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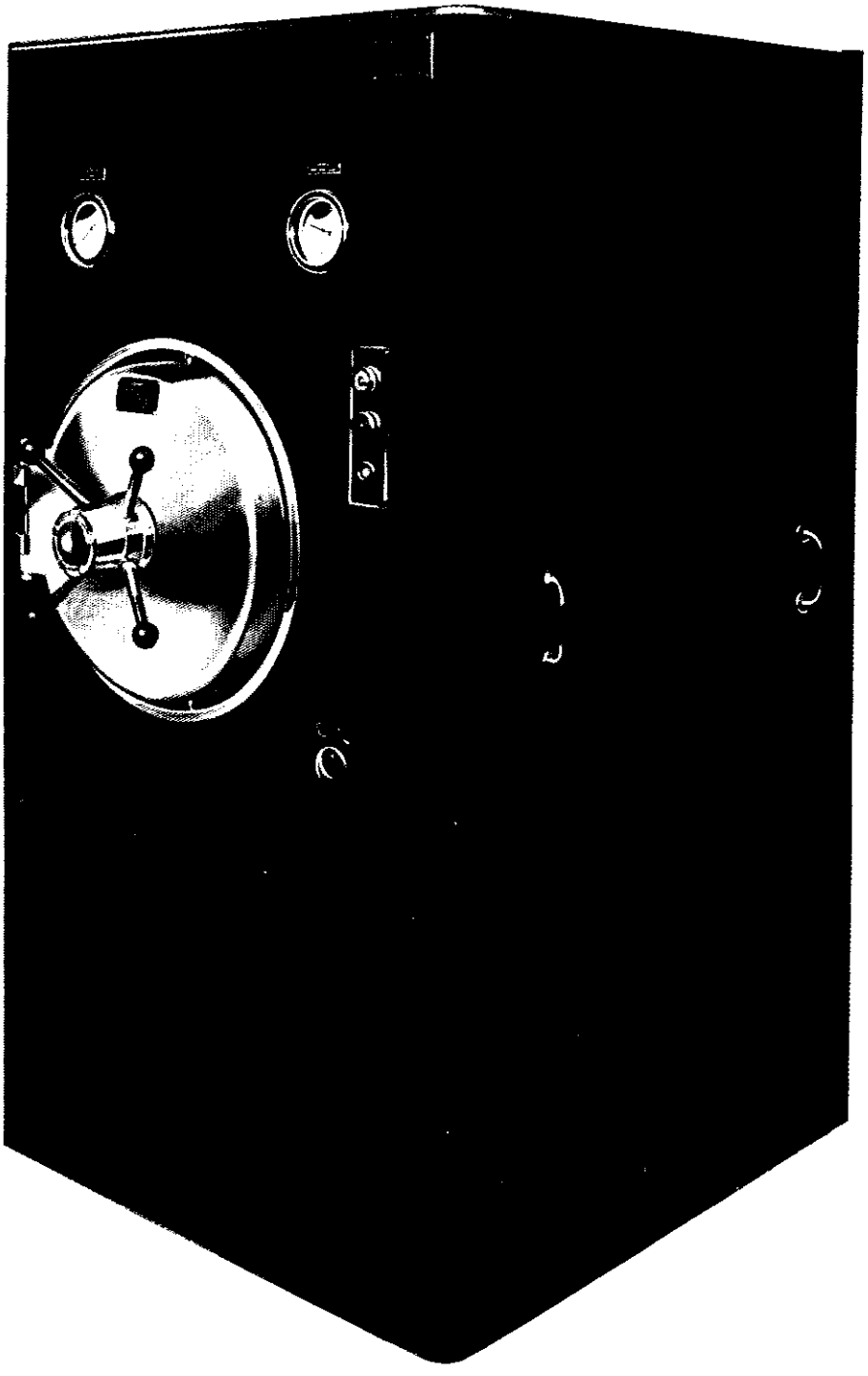

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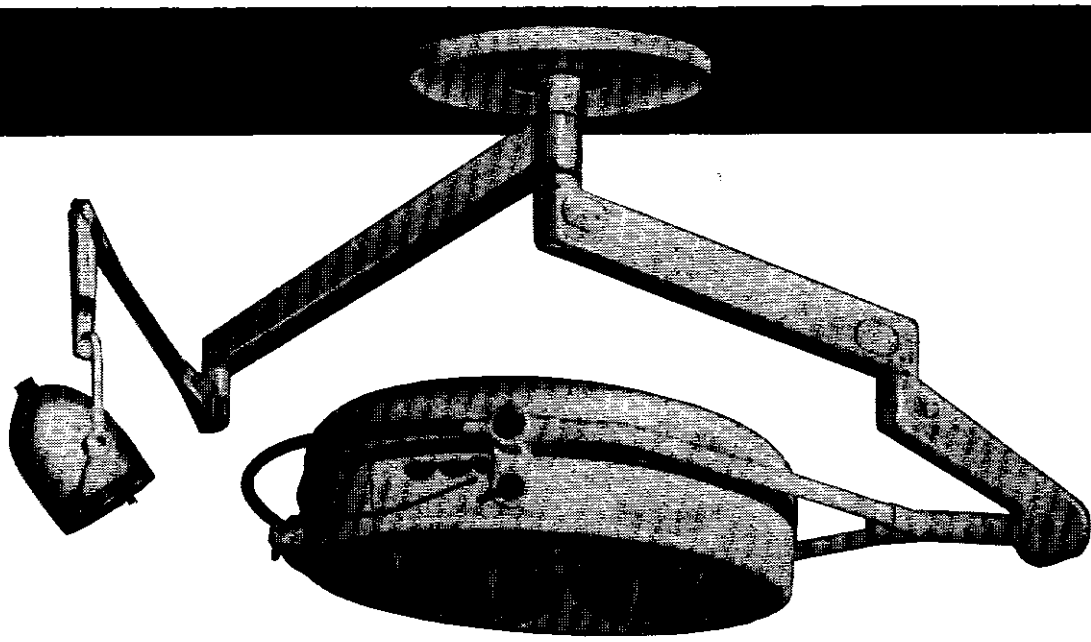

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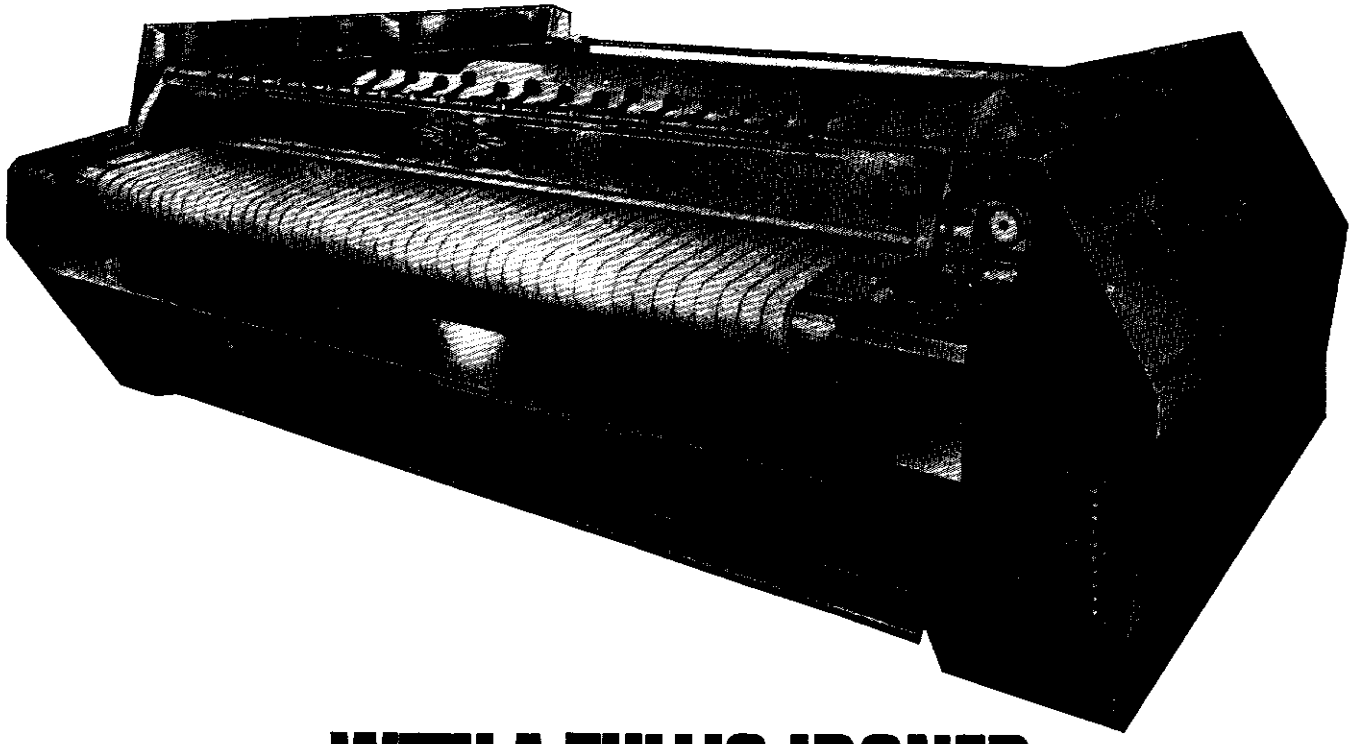

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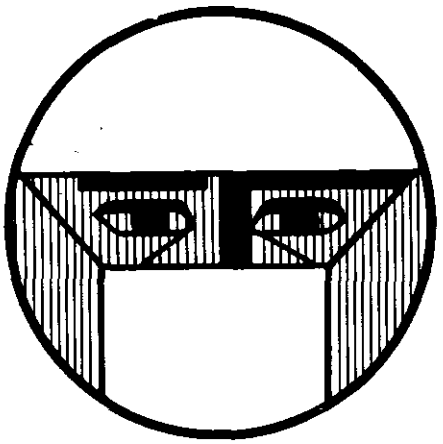

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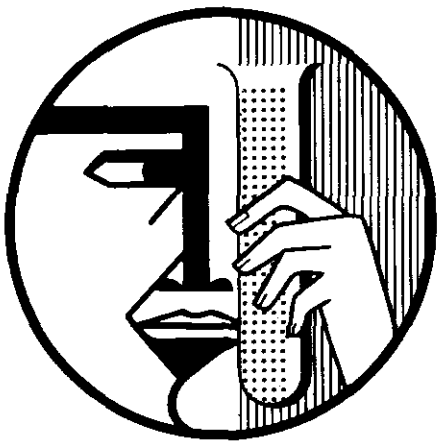

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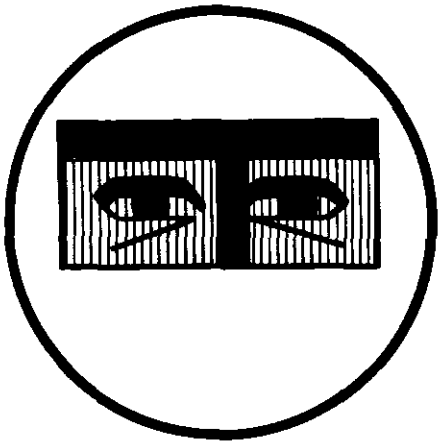

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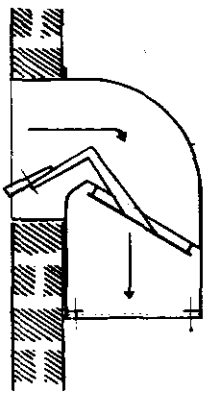

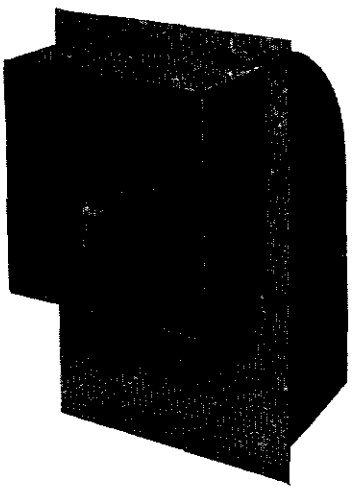

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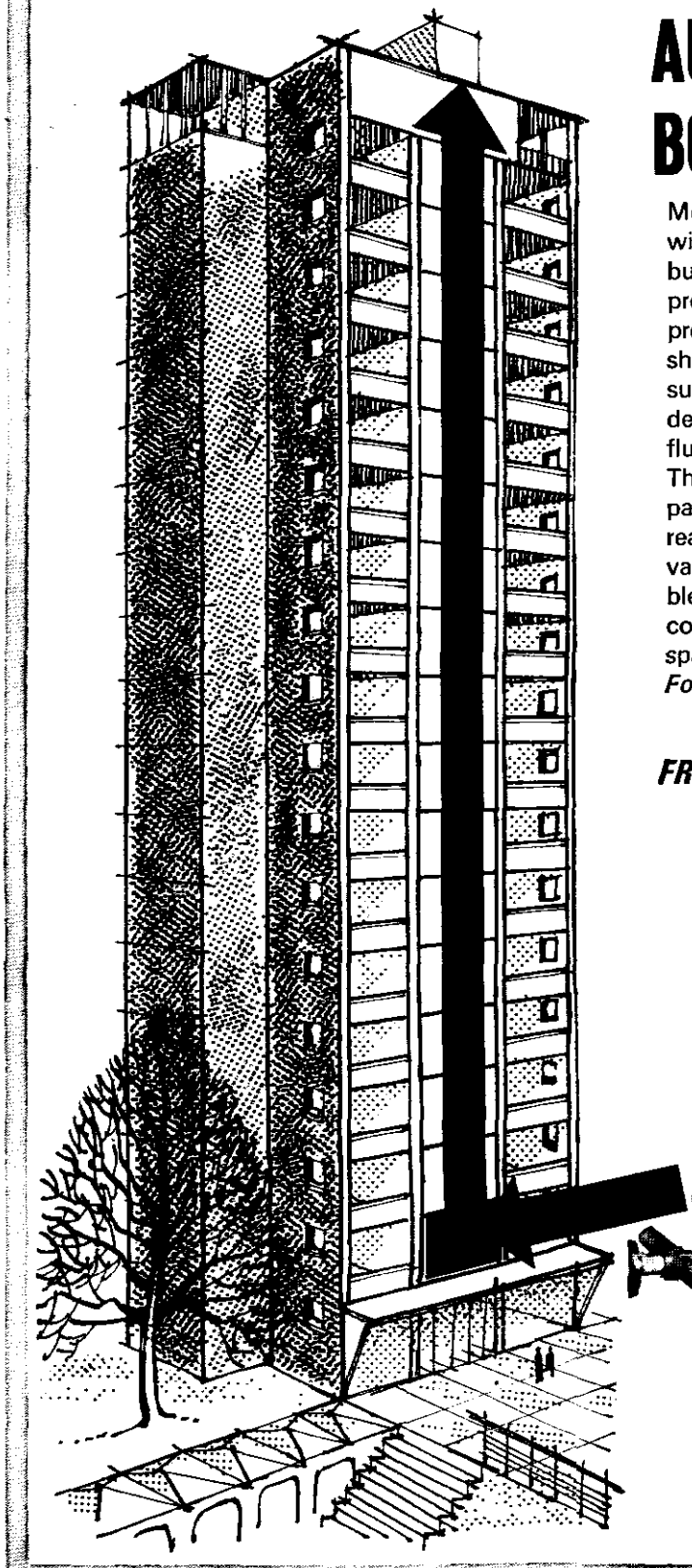

