification approved by the Secretary of State for Scotland:

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

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

(iii) Ministry of Transport First Class Certificate of Competency plus an Ordinary National Diploma or Ordinary National Certificate.

Salary scale £1,270 to £1,500.

Applications to The Secretary, Board of Management for Glasgow Royal Infirmary and Associated Hospitals, 13, Bath Street, Glasgow, C.2, not later than 23rd September, 1969.

ST. MARY ABBOTS HOSPITAL,
MARLOES ROAD, KENSINGTON, W.8

HOSPITAL ENGINEER required. Must have served an engineering apprenticeship and hold a recognised qualification; Higher National Certificate in Mechanical Engineering or City and Guilds M.E. (Part II), Plant Engineering or M.o.T. O.N.C. Building knowledge an advantage. Salary £1,360 to £1,590 p.a. Successful candidate must reside within easy reach of the hospital. Apply in writing, naming three referees, to Secretary, Chelsea and Kensington Hospital Management Committee, 5, Collingham Gardens, London, S.W.5.

EASTBOURNE HOSPITAL MANAGEMENT COMMITTEE

HOSPITAL ENGINEER

required at St. Mary's Hospital, Eastbourne. Post vacant 1st December due to promotion of present holder.

Applicants must have had a thorough practical training and wide experience in the management of Electrical and Mechanical engineering and should possess one of the following qualifications:

(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 02 level, or with endorsement in) Applied Heat and Applied Mechanics, provided he has suitable practical experience in mechanical engineering; or

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

Salary £1,370 to £1,605 p.a. Present pointage 29½. Responsibility allowance £100 p.a.

Application forms with further details and a job description available from the Group Secretary, 29 Bedfordwell Road, Eastbourne, to be returned by 29th September, 1969.