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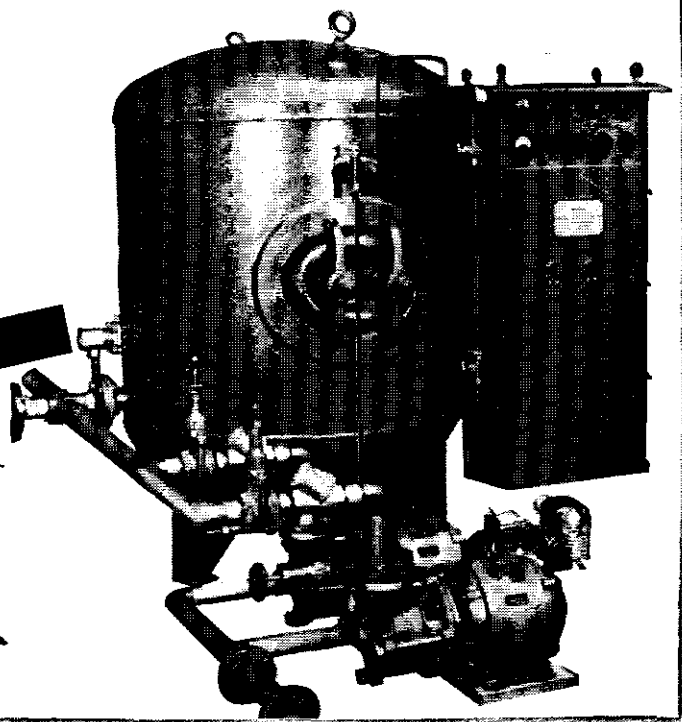

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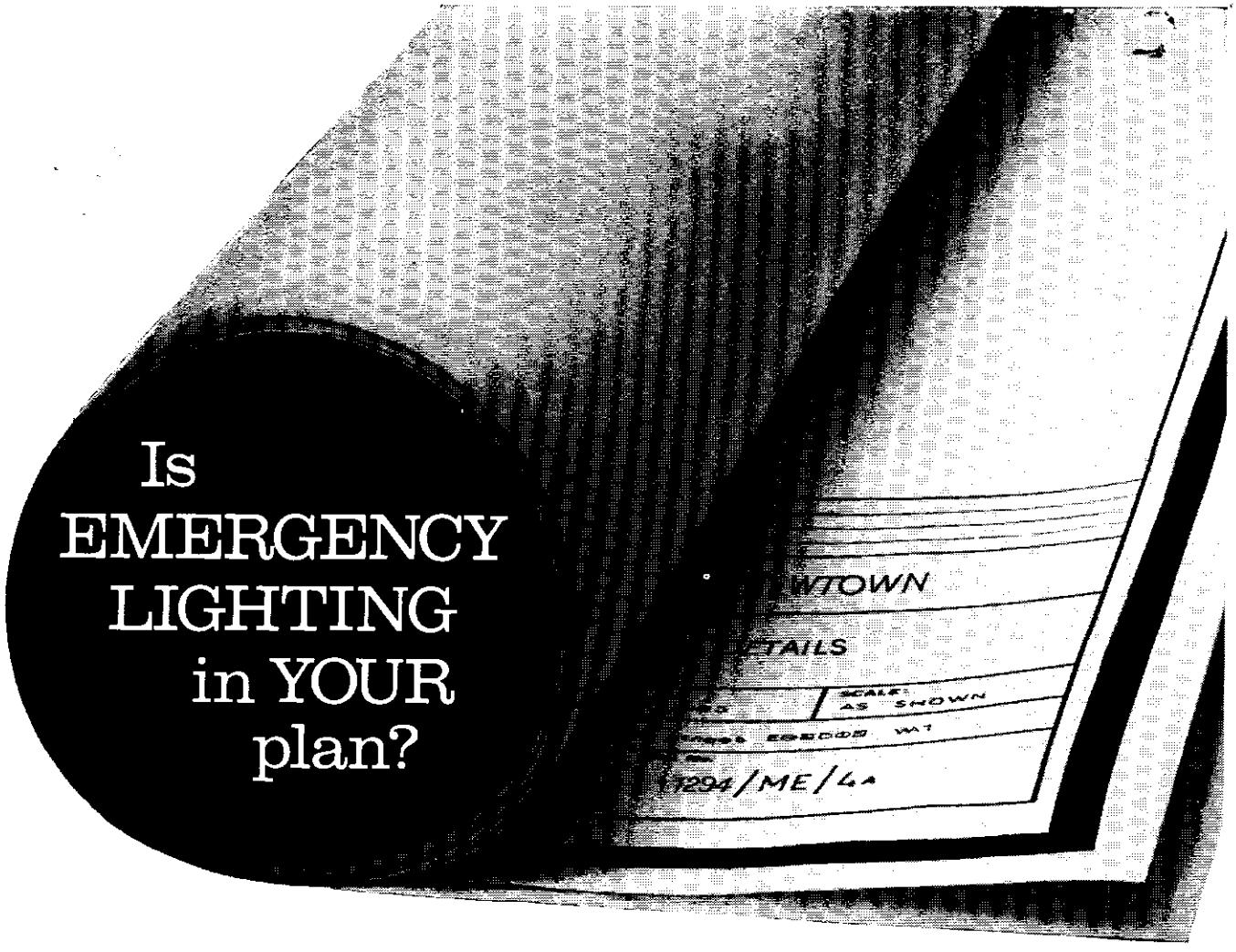

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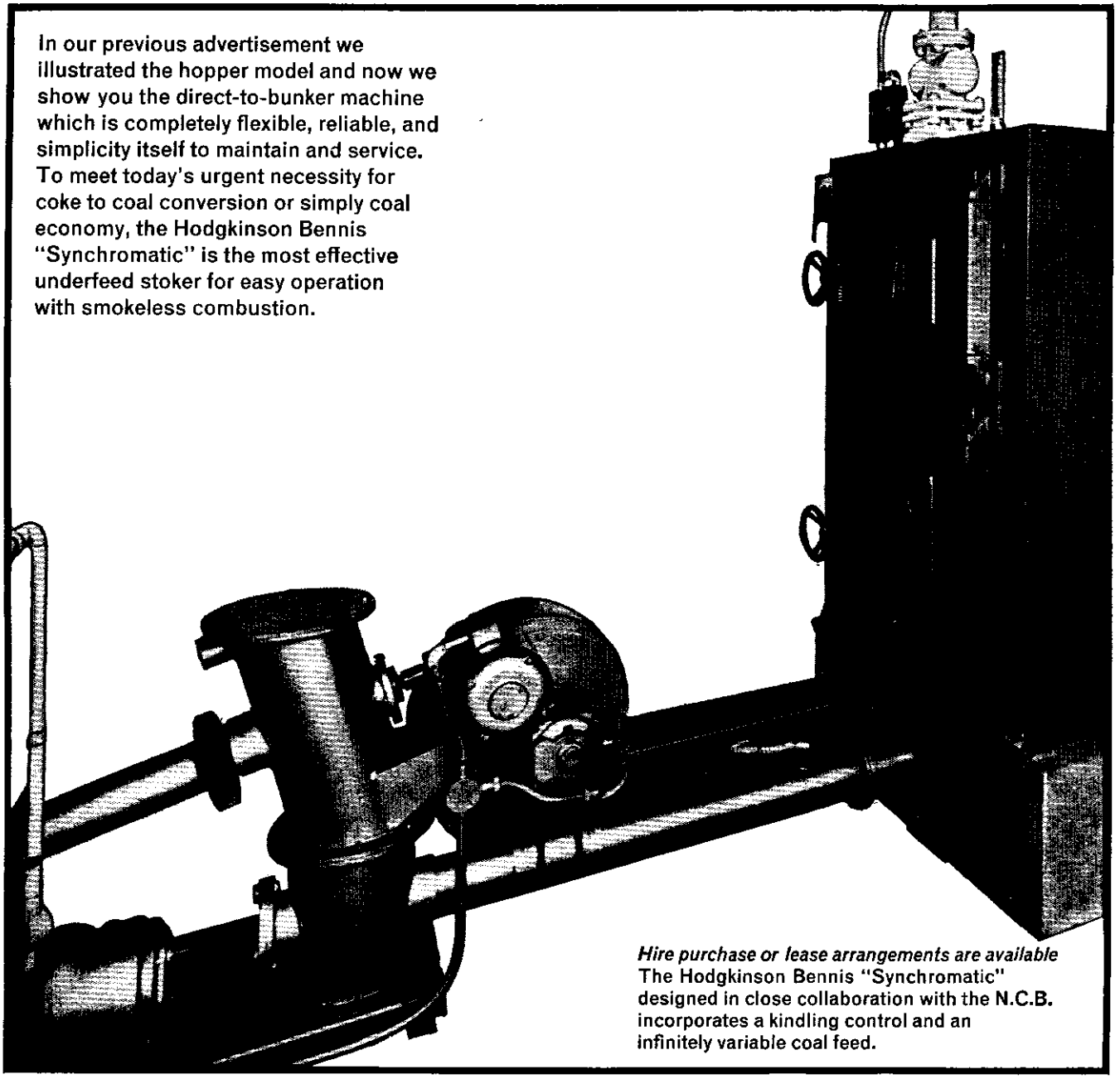

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THE HOSPITAL ENGINEER

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Volume XX: Number 4 July 1966

Transient Testing of a Pneumatic Servomechanism for Prosthesis Control

By R. P. BRANN, B.Sc., Ph.D.
and P. A. KIRKWOOD, B.Sc.
Department of Mechanical Engineering, University College, London

This new paper describes some fundamental work carried out recently towards the development of a servomechanism for use in the control of artificial limbs. It is one of the first contributions in a field still lacking in published groundwork.

SUMMARY

A LOW pressure pneumatic servomechanism was constructed and tests were performed to measure various system parameters and examine its closed-loop step response. The servomechanism incorporated a differential actuator and a Kiessling Roehampton valve. Feed-back from the actuator to the valve was in two separate forms:

(i) a light cable, pretensioned with a spring;
(ii) a light, rigid link.

The transient response of the system was investigated under various loading and feed-back conditions and comparisons were made with theoretical predictions. It is shown that the system appeared to behave in a manner predicted by linear theory, although there were some major discrepancies which were thought to be due to excessive friction and unsatisfactory valve characteristics.

INTRODUCTION

Statement of the Problem

A recent survey* of the application of engineering principles to the control of prostheses has concluded that future developments in the field will see sophisticated closed-loop systems used in the actuation of primary degrees of freedom of artificial limbs. At the present time it is thought that in high power locations, such as elbow joints, pneumatic power has most to offer, although it should be added that hydraulic power—with its associated background of advanced technology—would seem to be more suitable when certain engineering problems are overcome. Pneumatic systems, however, are being successfully employed at the present time for powering

*HALL, M. J., and LAMBERT, T. H. "Artificial Limbs—An Engineering Appraisal". *The Hospital Engineer*. Vol. XIX. No. 2. Feb., 1965.

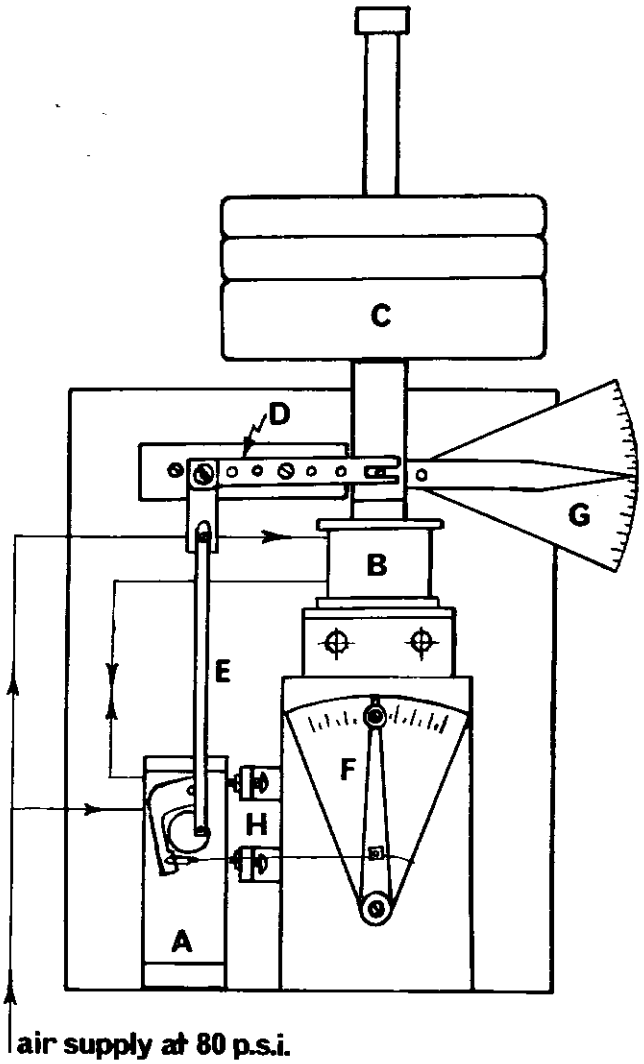

Fig. 1a. Layout of the system—

(a) Valve	(e) Feedback linkage
(b) Actuator	(f) Input scale
(c) Load	(g) Output scale
(d) Feedback lever	(h) Input stops

elbow flexion, wrist rotation and grip. These are essentially "open-loop" systems, however, and there seems to be a need at this stage to close the loop (that is to apply feed-back) so that accurate and relatively fast position control can be achieved.

Closing the loop of a low pressure valve/actuator system brings with it many fundamental engineering problems, one of which is a tendency for the system to perform self-sustained oscillations. Unfortunately, there appears to be a lack of published data in this field. This paper, therefore, represents the first steps in the development of a satisfactory technology on the subject which will lead, it is hoped, to the construction of a servomechanism for prosthesis control.

One of the specific purposes of the present work is to compare the behaviour of a suitable servomechanism with that predicted by a recent linear analysis.† The system is powerfully non-linear (in the mathematical sense) and it is essential, initially, to derive by experiment a qualitative assessment of linearity. Upon completion of this, one can then proceed to establish design criteria on the basis of more advanced non-linear mathematical analysis.

The Experimental System

Diagrams of the servomechanism are shown in Figs. 1 (*a*) and 1 (*b*), and a list of its relevant numerical parameters is given in an Appendix.

A differential actuator (whose piston area ratio is 2:1) is mounted on a vertical board and raises loads which are supported on its rod. The board can be inverted to allow the steady load to act in the reverse direction. Air to the actuator, from a constant pressure supply, is controlled by a two-way Kiessling/Roehampton valve. Feed-back from the actuator to the valve was accomplished, in the

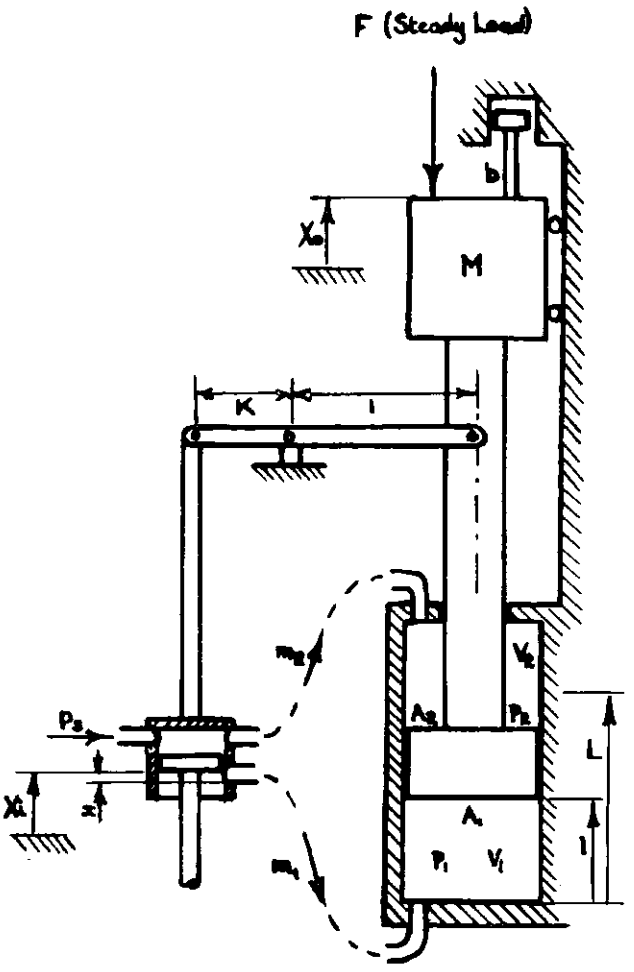

Fig. 1b. The system—schematic layout for theory and calculations.

†BRANN, R. P. "Linear Analysis of a Low Power Differential Actuator with Feedback for Prosthesis Control". To be published in *Control and Automation Processes*, Aug.-Sept. 1966.

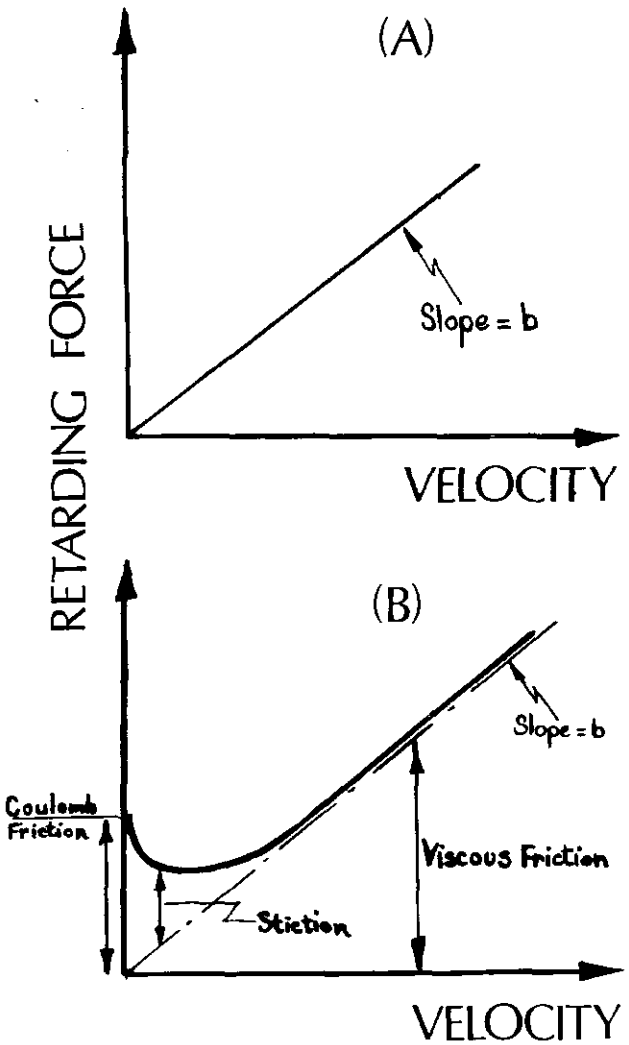

Fig. 2. Actuator friction characteristics—
(a) Ideal viscous friction.
(b) Typical real characteristic.

first instance, by a tensioned cable, which, when found to be unsatisfactory, was replaced by a rigid link. Variation of gain in the feed-back path is accomplished mechanically by a simple adjustment of a lever arm.

Amplitudes of input and output displacements were measured by means of graduated scales in some initial steady-state tests that were conducted. In the dynamic tests, however, a variable inductance transducer was used to pick-up the actuator's displacement and display it on a pen recorder.

ESTIMATION OF SYSTEM PARAMETERS

Friction coefficients

Despite taking elaborate precautions during the manufacture of the actuator to ensure longitudinal freedom of the piston in the cylinder, it was found that a considerable force was required to displace the piston. A high degree of surface finish was maintained on the cylinder bore and piston rod, and "Nu-lip" sealing rings (manufactured by Weston) were fitted to eliminate leakage. The whole system was lubricated with a molybdenum-disulphide based oil which was found to be more satisfactory than a recommended silicone grease.

The frictional characteristic of the actuator indicated that both Coulomb and viscous components were present. The first is a non-linear phenomenon, and its effect was not considered in the linear analysis referred to earlier. Viscous friction, however, is linear and can easily be included in a simple mathematical study of the system. It was found, in fact, to have a marked effect on the servo-mechanism's theoretical performance.

If it is assumed that the friction is ideally viscous, the retarding force can be expressed as ($b \times$ velocity of motion) where b is a constant. This is illustrated in Fig. 2 (*a*). When Coulomb damping is present, of course, the characteristic takes the form of that shown in Fig. 2 (*b*).

An estimation of the constant b was obtained by applying various loads to the free actuator and measuring the steady-state velocity of the piston. Typical displacement-time curves obtained with the pen-recorder are shown in Fig. 3. The velocity of the steady-state motion is

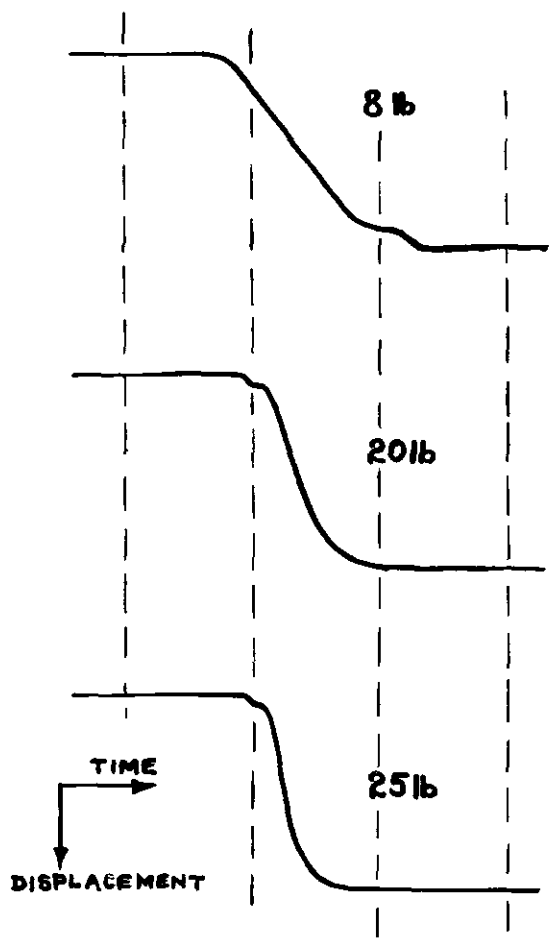

Fig. 3. Time histories of actuator piston falling under constant loads.

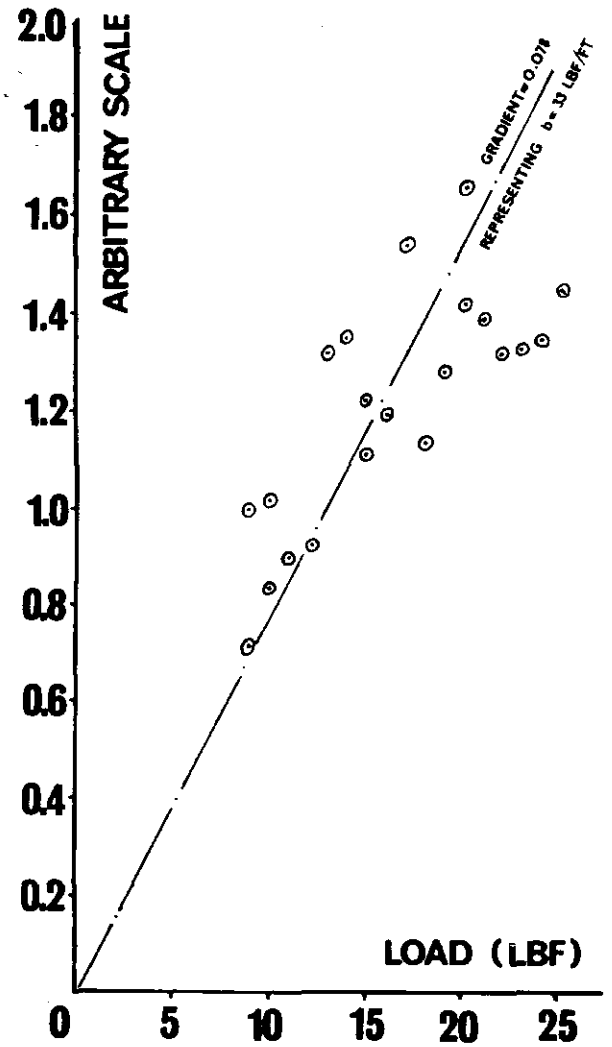

Fig. 4. Estimation of b, the actuator viscous damping coefficient.

the slope of the linear portion of a curve. From these results the graph of Fig. 4 was plotted. It can be seen that there is considerable scatter of results, but a fair line through the points gives a value for b of 33 lbf.sec./ft. This seems to be a reasonable value.

It should be mentioned, finally, that the minimum load under which the piston would just move was a little less than 8 lbf. This figure therefore represents the magnitude of the Coulomb friction force.

Valve characteristics

The rate of flow of gas through a valve is a function of valve opening and pressure differential across the ports. Variation of flow through the Kiessling/Roehampton valve was measured for various values of valve displacement and pressure differential. The curves can be seen in Fig. 5, where it will be noted that they all exhibit the following characteristics:

(i) A "dead zone". That is, there is no flow when the displacement is less than a certain fixed value.

(ii) Hysteresis. The curve which is measured when the valve is being opened does not coincide with that obtained when the valve is being closed.

(iii) Relative independence of pressure differential.

The first two characteristics make linearization of the valve's behaviour extremely difficult; the third, however, has the opposite effect, and lends weight to the assumption made in the theory that flow through the valve is a function only of displacement. Since the valve effectively is overlapped (as a result of (i) above) linearizing the effect of pressure differential is an impossible task. This can be seen from the following argument. If q, x and P represent flow, valve displacement and pressure differential respectively, we can write

$$q = \phi\{x, P\} \qquad (1)$$

where ϕ is some unspecified function. Now, on considering small changes of q, x and P, equation (1) may be rewritten as

$$\delta q = \frac{\partial q}{\partial x} \cdot \delta x + \frac{\partial q}{\partial P} \cdot \delta P \qquad (2)$$

where δq, δx and δP represent small changes of the variables. The term $\partial q/\partial x$ is simply the slope of the flow/displacement curve of the valve, and if the curve was linear, we could substitute $\partial q/\partial x = k_1$ where k_1 is a constant. Similarly, if the flow through the valve varied

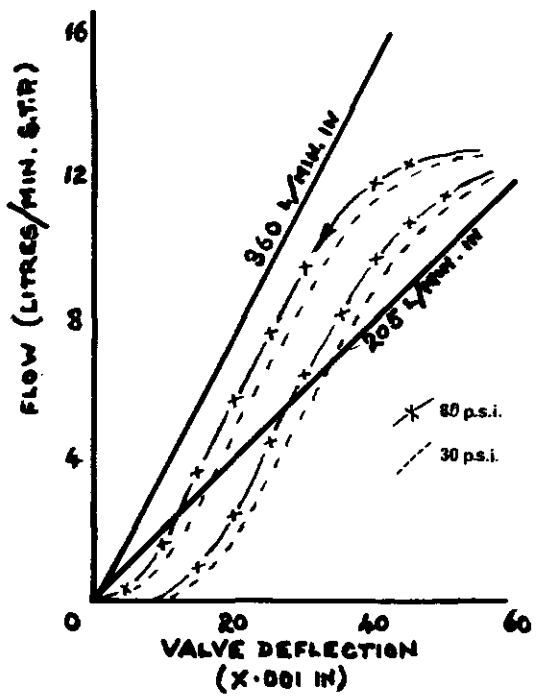

Fig. 5. Characteristic curves of Kiessling/Roehampton valve.

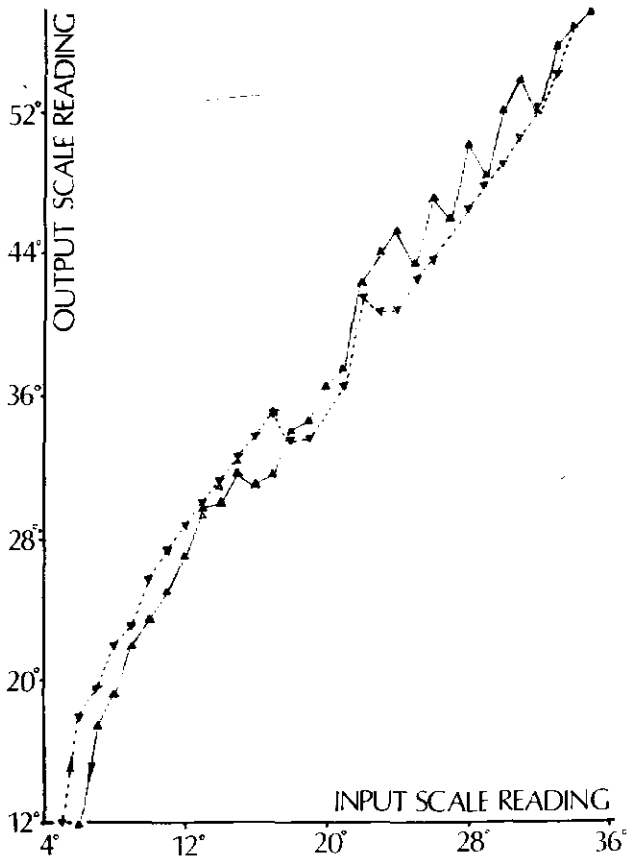

Fig. 6. System static characteristic (gain setting 3, no load, cable feedback).

linearly with P we could also write $\partial q/\partial P = k_2$ where k_2 is another constant. Thus equation (2) would become

$$\delta q = k_1 \delta x + k_2 \delta P \qquad (3)$$

Now, when $\delta x = o$, we see from equation (3) that $\delta q = k_2 \delta P$, which means that flow occurs even though the valve is closed. This means, explicitly, that the valve is underlapped. However, since a "dead-zone" exists in the measured characteristic of the Kiessling Roehampton valve, we must conclude that it is overlapped. Thus the linearizing process which led to equation (3) is meaningless when applied to the Kiessling Roehampton valve unless the flow is independent of P. That is, if the theory is to be meaningful we must take $k_2 = o$. The curves of Fig. 5 show that this is a reasonable assumption. They also show that if we are to take $\partial q/\partial x$ constant, we must approximate the characteristic to a straight line. For a characteristic of this type, the validity of a straight line approximation is open to conjecture. We can take a line parallel to the linear portion of the curve (360 L/min.in.) or a line which passes through the whole non-linear area of the characteristic (205 L/min.in.).

STEADY-STATE RESPONSE

In order to examine the steady-state response of the servomechanism, it was decided to apply displacements to the input of the valve slowly and in small increments, allow the system to settle, and then measure the position of the output. The results of such a test are shown in Fig. 6.

The feedback mechanism used in these tests was the pretensioned cable. It interfered with the dynamic response of the system in subsequent experiments, and was therefore replaced by a rigid link, but was satisfactory in these initial tests.

The response curve of Fig. 6 is not particularly satisfactory for it can be seen that the final position of the system's output was erratic and unpredictable, particularly at one end of the actuator. It is thought that this was due to the large amount of static friction in the actuator, and a random effect of the lubricant. Hysteresis is also present in the response, but this is to be expected in view of the unsatisfactory characteristic of the valve.

A phenomenon which was observed at high gain settings, when under heavy load conditions, was an extremely low-frequency relaxation oscillation, the period of which was about 5 minutes. This suggests leakage in the valve, or across the piston, although none could be positively observed.

DYNAMIC RESPONSE

Experimental study

Step displacements of small magnitude were applied to the input of the system and the resulting motions of the

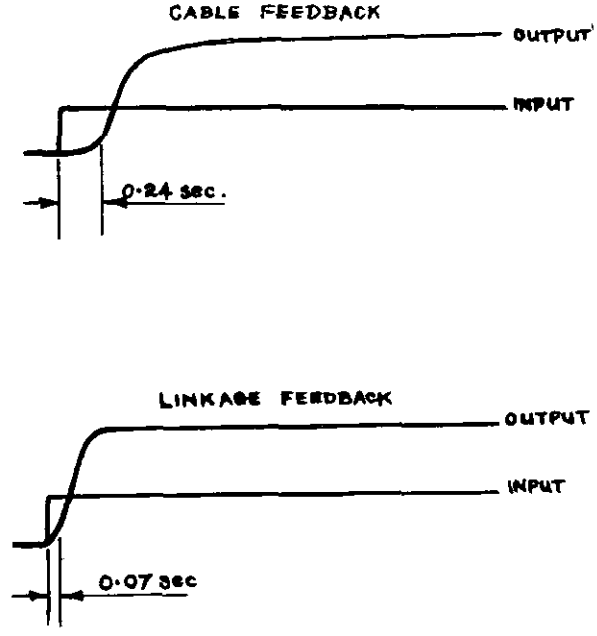

Fig. 7. Comparison of response using two forms of feedback.

output were observed on a pen-recorder. These tests were conducted with the system in various conditions, as follows:—

1. *Cable feedback*

The response was unsatisfactory with this type of feedback. This can be seen in Fig. 7, where the response is compared with that produced by a rigid feedback link. The cable appeared to slacken when a fast response was required and considerably slowed the system. Under certain conditions (when large steady loads were applied and when the step was in the direction of the load) the system with a cable link performed large, seemingly non-linear, overshoots. These were not observed when the rigid link was attached.

2. *Feedback gain settings*

Increasing this parameter produced two effects. (i) It decreased the magnitude of the steady-state output step, and (ii) it varied, qualitatively, the form of the response; that is, it changed the response from a sharp step at high gains, to dead-beat at lower gains as shown in Fig. 8. This is in accordance with basic linear theory. Although one would have expected to see the introduction of oscillatory components into the response at the higher gains, this was not the case. In fact, the system took on a marked oscillatory mode of response only when loaded. In this

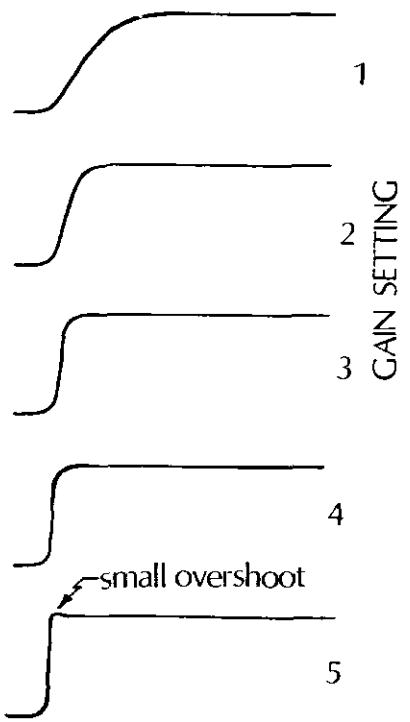

Fig. 8. Variation of output response due to increase of feedback gain—unloaded system.

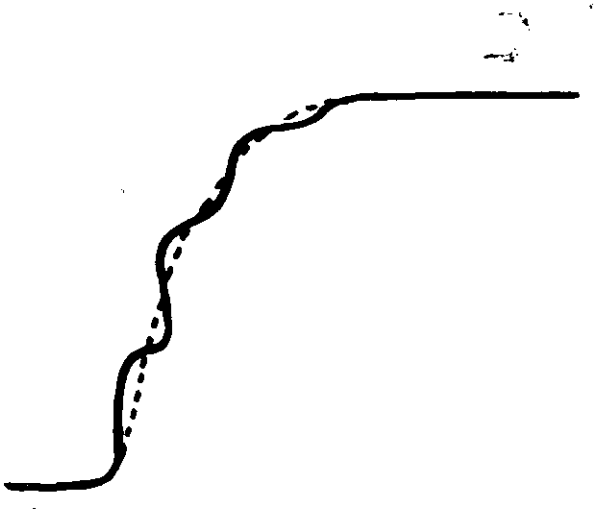

Fig. 9. Output response, when lowering 40 lb. The load is typical of a third order system.

condition, the response was typical of a third order system, a result predicted by linear theory. When oscillatory, the total response clearly consisted of a combination of an oscillatory component added to an exponential rise. This is illustrated in Fig. 9.

3. *Load*

The servo. was used to lift, and lower, various loads. The system therefore operated under a combination of inertia and steady-loads, as it would in a prosthesis. The form of the response (that is, either oscillatory or dead-beat) was found to be dependent upon the load, and was oscillatory at higher loads when lowering. There seemed to be a significant change in the response when the servo. was inverted and the direction of the steady load was reversed. Typical responses are shown in Fig. 10.

4. *Valve dead-zone*

This parameter was varied simply by pre-loading the input spindles of the Kiessling/Roehampton valves within the dead-zone range.* At very small values of dead-zone, the system responded with little finite time delay.† Upon increasing dead-zone, however, time delay increased and the response became more oscillatory.

Comparisons with theory

It is an easy matter to compare the response of the experimental system, qualitatively, with that predicted by simple theory. The servo. can be described by a third order differential equation of motion. The measured step response is typical of a third order system and shows, therefore, that in general the theory has some relevance.

*Dead-zone cannot be totally eliminated by this method for after a short period of about two hours, the O-rings in the valves appeared to harden, and dead-zone returned.

†Finite time delay was observed in every response.

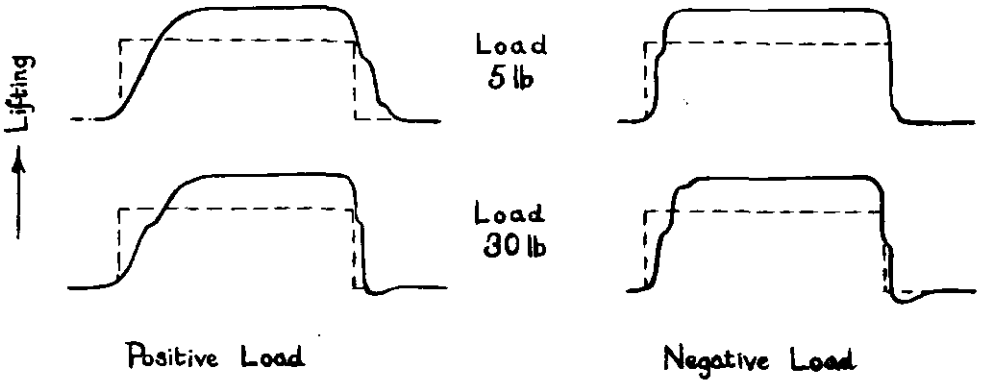

Fig. 10. Time histories of typical responses due to input pulses. The load is positive when the system is arranged as in Fig. 1.

In particular, the increase in the oscillatory component of the response with increased mass is predictable and lends weight to the theoretical assessment of the system.

Some factors were not predictable however. The most notable of these were

(i) finite time delay;

(ii) erratic steady-state response;

(iii) low frequency oscillation.

The first two were, no doubt, due to unsatisfactory valve performance and heavy static friction. The last factor proved to be difficult to eliminate, but was thought to be a combination of slow leakage in the valve together with hysteresis in the rubber O-rings.

CONCLUSIONS

The response of the system described here—which was built merely for initial experimental investigation—proved to be most encouraging. It would appear that such a system is applicable to theoretical analysis and behaves in a predictable manner.

Some improvements suggest themselves. These are concerned mainly with the valve and with friction in the actuator.

An ideal valve is one having a linear characteristic with underlap to the actuator (underlap to exhaust, although an advantage so far as stability is concerned, is unacceptable due to gas wastage) and being free from hysteresis The Kiessling Roehampton valve is far from this ideal. Although these valves have proved themselves worthy in open-loop prosthetic systems, it seems that they cannot be used in closed-loop form. The normal type of servo. valve using a sliding spool or plate may be applicable. Those at present on the market are too large for use in artificial limbs. There seems to be a need for the design of a miniature spool valve, similar in form to the Hendon valve. One which requires less power for actuation than the Hendon valve would be desirable so that it could be driven by a torque motor, thus enabling the feed-back loop to be an electrical signal.

Static friction in the actuator, although inevitable, must be reduced. In the past, where high pressure (greater than 1,000 p.s.i.) pneumatic control systems have been in use, a static friction force of say 20 lb. was negligible. If servo. systems of 100 p.s.i. working pressure are to be satisfactorily developed, it is essential that much effort be expended on the problem of piston seals. This is a difficult problem, for leakage cannot be accepted since it represents a power drain. The rolling diaphragm type of seal suggests itself, although it may prove unsatisfactory due to necessary restrictions on size.

A problem that was highlighted by the linearized theory, but which has not been mentioned so far, is dynamic instability. Because of the "softness" of the low pressure fluid, a closed loop servomechanism, heavily loaded, is prone to self-excited oscillations. The experimental system described in this paper proved to be stable because (*a*) it was not loaded near capacity and (*b*) the inherent static friction was so heavy. If such a system were used for elbow flexion of an artificial arm, the inertia load felt by the actuator would be extremely great. This would be a result of the high velocity ratio of the mechanism linking actuator to arm. Theory shows that instability occurs when the inertia load is large, so that this problem of self sustained oscillations could be met in a practical system. If it is, it may be avoided by increasing the viscous friction at the load which will, of course, put a power drain on the supply fluid. This is undesirable, and stabilization may only be achieved without power drain in a more sophisticated system having electrical feed-back links by suitable compensation techniques.

In all the tests carried out on the loaded servomechanism it was apparent that a faster response to a step input was obtained when the steady load was negative.‡ This agrees with the theory for in such a condition, it is predicted that the system should be more oscillatory. It is unfortunate that this is so, however, because in the application of

‡This means that the fluid in the low area chamber of the cylinder was opposing the steady load. Or, to be more explicit, the force F in Fig. 1 (*b*) was reversed.

elbow flexion of an artificial arm it is likely that the direction of the steady load will often change. Thus the speed of response of the arm to the input signal will depend upon the direction of desired motion, and this may be a hindrance to the amputee. A servo. comprising a balanced actuator would overcome this fault of course. However, this would then involve other complications such as three seals on the actuator instead of two and the necessary use of a four-way valve instead of a two-way valve.

APPENDIX

List of Numerical Parameters

Total stroke of actuator: 0·75 in.
Diameter of piston: 1·5 in.
Differential piston area ratio: 1 : 2
Fluid supply pressure: 80 p.s.i.

Feedback Setting	*Equivalent Open Loop Gain*
1	0·131
2	0·320
3	0·617
4	1·150
5	2·400

Accidents in Laundries

How they are caused and how to prevent them. Based on certain accidents notified to HM Inspectors of Factories.

Domestic type machines used in factories

THAT special problems arise when a machine intended for domestic use is introduced into factory production routine is well illustrated by the following accident.

A modern wringing machine of domestic type was in use in a large factory. Its function was to remove wrinkles from gloves made of asbestos fabric. A woman suffered severe hand and arm bruising and friction burns (requiring skin graft treatment) when her hand and forearm were drawn into the "nip" between the rubber rollers. At the time, a large mitt was being wrung, but the job was a usual one.

Whilst it is not known exactly why she got her hand in the "nip", it is certain that the trip mechanism provided as the standard safety device did not work, although the operator did attempt to operate the trip bar on being drawn in. Investigation revealed that whilst the trip mechanism was effective when thin materials were being wrung, the heavy pressure exerted between the rollers during wringing of thick materials made the trip mechanism extremely hard to operate. This was in spite of the maker's endeavours to attain fairly uniform trip forces throughout the full range of thicknesses of material for wringing. Another factor, however, was that infrequent lubrication and the presence of paint on a vital roller in the mechanism had considerably increased the resistance to tripping.

There are several important aspects of this accident. First, domestic equipment is seldom, if ever, suitable for factory use. Instead of working a few hours each week, the machine is subjected to heavy and continuous use. Large outputs are required as compared with domestic use and the machine is often subjected to rough treatment so that guarding arrangements which may be satisfactory in the home are not sufficiently robust for factory use. Maintenance is vital both in factories and at home, but even planned maintenance schedules are unlikely to cope with the attention required by a domestic machine worked far beyond its real capacity. Detergents can also play havoc with lubrication.

Whilst wringers are not so commonly used in factories as was once the case, they still exist, and it should be clearly understood that the in-running "nip" between the rollers is most dangerous. Fixed guarding with small apertures can often be applied successfully (to both back and front if the rollers reverse) when materials are thin. Should fixed guarding be impracticable, then an automatic device should be provided and properly maintained at all times and frequently tested. For machines in constant use on a restricted range of sizes of material, development of automatic feeding should be considered.

Caught in overhead shafting

In a laundry, sorted garments were dropped through a square hole in the floor into a chute which could be directed into either of two segregating bins on the floor below, the bins being raised above floor level for convenience of handling. A transmission shaft, driven by an electric motor, was supported by brackets fixed to the wall behind the bins, and the free end of the shaft, which projected beyond the end bearing, was only 18 in. from the edge of the chute and directly over one of the bins. The shaft was 2 in. in diameter and revolved at 250 r.p.m.

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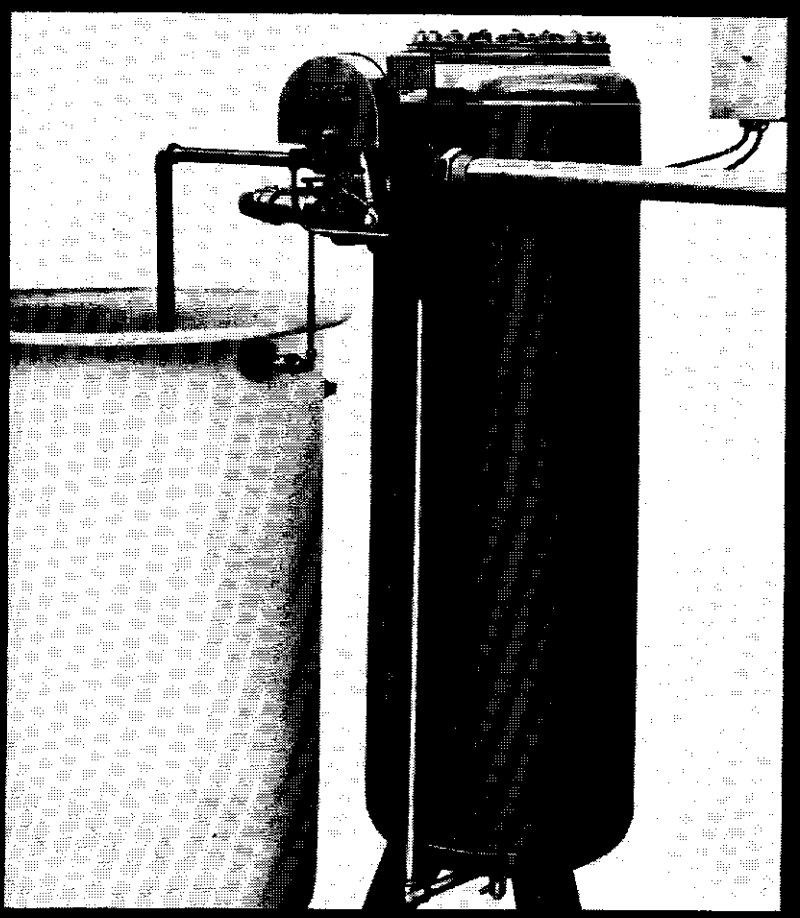

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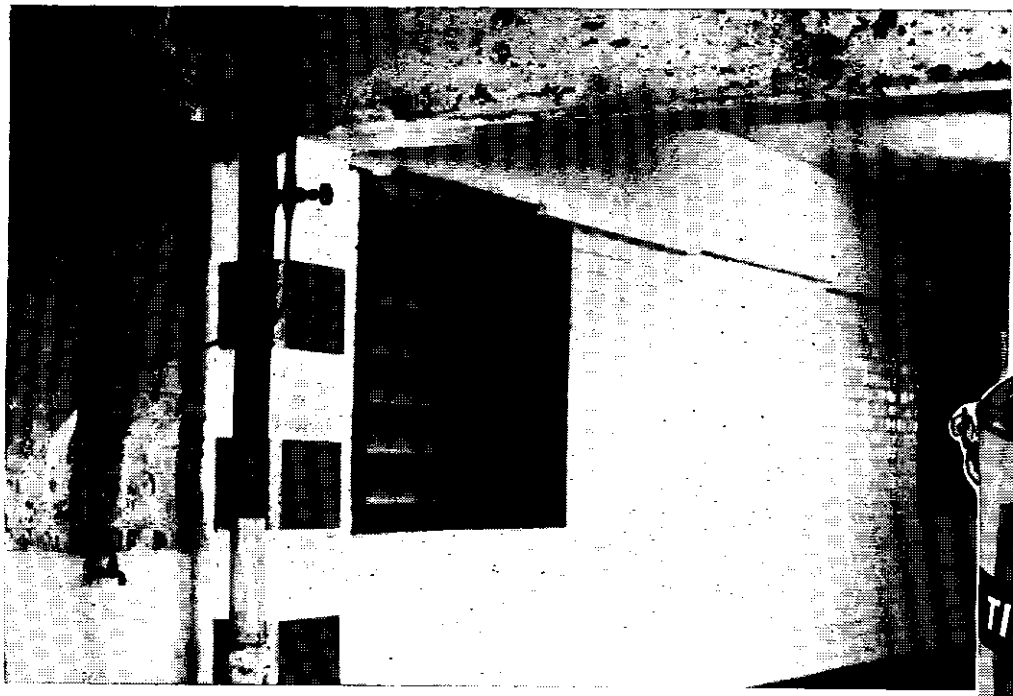
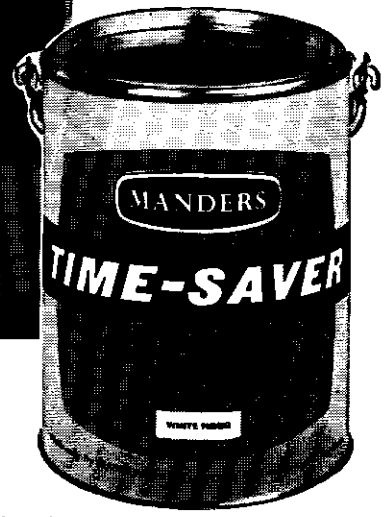


Photograph by courtesy o the Borough Surveyor, Mr. Arthur Hamilton B.Sc., M.I.C.E., M.I.Mun.E., A.R.I.B.A.



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During an exceptionally busy period, the garments had piled up in the bin and had jammed the chute. Seeing this, a sorter jumped into the bin and mounted the pile of garments in an attempt to free the blockage. She managed to clear some of the blockage including a blanket, the end of which fell on to the end of the revolving shaft. In trying to free it, she was caught in the folds and dragged on to the shaft. The blanket was old and broke fairly easily, releasing her, but she suffered a compound fracture of the arm.

Similar accidents involving entanglement on overhead shafting have been featured in previous issues of *Accidents* (see Vol. 5, page 4; Vol. 9, page 4 and Vol. 13, page 9), but despite repeated accidents and publicity, there remains an unfortunate reluctance to provide guarding, too much reliance being placed on a hopeful assumption that no approach will be made whilst the shafting is in motion. This accident serves, once again, to illustrate the futility of relying on safety by virtue of position, even in cases where any approach to revolving shafting is strictly forbidden. The possibility of approach in this case should have been foreseen. Protection against entanglement can be ensured only by the provision of secure guarding.

Hydro extractors

A hydro extractor installed in a textile mill was provided with a lid which was interlocked to ensure that the lid remained closed while the cage was in motion.

Unfortunately, maintenance had been neglected, with the result that the interlocking device was broken and the lid was fitting imperfectly. On one occasion, when material had been loaded into the hydro extractor by means of overhead chain blocks, the chain was left inside the machine under the lid when the hydro extractor was switched on. The chain was carried by the whirling cage and its contents until it wrenched off the lid, which struck an employee, inflicting head injuries. It was fortunate that the injuries and structural damage were not more severe. All process machinery and safety devices should be frequently inspected and effective steps taken to rectify any fault as soon as it becomes apparent and before the machine is put back into service.

Garment presses—limitations of two-hand control

In the absence of an efficient form of guarding, the principle of two-hand control has, for many years, been the accepted method of protecting the operators of garment presses commonly used in laundries and clothing factories; but experience has proved that this method is not reliable. Danger arises when more than one person is at such a machine. If a passer-by stops to talk to the press operator and stands close to the machine, or the operator is working the press with an assistant, the operator, when initiating the downward movement of the head, can easily fail to notice that the other person has a hand resting on the buck.

Considerable work has already been done, both by makers of the machines and users, in the development of effective trip guards, and advances have been made in the provision of fixed guards for various types of garment presses. Further development work is, nevertheless, very necessary, and it is important that there should be close co-operation between the machine makers and the users to ensure that the highest standard of safety is achieved whilst maintaining, so far as possible, the speed of operation of the machines. It should always be remembered that all persons who may be in the vicinity of the machine are at risk —not only the machine operator.

An accident occurred when a girl carrying clothes to a work-box walked between a garment press and the rail on which finished work was placed. She inadvertently placed her hand on the press table at the moment when the operator depressed the two-button control. The press closed on the girl's hand, and four fingers were so badly burned that they had to be amputated.

Unless two-button controls and their associated mechanisms are regularly and thoroughly maintained, faulty operation and the risk that the machine will operate with only one button depressed will arise. Two-button controls have been in use on garment presses for many years and probably many of them are in need of overhaul.

In some factories groups of similar scissor-type presses with two-button control are used in series. With such an arrangement a team of workers is employed and it is of prime importance that they should have a clearly defined operating drill, adhering rigidly to it under all circumstances.

A group of five presses was used for pressing shirts in a laundry. The presses were operated by a team of three women who also attended to a folding and packing machine. One woman operated the first two presses, another worked the three remaining presses and the third woman attended to the folding and packing machine. Near the end of an afternoon, when most of the laundry workers had finished and were moving towards the doors, the woman operating the first two presses had just put a shirt in one of them. At the moment when she operated the two-button control, another member of the team, due to a misunderstanding, attempted to remove the shirt from the press. When the press head descended her hand was trapped between the buck and the head, and badly burned. With commendable presence of mind, the other woman operated the "quick release" button which raised the head to release the woman's hand. Had this not functioned perfectly the injury would undoubtedly have been more severe.

*Reprinted from *Accidents*, published by H.M.S.O.

Static Electricity—Fire dangers and how to avoid them

PREPARED BY THE FIRE PREVENTION ASSOCIATION, QUEEN STREET, LONDON, E.C.4.

Most people have experienced the effects of static electricity at one time or another. The crackling noises from clothes when they are taken off—and their tendency to stick together—is one example; static is also the cause of the unpleasant shock sometimes felt when getting out of a car. These effects, it may have been noticed, are particularly common in dry weather. The accumulation and subsequent discharge of static electricity can also have more dangerous consequences. Unless suitable precautions are taken, static electricity can accumulate in the course of many industrial processes to the point where a discharge may occur. And the discharge, if it gives incendive sparks, may cause a fire or explosion if flammable materials should be present.

TO understand the circumstances in which static is likely to accumulate, and to appreciate the precautions which can be taken against this accumulation, it is necessary to understand a certain amount about the nature of the phenomenon. Static electricity results from the disturbance of the surface electron structure of the material concerned—a deficiency or surplus of a single electron among 100,000 atoms gives a strong static charge to a surface. These surface disturbances can be created in many ways, but all involve movement of some kind; they can result from friction or induction or simply from the contact and separation of materials. When two materials are brought into contact with each other a transfer of electric charge almost invariably occurs between them. Practical effects are not noticed until the materials are separated from each other, liberating opposing molecular forces. These forces appear as charges on the two materials involved, the charges being positive on one material and negative on the other. But if a material is an earthed conductor, the charge will flow away so rapidly after separation that it cannot be detected.

On the other hand, if the material is a non-conductor or a perfectly insulated conductor, the charge cannot leak away or "relax", and it remains locked on the surface. It is because it is unable to flow that the charge is referred to as "static" electricity. And for each static charge it must be remembered that there is an equal and opposite charge usually nearby or "grounded".

How Static Electricity Accumulates

It is not possible to prevent the generation of static, and this generation is not, in itself, a hazard. The danger only comes when the static accumulates sufficiently for a discharge to occur. For static to cause a fire or explosion, four factors are therefore necessary:

A source of static generation;
A means of accumulating the charge;
A discharge providing sufficient energy to cause ignition;
An ignitable mixture of gas, vapour or finely divided solids in air or oxygen.

There are many industrial activities where all four of these conditions might be met. They will be present during the storage, transport and handling of flammable liquids; in the manufacture, handling and storage of fibres and dusts; in the storage, mixing, compression and discharge of gases and vapours; during painting and coating work, and while materials are being impregnated or affixed in the presence of low-flash-point solvents; in the course of operations involving the mixing, grinding and sieving of solids. Other situations where these conditions may be present are in moving vehicles, in dry cleaning operations and in hospital operating theatres.

Continuous flow operations and high operating speeds, using belt, pneumatic or hydraulic conveying methods increase the generation of static. Plastics are usually very poor conductors of electricity and may permit static charges to build up on their surface unless specially treated.

Ways of Dissipating Static

The most practical way to avoid danger from static is either to prevent the accumulation of a charge by providing a conducting path to earth or between the affected

materials, or to discharge the electric accumulation at a point known to be safe. Four main ways of dissipating static are in common use.

Bonding

The term "bonding" is used to describe the connecting together of two or more conductive bodies by means of an electrical conductor. Bonding minimizes potential differences between conducting bodies.

Earthing or Grounding

Conducting bodies are said to be "earthed" or "grounded" when connected to the ground by means of an electrical conductor. Grounding is used to minimize potential differences between bodies and the ground. Most of the resistance of an earthing circuit is at the ground end between the ground rod and the soil; it will vary according to the amount of moisture present, the nature of the soil and the contact area. Making adequate contact can prove a problem in some dry areas.

Humidification

Materials such as wood, paper and fabrics—very poor conductors by themselves—will contain a certain amount of water in equilibrium with that in the surrounding atmosphere. Their conductivity will therefore depend on the amount of moisture in the air, usually referred to as the relative humidity. This can vary from 0 per cent (absolutely dry) to 100 per cent (saturated). If the relative humidity is high (60 per cent or above), the amount of moisture in the materials will probably make them sufficiently conductive to prevent the accumulation of static. On the other hand where the relative humidity is low (30 per cent or less), these materials become good insulators and can accumulate static. The ease with which some fibres conduct electricity varies very greatly with the relative humidity. At 90 per cent relative humidity their conductivity can be a million times greater than it is at 10 per cent relative humidity.

Certain materials—such as nylon, terylene and acrylic fibres—would need a relative humidity of more than 90 per cent to avoid static. These fibres can be treatedwith antistatic agents, but their effect is only temporary and is destroyed when the fabrics are washed.

If it is intended to keep the atmosphere within a building at a certain humidity, allowance has to be made for the fact that the relative humidity of air decreases as it is heated. For example, air of relative humidity of 90 per cent at 32°F. will have a relative humidity of only 20 per cent when its temperature is raised to 70°F.—and will be drier than the air normally is over the Sahara desert. So, if air from outside is taken into a heated building during winter, moisture will have to be added to maintain a high relative humidity.

Air conditioning systems can be used to maintain the relative humidity within a building at the desired level. In some cases, however, humidification is not practicable owing to its effects on the materials being handled. And in hot areas high humidity can make conditions intolerable for personnel.

Where humidification of the air is only necessary at one particular point in a process, localized humidification can be achieved by impinging steam jets on specific areas.

Ionization

Ionization means splitting the molecules of oxygen and nitrogen in the air into positively and negatively charged parts (ions), making it electrically conductive. In this way air can be made sufficiently conductive in the area where the static is being created in order to allow the charge to leak away. There are four ways in which ionization can be achieved:

1. Radiation

   Radio-active isotopes can be used to emit ionizing rays. These can present a health problem, however, and expert advice is necessary.

2. Electrical neutralization

   An ionized atmosphere can be produced near the charged surface by applying an external potential. This method should not be used where flammable vapours, gases or dusts may be present.

3. Static comb

   This usually takes the form of a metal bar with a number of teeth with needle points; alternatively, a metal rod with trailing tinsel streamers may be used. The comb is brought close to the charged surface and a high potential is set up at the needle points by the static charge—this is sufficient to ionize the air locally and permit the charge to bleed away.

4. Flame ionization

   This method obviously cannot be used where flammable liquids, vapours or dusts are present. It is used in paper-making to disperse static which would otherwise cause sheets to adhere and make subsequent processing difficult. A surface charged with static can therefore be passed rapidly through the flame or very close to it, and the static is dissipated, since an open flame produces ions due to its high temperature.

Special Methods

Various other ingenious methods have been devised for combating the hazards of static electricity. Many insulating surfaces can be made more conductive by coating or impregnation with a suitable film. Metallic oxides, metals, carbons, aqueous compounds and wetting agents have all been used for this purpose.

Carbon black is frequently used as an additive to materials to control their conductivity, and is particularly useful for making conducting rubber footwear and tyres. It has also been used to produce a rayon yarn containing about 30 per cent of carbon black. Although this weakens the thread, it makes it an effective conductor, and one or

two such threads per inch in a fabric are sufficient to confer suitable conductive properties on the whole material. A 33 per cent 67 per cent rayon/cotton fabric with some of the rayon threads treated in this was has been commercially produced for certain applications.

One idea produced to overcome the static caused by rollers has been to make the roller of a series of alternate segments, each imparting opposing polarity. The surface of the material passing the roller would then emerge with a number of static "stripes" of positive and negative charges of roughly equal strength which would easily be neutralized and would not build up to a high degree.

Danger Areas for Static in Industry

The explanation of the static electricity phenomenon will have suggested a number of points where fire dangers could arise in industry. Some of these—and corresponding precautions—are discussed in the following paragraphs.

Flammable liquids

Low-flash-point liquids may give rise to flammable mixtures of vapours and air when they are being handled or stored. Static is generated when liquids are in motion—for example, while they are being pumped, mixed, blended or stirred—and a hydrocarbon air mixture can be ignited by a spark energy as low as 0·2 millijoules.* Oils are poor conductors; but since they do not all have the same conductivity, some will accumulate static and others will not (this also depends to some extent on the presence or absence of impurities).

As a stream of hydrocarbon liquid flows into an earthed conductive tank, the static charges in the liquid tend to flow to the surfaces of the liquid. If the charging rate is high, it is possible that the potential difference existing at the surface may break down the resistance of the air and cause an incendive spark between the liquid surface and the tank wall or between two waves on the surface of the liquid.

Turbulence in bulk storage tanks should therefore be kept to a minimum, and for this reason overhead filling should be avoided. The inlet nozzle should be near the bottom of the tank and should be mounted horizontally to minimize agitation of the material at the tank bottom. The pumping speed should be restricted to a low value (say 3 ft./sec.) and special care is necessary until the inlet nozzle is submerged at least several feet below the surface.

Explosions have taken place when hydrocarbons were pumped too fast before the inlet nozzle was submerged. In general, the hazard is less severe in tanks with floating roofs than in those with fixed roofs, on account of the elimination of free vapour space above the liquid surface. The roof floating on the surface of the liquid also provides additional dissipation area for the static charge migrating from the liquid.

*For comparison, the human body can accumulate a static charge capable of giving a 10 millijoule spark.

All piping, tanks, pumps and other equipment must be properly bonded and earthed.

Road tank vehicles carrying hydrocarbon liquids may be in danger from static electricity unless correct precautions are taken. The static can be generated both by the filling operation and by the action of the rubber tyres when travelling at speed on a dry road. The tank itself is, of course, highly insulated from the ground. What happens is that the static on the surface of the liquid in the tank attracts an opposing charge to the inside of the tank walls. This in turn leaves an unbound electric charge on the outer surface of the tank walls; this charge on the outer surface is of equal magnitude to, and of the same polarity as that in the liquid. Whilst the liquid remains in the tank these charges are bound, and will not be released by earthing. When the tank is emptied, however, the removal of the charged liquid (and consequently of the opposing charge on the inside wall of the tank) leaves the charge on the outer surface of the tank unbound.

This type of charge can give an incendive spark when seeking earth—for example, when the empty tank is next opened and a delivery hose inserted—and is suspected of having caused a number of fires. The tank should therefore be earthed to drain away the charge before the filling port is opened or any connection or delivery nozzle is inserted; straps or chains hanging from the vehicle cannot be relied on to disperse the static. All filling hoses and piping should incorporate continuous bonding.

Similar bonding and earthing precautions against static should be observed in the case of rail tankers, portable containers, barges and aircraft whenever fuel is being transferred.

Dusts, powders and granular materials

The surface area of solids is increased enormously when they are finely divided. Since combustion of solids is essentially a surface reaction, this means that the ignitability of a solid is also greatly increased when it is in finely divided form. Some dusts require only very low energy for ignition (as low as 5-10 millijoules) and, once ignited, many finely divided materials burn with explosive violence. Since static can be generated by operations such as grinding, sifting, blowing, fluidizing and pouring, all equipment used for such processes should be bonded and earthed. If the divided material is not a good conductor it may be some time before the charge is dissipated even by earthed equipment.

Materials in powder form are usually very convenient to use in industrial processes, since they are easy to handle and they disperse, dissolve or react rapidly. The powder is usually supplied in sealed containers or bags which keep it dry and prevent caking. There is now a trend towards using bags or inner liners made of a plastic material; fertilizers and paint pigments are examples of powdered materials often packed in this way. Since it is possible that a dry powder being poured from a non-conducting package lining could give rise to a spark discharge, this

form of packaging could result in a fire danger if the dust is combustible or flammable vapours are present in the area in which it is discharged.

Gases

Only a very low spark energy (less than 0·02 millijoules) is required to light some gas/air mixtures. Gases themselves, when pure, usually generate little static; but a gas contamined with impurities such as rust or water may generate static as it leaves a nozzle. The main danger, however, is that a flammable gas/air mixture will be ignited by a discharge of static from some other material in the vicinity, and the obvious precaution is to keep such mixtures well clear of any object that could provide a static discharge. Gases themselves should be kept as pure as possible to minimise the risk of their generating static.

Other processes

Static should be grounded by means of static eliminators and the frames of machines should be bonded and grounded. Humidification may be used if it is not injurious to the process, and adequate ventilation should be provided to remove dangerous accumulations of flammable vapours.

All power transmission or conveyor belts should be fitted with static collectors, and these should be mounted so as to bleed off any static at a distance of 4-6 in. beyond the separation point of pulley and belt, on the inside face of the belt.

Hospital operating theatres

Stringent precautions against the possibility of static sparks in operating theatres are essential on account of the presence of flammable anaesthetic gases. Accidents have occurred while ether was being used as an anaesthetic.

The breathing bag must not generate static while expanding and contracting. Any blankets or clothing used during operations must also be prevented from generating static—this can usually be achieved by means of adequate humidification. As an extra precaution, theatre personnel should not wear clothing made of synthetic fibres, nor wear rubber-soled shoes. Trolleys and equipment used should either be mounted on conducting tyres or be soundly earthed, and the floor of the theatre should be of conductive material; floor maintenance compounds used on it should also be conductive.

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How noisy can a noise be?

By DAVID WILSON

This article reviews the growing problem of noise and describes the research work into noise now being carried out in the United Kingdom.

NOISE is generally reckoned to be one of the curses of modern industrial civilisation. Britain's National Physical Laboratory (NPL) has found that it interests the public more than any other as a subject for scientific research and has recently launched a major research programme into noise. It involves several of Britain's biggest laboratories and research stations.

Noise can be defined as "sound unwanted by the hearer." If this sounds unscientific, the reason is that noise itself is an unscientific concept.

Noise is subjective. What is a dreadful scraping to one man is serious music to another; the music of one race may be just noise to men of another culture; the roar of a motor cycle is a thrilling noise to one, a shattering of the peace to another.

Even in scientific terms this contrast holds true—sound at one frequency may be objectionable to one hearer, but acceptable to another, and at any one frequency different people will find different levels of loudness objectionable or even intolerable.

It is therefore impossible to measure "noise" by a set of units in the way we can measure length or electrical charge. The best the scientist can do is to set groups of people in well-defined surroundings, to project steady, single-frequency sounds at them at different levels of intensity and then to build up an artificial scale of loudness by taking the reactions of the majority of the hearers.

In this sort of work the NPL is one of the foremost establishments in the world and an internationally-

accepted scale of correlations between intensity of sound and apparent loudness has been built up. But the difficulty of the problem is illustrated by other research done in Britain. This has shown that, in a noisy situation, at least 15 per cent of people are quite undisturbed by an extra noise that the rest find intolerable.

Nevertheless, noise is a social problem. People want "something done about" things such as pneumatic hammers and jet airliners and roaring motor cycles and lorries. For a society to tackle this, it must consider prohibiting or limiting such nuisances. The problem is how to set legal limits to something so difficult to measure.

Scientists can, however, work towards the same type of achievement as the measurement of loudness. They can produce a generally acceptable set of rules. This sort of work is being pursued in Britain, mainly at the Building Research Station near Watford, Hertfordshire. The scientists are, at the moment, concentrating on pneumatic drills or hammers with their attendant air compressors which are usually powered by diesel engines mounted on lorries or trailers. Sets of rules are being worked out by measuring the sound intensity of the pneumatic drill with microphones placed at precise distances while the drill breaks up a specified area of standard concrete. From this basis it is possible to measure the effectiveness of various types of muffles or noise suppressors which have been made for fitting to the drills and machines.

Similar work has been done by the Motor Industry Research Association and NPL, to establish standards of noisiness for motor vehicles. Again, the best that could be done was to set up a test situation in which the car or lorry has to be driven in a certain gear at a certain rate of acceleration in an open place (to avoid the complications of sound being reflected from buildings). The sound is measured by microphones in a set arrangement and the sound intensity at certain frequencies correlated with what juries of people found "noisy," "quiet" or "intolerable." On this basis it is possible to set legal limits to define a vehicle which is so "noisy" as to be a public nuisance.

Another group of research projects deals with trying to reduce the inevitable noise of a modern industrial civilisation. The basis of the work is a question—"Are conditions getting noisier, and, if so, in what way?"

In London what is believed to be the world's first attempt to answer this question on a large scale has been started—an attempt to draw a noise map of the city and to see how it changes over the years. A grid of imaginary lines is placed over a map of London to establish a set of points. Then mobile noise laboratories are stationed at each point in turn and they record the noise at particular hours of the day or for the whole 24. The tape recordings are later analysed for the levels of intensity and the predominant patterns of frequency and loudness are isolated. This work has not been going on long enough for conclusions to be drawn.

Insulation against noise is one of the biggest fields of work of the Building Research Station. Scientists have built up an immense basic knowledge of the sound transmission characteristics of most commonly-used building materials. They have built up similar knowledge of how the architectural construction of different types of buildings can best be managed to reduce unwanted sounds.

One of their most interesting experiments was to find a method of sound-proofing a modern house against aircraft noise, a problem in houses near the runways of London Airport.

They found that putting another layer of glass in the window spaces, leaving a gap of several inches of air as an insulator between the two layers, achieved the required reduction of noise. The only problem then was to find some method of ventilating the rooms without knocking another hole in the wall for a fan that would let the sound in again. Eventually a normal commercial model was found to do the job.

But noise control costs money. Reducing the noise from a jet engine or a pneumatic drill by a baffle or silencer also reduces the efficiency of the machine. Even though it may be only by one or two per cent the machine becomes more costly to run. Defence against invading noise in buildings can be achieved, but it means more careful construction, and materials that usually cost a bit more. Almost any reduction in noise can be achieved if you are prepared to pay for it.

Some of the equipment required for noise research can, itself, be quite expensive. The Building Research Station has just completed one of the finest "anechoic" chambers in the world (*Spectrum* 10). This is a room more than 30 feet (9 metres) in every direction, in which the amount of reverberation or echo is reduced to an absolute minimum. Floor, walls and ceiling are covered with thin wedges of plastic foam only a few inches (centimetres) square at their base but more than two feet (60 centimetres) long—more than 20,000 of them. The scientists walk about inside this room about four feet (1·2 metres) above the real floor on a false floor of steel wire mesh.

The sound of a gunshot in this anechoic chamber is reduced to something like one clap of the hands in a normal room. Next door is just the opposite type of room, a reverberation chamber, with no furniture, smooth walls, floor and ceiling and built so as to be not quite "square." Here the sound of a gunshot is intolerable as the echoing sound waves bounce to and fro, reflected and re-reflected.

These two chambers have a small section of wall in common. Into this, different materials and different types of construction are built for measuring the sound transmission characteristics.

Scientific problems of the basic causes of noise and

ways of reducing it are also investigated. One of the commonest causes of noise is a turbulent flow of air—a jet engine produces this, for example. A British scientist has discovered the basic scientific law covering this case, a law which is now part of the international body of scientific knowledge. He is Dr. J. Lighthill, formerly Director of the Royal Aircraft Establishment at Farnborough, Hampshire, an establishment where aircraft noise is much in mind. Dr. Lighthill is now a special Research Professor at the Imperial College of Science and Technology in London, where he is working on noise.

At the National Physical Laboratory, there is much research into jet engine noise at the basic scientific level. One promising project is an attempt to find out where a jet of air emerging from the nozzle is noisiest and where this noise dies away. A simple experimental set-up is used—a jet of compressed air coming through a conical nozzle to simulate the hot gases coming from the back of a jet-engine. The scientists have found that a simple modification to the nozzle, to give a twist and spiral motion to the airflow, cuts down the length of its noisy part by as much as a half. This could eventually lead to better silencers or baffles on big jets.

Similar basic work is going on at the National Engincering Laboratory at East Kilbride, near Glasgow, in Scotland. One programme there is aimed at finding out what is the inherent noisiness of such basic mechanical actions as impacting, sliding and rolling. Another programme has already demonstrated that apparently identical sets of ball-bearings may differ greatly in the amount of noise they produce. The reason is that sometimes the ball-bearings are not perfectly round—though the fault may only be measured in millionths of an inch (thousands of a millimetre).

It is regrettable that, despite all this work, some people may have their hearing damaged by too much noise. The Medical Research Council and the Ministry of Pensions and National Insurance, are concerned with this problem. They are running a programme of investigations among industrial workers in which a mobile laboratory has been visiting factories. It is operated by scientists and technicians from the National Physical Laboratory who measure the noise levels inside the factories and test the hearing of the workers with special apparatus. Inside, workers press a button to show whether or not they can hear a simple single-frequency noise, the intensity of which is automatically raised and lowered.

Analysis shows the " threshold " at which the subject starts hearing it, and so whether his hearing is being affected.

Another Medical Research Council project, at its Applied Psychology Unit at Cambridge, concerns the effect of sounds, especially sudden, loud sounds, on people's ability to concentrate. The effects of sonic boom produced by aircraft breaking the sound barrier are a particlar interest now. It is too early to say what the results are likely to be.

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IBIS LONDON HOSPITAL WASHING SYSTEM

Isaac Braithwaite & Son Engineers Ltd., apart from manufacturing three major Washing Systems, offer in conjunction with Laundry Engineering Services Ltd., the Ibis London Washing System, which has a specific application to Hospital Laundries.

THE modern practice in hospital laundry layout (vide the Cunliffe Report) is to install washing plant which can be included in a " barrier system," with no direct contact between the department handling the soiled and possibly infected linen and the clean side in the finishing department.

An important feature of the Ibis London Washing Machine, manufactured at the Laundry Engineering Services Ltd., Acton Works, is the low loading factor, 3·8 lb. per cu. ft. (600 lb. for a 60 in. x 94 in. machine). This enables efficient washing and rinsing to be maintained with shortened washing processes. It is considered that the articles which are to be used in the wards must be thoroughly cleansed and as free as possible from mineral deposits and soiling matter. It is not sufficient merely to produce a sterile article.

For a demonstration held at the New Model Laundry, Leyton, recently only one 600 lb. Ibis London Washing Machine was used. This produces 900 lb. per hour (900 lb. per operator hour). The complete cycle of one 600 lb. load consisted of:

approximately 5½ minutes to include inching, opening of outer and inner doors, loading and closing of doors;

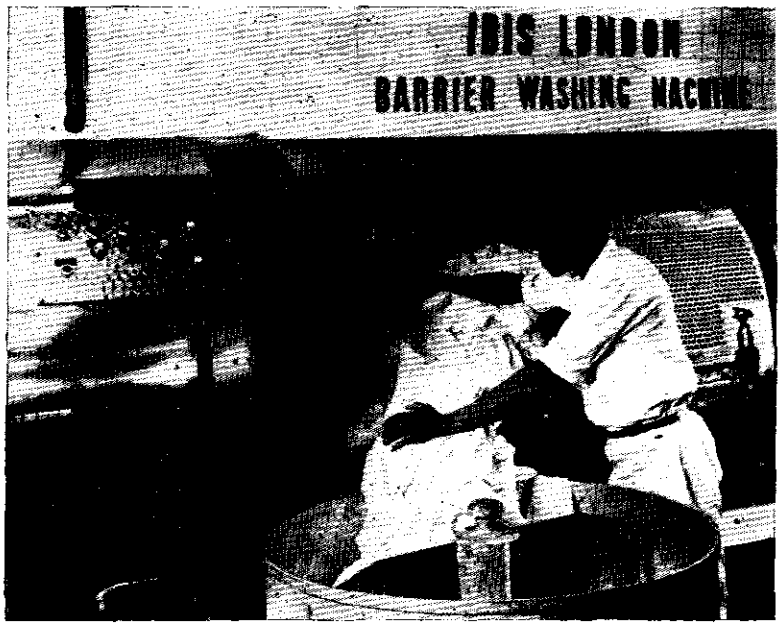
approximately 5½ minutes for inching, opening doors, unloading into hydro baskets and closing of doors;

27 minutes washing cycle.

On a one machine unit the operator is not fully occupied and the output per operator hour increases with the number of machines installed, up to the optimum operator utilisation. One operator in an Ibis London barrier hospital system can LOAD up to four or even more Ibis London Washing Machines. One operator can UNLOAD two or even three 600 lb. machines and also operate the hydro-extractor during the period of the washing cycle. On a two machine unit the output per operator hour is therefore 900 lb. On a three or four machine unit the output is considerably in excess of this figure, depending on labour required for hydro-extraction.

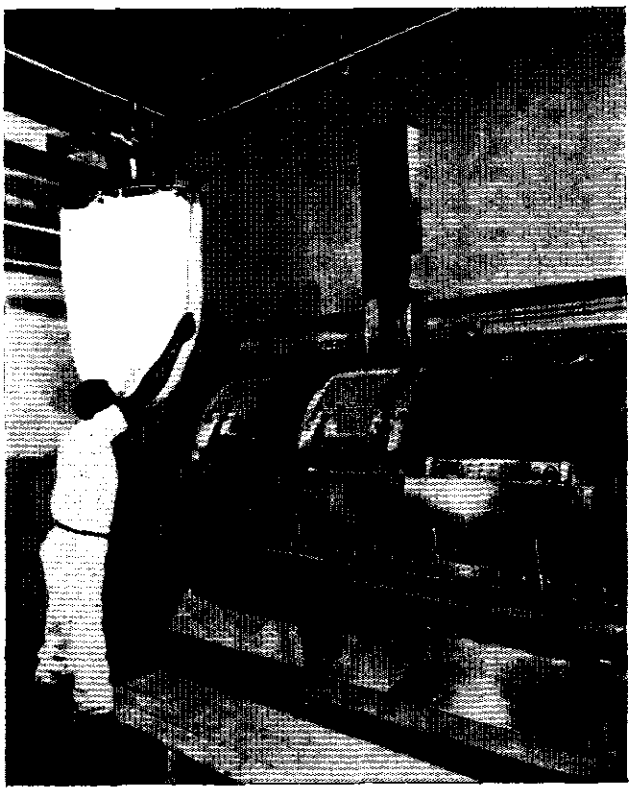
The exact allocation of labour will depend on the layout of the plant and the number of ancillary machines that may be installed.

Indications are that future hospital laundries will be based on a throughput of 100,000 pieces per week. In many instances it should be possible to include an Ibis London Washing system to give at lease 1,200 lb. per operator hour.



Unloading into the hydro-extractor.

The "dirty-side" with the gravity conveyor.



The Ibis London Washing Machine included in the system has been designed on the double door principle to produce highest quality work and optimum efficiency with minimum operator fatigue. The system also incorporates the " Magpie " gravity monorail Conveyor manufactured by Holborn Metal Works Ltd. This conveyor carries bags containing 100 lb. loads of soiled work from the sorting department directly to the loading point above the machine. A Broadbent 200 lb. 42 in. JB Hydro Extractor with two blade " Easylift " divider is also incorporated in the system. Each half section of the " Easylift " has a capacity of 100 lb. and will therefore take the load from one " D " pocket of the washing machine.

The washing cycle is automatically controlled by the inclusion in the system of a Fisher control supplied by Process Units Ltd. Contributing to the high output and ease of operation are the spring balanced and air operated outer case doors. Controls are fitted to eliminate the possibility of both doors being open simultaneously thus ensuring an air tight condition between the dirty and clean sides of the wash house. Pneumatically operated outlet valves are fitted for direct connection to the main drain or water reclamation system. The anti-cross-infection external barrier consists of stainless steel extension pieces to the outer case and incorporates air-tight control panels and a signalling system between the dirty and clean sections.

A problem arises with the maintenance of washing machines, and authorities differ as to whether the mechanical gear which needs periodic attention should be on the soiled or clean side of the barrier. There are disadvantages in having maintenance staff either in the soiled or clean departments. The design of the new 600 lb. Ibis London Hospital Washing Machine incorporates the option of a separate maintenance gallery beneath the machine itself, and provides a third, or neutral, zone in which the maintenance staff can work at any time without entering either the soiled or the clean areas.

Although primarily designed as an anti-cross-infection washing machine the " Ibis London " is also supplied for commercial laundries handling contract work, linen hire, etc., either as a double-door machine or for conventional one-sided loading and unloading. It can be supplied with standard outer case doors or with the spring balanced air operated doors as recommended for hospital laundry barrier use. The system can be provided to incorporate washing machines with the same loading factor in capacities of 400 lb., 600 lb. and 800 lb. and the 100 lb. Ibis end loading " Double-door."

FAIR-FACE STEELWORK AT SEVENOAKS HOSPITAL

STRUCTURAL steelwork is customarily concealed from view because of fire regulations and the need for reduced maintenance costs, although modern methods in both fire protection and anti-corrosive cathodic protection of steelwork has allowed special purpose buildings to be designed with an exposed steel frame.

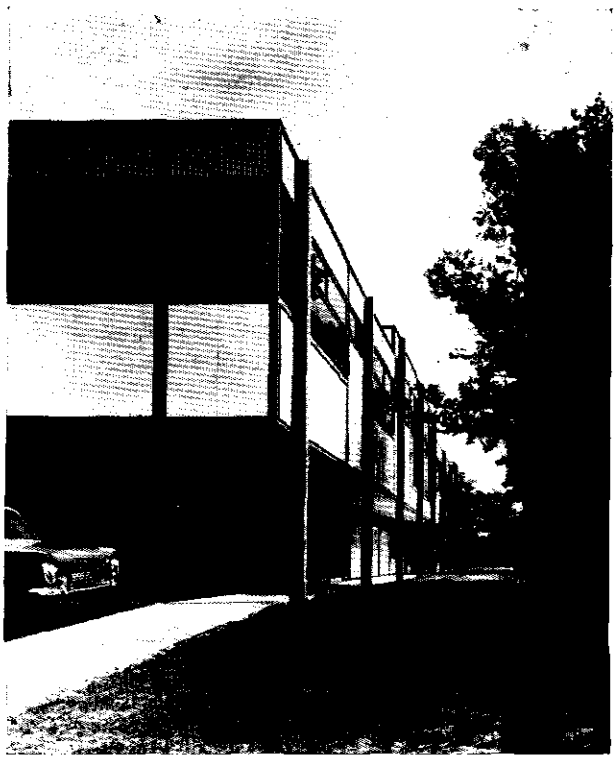
The recently-opened out-patients and maternity building at Sevenoaks Hospital, however, is believed to be among the first examples of the complete integration of a structural steel frame, a cladding frame and precision-cut vitrolite cladding and glazing, arranged to produce a functional architectural effect.

The project represents the first stage in the development of the present Sevenoaks Hospital into a small district general hospital as agreed by the Ministry of Health and the South East Metropolitan Regional Hospital Board.

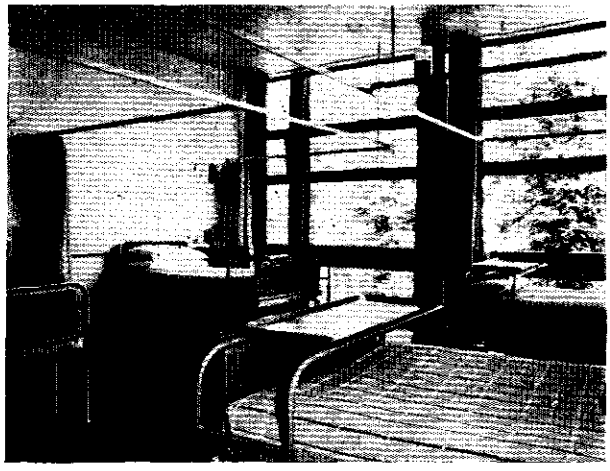
Compactly planned, the Out-Patient Department is housed on the ground floor and the Maternity Department on the first floor of the building and both are planned on the newly adopted race-track principle with service rooms and sanitary accommodation in an artificially lit and ventilated central core with the main rooms on the perimeter.

The complete structural frame and steelwork for this building, which amounts to approximately 75 tons, was designed by Clarke, Nicholls and Marcel, civil and structural engineers of Hammersmith, and fabricated and erected by Sanders and Forster Ltd., Bridgwater House, Warton Road, Stratford, London, E.15, the structural engineering company of the Chamberlain Group of companies.

Working to tolerances as fine as plus or minus $\frac{1}{32}$ in. in the cladding steelwork and plus or minus $\frac{1}{16}$ in. in the steelwork for the main frame, the fabrication and erection of the steelwork necessitated careful planning and phasing to ensure the high degree of careful preparation and accurate workmanship required throughout all stages of shop fabrication, site erection and welding. Furthermore, because all the steelwork is fully exposed on the exterior of the building, all joints had to be prepared by site grinding prior to welding and reground afterwards to produce a fair surface to ensure the accurate fitment and bonding of the fenestration and cladding.



A view of the fully exposed steelwork and vitriolite cladding.



Inside a typical ward.

The contractors for the frame state that the fine tolerances were imperative because the fenestration and cladding was attached directly to the steel structure by means of neoprene gaskets, which mean that the glass had to be cut and the windows and cladding manufactured prior to and during the erection of the cladding steelwork to avoid construction delays, and to permit work on the inside of the building to proceed during the winter months of 1964 and 1965.

The exposed steelwork of the structure was shot blasted and corrosion protected at the Stratford works, and when erected received an additional intercoat and a final coat of stainless steel enriched sealer to complete the full Metalife system of corrosion protection.

Design of the building was by Gollins, Melvin Ward and Partners, the London firm of architects, and Charles F. Scott, A.R.I.B.A., Dip.I.P., the Regional Architect to the South East Metropolitan Regional Hospital Board.

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VICKERS-OXYGENAIRE HYPERBARIC BED SYSTEM

THE HYPERBARIC bed system has been developed by a team of engineers, designers and doctors at Vickers research unit to treat patients whose condition would be worsened by prolonged periods in the horizontally prone position of the Clinical hyperbaric system. Its main design features are that the patient can sit up straight or recline on an adjustable back rest, through any angle down to the prone position. In addition, the bed structure tilts through an angle of 10°, head up or down. It is basically a bed on which the patient can be nursed and thus coronary and post-operative cases can be given hyperbaric therapy without the need for them to be moved.

The bed fulfils the following specifications: —

(*a*) a chamber of minimal overall cross section or weight capable of withstanding the required pressure.

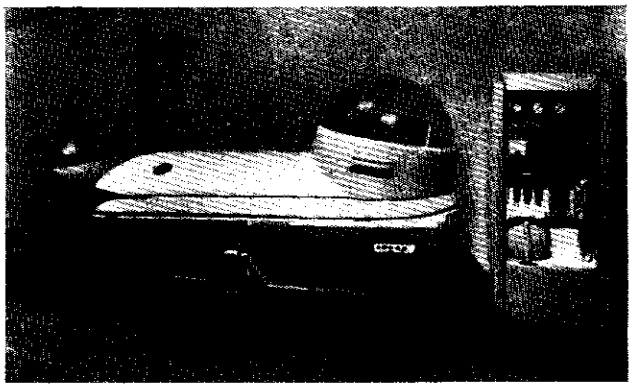
The bed base is of thick steel; the top section is double skinned light alloy sheets with rigid foam filling. Maximum height with the bed open is 7 ft. 3½ ins. and weight 900 lbs. The plastic dome, which holds the pressure, is encased inside a second dome, which protects it from damage and forms a fail safe device.

(*b*) an adjustable structure giving variable support to the sitting patient.

The bed base is centrally pivoted on a sub chassis; a jacking system controls the tilt of the bed through an angle of 10°. The adjustable back rest provides comfortable sitting in a reclined or upright position, and the patient has a clear view of the surroundings and the operators and nurses. Radio and television programmes or taped music can be replayed over the intercom, and the patient can also watch television on a set placed outside the bed.

(*c*) semi-automatic pressurisation, with control of temperature and humidity.

Temperature and humidity can be held within comfortable limits and adjusted to suit individual patients. The percentage of carbon dioxide in the gas coming out of the bed



is continuously monitored and displayed on a dial on the console. Compression and decompression rates are selected by the operators and the required treatment pressure can be pre-set, but the pressure can be held at any intermediate figure.

(*d*) an efficient monitoring system for communication between patient and medical staff.

The patient's voice can be transmitted over a loudspeaker located in the console and if required, medical staff can talk to the patient by means of the handset. Pneumatic and electrical connections are provided in the bed base to enable monitoring and support facilities to be operated.

(*e*) easy handling and nursing of the patient within the chamber. When opened, the structure allows 3 ft. 8 in. opening at the head end. The back rest can be removed for rear or sideways loading of the patient. Since the top section is counter-balanced, it can be easily raised and lowered and will stay in the open position.

(*f*) a reasonable locking unit, easy to clean and not too frightening for the patient.

The locking action is electrically operated, but has an emergency handle available for power failure conditions.

AVERY BED WEIGHERS AT ARTIFICIAL KIDNEY UNIT

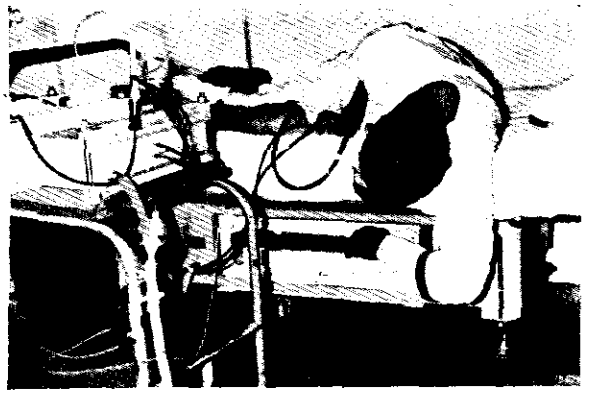
OF THE 2,500 people between the ages of 15 and 50 who die in England each year from kidney failure, some 500 could be saved if artificial kidneys, ancillary equipment, trained medical staff and the money to provide them were available.

Among the few specialist kidney centres to be established in the world is that located at the Royal Free Hospital, Hampstead. At this centre—the largest in Europe—treatment can be given to 15 patients on a regular basis and one or two more can be accommodated in an emergency. Here the work is under the direction of Dr. Stanley Shaldon and the unit is said to be ahead of any others including those in the U.S.A.

What makes the Hampstead unit more sophisticated is the reliable and sensitive alarm system that has been developed, and the inclusion of Avery weighing machines which allow the patients to be weighed whilst they are sleeping, without being disturbed. Under this system one nurse can attend to five patients. In the U.S.A., however, each patient requires an attendant nurse during sleeping hours to check the amount of fluid removed and to take blood pressure readings.

A healthy person's kidneys work normally by extracting the impurities contained in the blood which are discarded as urine. People whose kidneys have failed can only survive by the use of an artificial kidney, a machine which filters out the impurities. At the Royal Free Hospital unit the patients, who lead a fairly normal life, come in twice a week for two 14-hour periods. During this time they are physically attached to the artificial kidney and it is essential that the amount of fluid drawn off is checked each hour.

The patient rests and sleeps during this period on a bed mounted on an Avery 33N5 weighing machine. As the weight of the bed and the clothes are known, the weight of the patient is readily obtained. As can be seen in the photograph the patient can easily check his or her own weight during waking hours and when they are asleep the nurse takes over.



Extreme sensitivity is demanded of the Avery machine as the average amount of fluid removed per hour is only around 120 gm. Naturally an accurate check is kept on weight change of the patient during the 14-hour period and any excess removed is returned to the patient.

The capacity of these weighing machines is 220 kg. with minor graduations of 50 gm. The steelyard is housed in a hardwood case and is finished in white acrylic enamel, stainless steel and chromium. There are no loose weights and weight indications are easily read from white figuring and well spaced white graduations on a black anodised index plate.

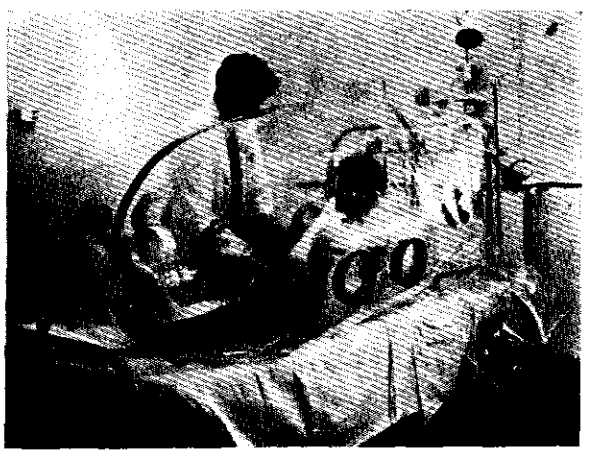
The castor legs are separately adjusted and a handle initially lifts the whole bed off the floor. There are two main weighing levers of tubular construction coupled to an intermediate lever.

Several Avery chair weighers have also been purchased by the Hampstead unit. Although they perform perfectly satisfactorily they do have the disadvantage that the patient has to get out of bed. This is difficult, as he or she is physically attached to the kidney machine. However, because they are less expensive than bed weighers they are used by patients who have a kidney unit in their own home. Another bed weigher is on order and as soon as funds permit further machines will be required. The Avery weighers have a considerable export potential as the Hospital states that they are more sensitive than German models available and much less expensive than American machines.

NEW TRANSPLANT WARD AT ST. MARY'S

A NEW kidney transplant Ward, named Fleming Ward after Sir Alexander Fleming who discovered penicillin at St. Mary's, London, has been built to provide the special facilities needed to transplant patients under conditions which will minimise the risk of infection to which they are prone in the operative period and while awaiting surgery. Since patients have to wait for a suitable kidney from someone dying, facilities have to be provided to keep them fit and happy while they are waiting. It is unavoidable that they are under severe strain whilst waiting, knowing that they may be operated upon at a few minutes notice, and the maintenance of their morale by pleasant surroundings is most important.

The opening of the new ward in June represents a further phase in the development of transplantation in the hospital which started in 1959. With improved techniques 18 out of the 43 patients transplanted in the present series which started in 1963 are alive, and they are leading normal and active lives after they have left hospital, 10 of the last 12 operations have been successful. All these people have received kidneys from people who have died. The use of kidneys from the dead presents special problems which we have largely overcome, and St. Mary's are about the largest centre in the world using only kidneys from this source. They have also the most successful series of transplanted patients of any sort in this country.



It will be evident that the transportation of organs and subsequent surgery require absolute sterility and Vickers Research Establishment has specially co-operated on these problems. A sterile inflatable tent for nursing patients has been developed as in the accompanying photograph.

Background to Clinical Transplantation

About 2,000 people in this country die of kidney disease each year. Most of these patients could be treated either by maintenance for life on an artificial kidney machine, or by having a new kidney transplanted into them. At present the first treatment is available to very few patients, about 90 per year. Recently there has been much publicity about the artificial kidney machines: these can be expected to take only about 20 new patients a year. Once a patient enters such a programme, he requires treatment two days each week for the rest of his life. Thus it would need a continually expanding programme in order to continue to take new patients into the scheme. The cost of such treatment varies with the type of machine used, but excluding capital costs averages £1,500-£3,000 per patient each year.

Transplantation has been largely ignored in the recent discussions of artificial kidney costs, because the majority of people, including doctors, do not realise how successful transplantation has become. Throughout the world, as well as in the U.K., a transplant has at the moment at least a 50 per cent. chance of success. A successful result in a patient means that he can live an entirely normal life while taking his tablets: he does not have to spend 20 hours on dialysis each week on the artificial kidney and he does not

(Continued on page 112)

MEDICAL RESEARCH COUNCIL RESPARAMETER

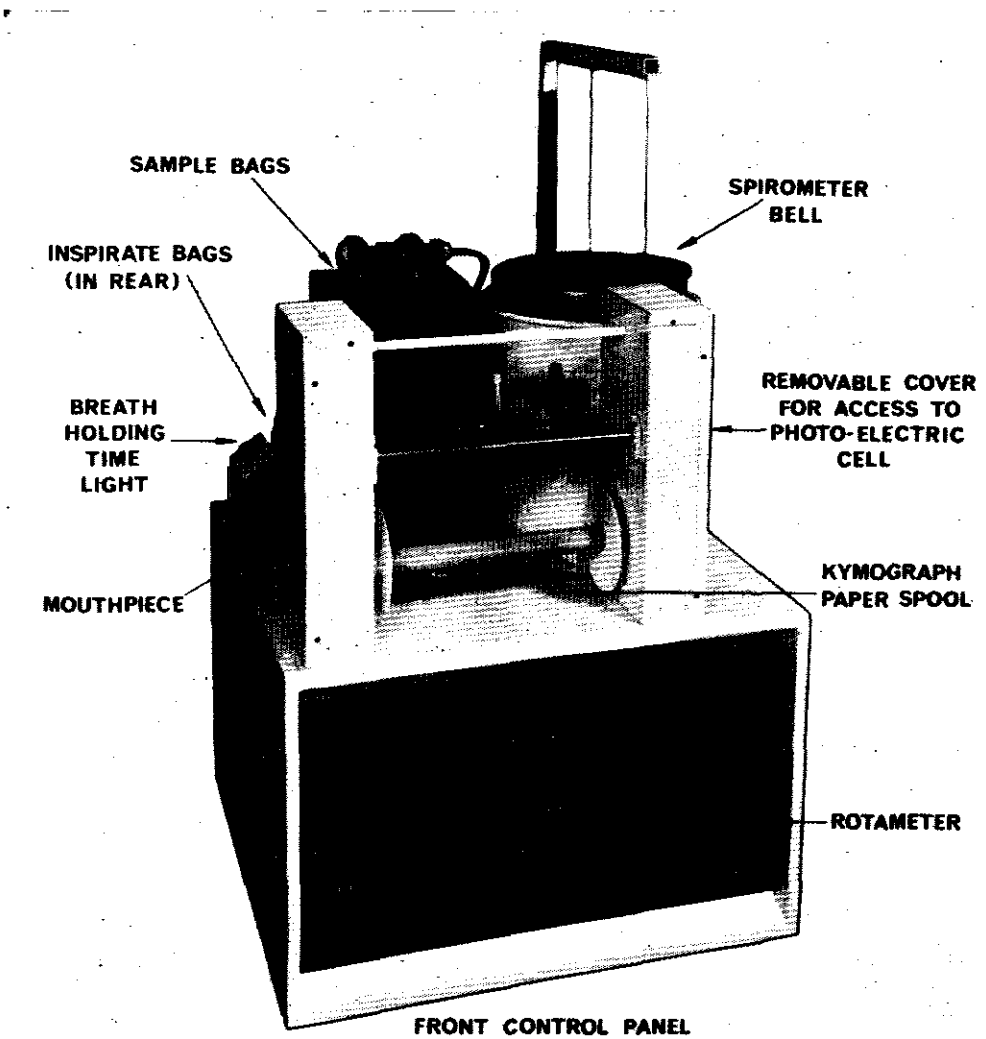
THIS is an apparatus for measuring lung volumes and the transfer factor (i.e. the efficiency of the lung in transferring oxygen from inspired air to the blood stream) of a patient and is of particular use in the study of various lung diseases. It is also used in the research into methods of protection of people who work in such atmospheric conditions that they may inhale noxious dusts and vapours. The unit illustrated is the latest of a series of research prototypes built over the last four years for the Medical Research Council Pneumoconiosis Research Unit at the Llandough Hospital, Penarth, Glamorgan.

The resparameter is shown in the photograph, but not the associated gas analysers that are required for the various tests. For the basic tests a helium katharometer and a carbon monoxide analyser are required. For the more complicated applications oxygen and carbon dioxide analysers may be required or alternatively a gas mass spectrometer can be used.

The total lung capacity of a patient and its subdivisions, tidal capacity and residual capacity, are estimated in the following manner: the patient is allowed to breathe freely until his lungs are completely washed out with air. He is then switched into a closed circuit which initially contains a known concentration of the inert gas, helium, in a mixture of air; he is allowed to breathe in this closed circuit until a new steady reading is obtained on a helium gas analyser.

From this new reading the quantity of air contained in his lungs may be compared with the quantity of air already known to be contained in the closed circuit. The drop in percentage content of helium is due to the fact that the helium contained in the closed circuit becomes diluted with the air originally contained in the patient's lungs.

The transfer factor is calculated from the percentages of gases contained in alveolar gas samples (i.e. gas contained in the working part of the lung). The patient inspires



with a known concentration of oxygen in air or alternatively pure oxygen, holds his breath for a fixed period, usually 10 seconds, and is then allowed to exhale into the sampling control box. Of this exhaled volume the first 700 ml. are discarded; this sample contains gas originally in the trachea etc., and is not representative of the gas contained in his lungs. The next 500 ml. are then switched into a sample bag and the rest of his expirate is again discarded. This completes the test. The gas in the sample bag is then pumped through a series of gas analysers and from the concentrations of the various constituent gases the patient's transfer factor can be calculated.

This particular apparatus was specifically designed with field surveys in view. It was therefore an aim of the design team to keep it as compact and as light as possible while also being relatively robust and vibration-proof. The spirometer was a major problem due to its large size. This was overcome by increasing the diameter and reducing the overall height and also by reducing the total volume to seven litres. It was felt that this would be quite enough for the type of tests envisaged. In most cases lung capacity is well under 5-6 litres.

The gantry unit which suspends the spirometer may be collapsed down for transit. The complete equipment weighs approximately 36 kg. and measures approximately 20 inches by 20 inches by 24 inches high.

By means of a system of pulleys and cord, the vertical movement of the spirometer is transferred to the horizontal movement of the pen across the kymograph. As the diameter of the spirometer was increased a certain degree of accuracy was sacrificed on the kymograph, since a given volume now displaces the pen a smaller distance; but this was felt justified in the interests of keeping the equipment as small as possible. The kymograph itself was designed to take a spool of standard teleprinter paper since this is relatively cheap and easily available. The controls on the front panel were kept to a minimum by means of the ganging together of valves internally and therefore having fewer external knobs to operate. This was achieved by gearing together some of the taps inside the unit and designing the circuit so that relatively few taps had to be operated during the test.

The programming of the two tests is done electrically and the latest version of the resparameter contains an entirely transistorised counter unit. This was designed partly to increase the reliability of the equipment but mainly to reduce noise. Earlier prototypes used Post Office uni-selectors which make a considerable amount of noise and could upset the patient.

The equipment contains two inspirate reservoir bags from which the patient inhales, and two sample bags, so that two consecutive experiments may be conducted in order to determine the patient's transfer factor. For certain investigations it is useful to know the two transfer factors for the patient breathing air or oxygen.

Several examples of this apparatus have been used with great success on field surveys including one case in Bergen, Norway. Although at first sight the complexity of the equipment seems very great, it has been found that a technician can be trained to use it in approximately five hours.

The resparameter has proved itself to be a very versatile research instrument and apart from the two tests already described, it may be used for other experiments, for instance finding the single breath indices of uneven ventilation and perfusion. Small numbers of these units are now being manufactured by Lloyd Instruments Limited, Furrow Lane, London, E.9, and are marketed by P. K. Morgan Limited, 10 Manor Road, Chatham, Kent.

GALVANIC SKIN RESISTANCE METER

SHORT BROTHERS and Harland's Precision Engineering Division has entered the medical engineering field with an instrument which enables psychologists to measure emotional reactions in patients. Two of these instruments are already being used successfully by the Psychology Section of the Department of Mental Health of the Belfast City Hospital, which collaborated with Shorts on the design.

The instrument, the Galvanic Skin Resistance Meter, works by measuring the electrical resistance of the skin of the patient's fingers, which is affected by the activity of the sweat glands when the patient subjectively imagines anxiety provoking situations. By carefully measuring the change of resistance it is possible to obtain a quantitative measurement of the patient's anxiety. As the current used is only ten millionths of an amp and is applied through skin electrodes, the measuring process is imperceptible and causes the subject no discomfort whatsoever.

The Short instrument has an advantage over existing galvanic skin resistance meters in that it is very much simpler to use. Conventional meters show the subject's overall resistance and the psychologist is required to make various adjustments in order to observe the small moment-to-moment changes which are what interest him most. In the Short meter the subject's basal resistance and the temporary changes are separated, the latter being shown by a pen-recorder which indicates zero when no change is taking place.

The Short G.S.R. Meter is a self-contained instrument powered from 230V A.C. mains and rated at 30W. The skin electrode leads plug into two sockets on the front panel and a constant current of 10μA is passed through the skin path under test. The front panel meter shows the basal resistance and is not affected by variations in resistance. Three ranges are provided giving full scale readings of 100 K.ohms, 200 K.ohms and 500 K.ohms (accurate to 2 per cent of full scale). A front panel jack is used to connect a pen-recorder which records only the changes in resistance and shows zero when no change is taking place.

This separation of basal resistance and resistance changes is a great advantage over many other G.S.R. meters which require the operator to adjust potentiometers to back off the basal resistance in order to observe the changes. The only adjustment necessary with the Short instrument is a daily setting of the amplifier zero controls on the front panel.

THE PAPER SACK—A NEW SERVANT

The paper sack is rapidly becoming an important tool in the services of industry and hospitals alike. Transport of materials and packaging are almost as important today as the finished product itself. But the main purpose of the paper sack is still in the collection and transport of refuse. Hospitals are using the paper sack system because it is quicker, more hygienic and saves on labour. Paper sacks are light, clean and can be stored easily. The danger of spilt refuse is eliminated, as are smells, noise and dust. Although this is a slightly more expensive method of refuse collection, the cost is far outweighed by the advantages gained by using them.

Specialised applications of paper sacks are the use of the 1¼ cu. ft. sack in small clinics and the larger 4½ cu. ft. sack for the collection and distribution of laundry.

A new miniature holder called the 'Mini-Stand' has recently been put on the market by **Paper Sacks Ltd.**, of Northfleet, Kent. This stand, for the 1¼ cu. ft. sack, also comes as a clip-on holder only, and is ideal for use where space is very limited. The holder unit comes in white and is plastic coated for hygiene and quietness.

HARDWEARING ARBORITE SIGNS

Fifteen of the most commonly used signs in shops, offices, hospitals and public buildings have been silk-screen printed into Arborite decorative laminate panels.

The words "Exit", "Toilets", "No Smoking", "Lift", etc., are printed black onto a white background and are made from Arborite ⅛-in. Solid Grade. The large signs are 4½-ins. deep with a type size of 2-ins.: the smaller ones are 3½-ins. deep with a type size of 1¼-ins. The face chosen is the popular Helvitica.

This type of sign is most hardwearing as the lettering is covered and protected by the melamine-impregnated overlay sheet common to all Arborite decorative laminates.

The signs cost from 5s. 9d. to 16s. 6d. (average price, 10s.) and are available from Arborite main distributors. Further details from **Arborite Limited,** Bilton House, 54/58, Uxbridge Road, London, W.5.

CONDENSATE RECOVERY UNITS

A new range of standard packaged condensate recovery units for handling condensate at a maximum temperature of 212 degrees F. and return rates up to 40,000 lbs. an hour, has been introduced by **Girdlestone Pumps Ltd.** of Woodbridge, Suffolk, as an addition to their extensive range of special condensate recovery equipment. Girdlestone have produced many thousands of condensate recovery units during the past 25 years, the majority of them to individual customers' requirements.

This new range has been introduced as a result of the growing demand by steam users, throughout industry, for larger packaged units for handling condensate at higher temperatures to effect the maximum saving of heat and treated water and also reducing installation costs.

The new condensate recovery units are extremely compact, with single or duplicate centrifugal pumps mounted under the receiver on a base integral with the supports. Standard receivers ranging from 25 to 300 gallon capacity are constructed from mild steel, galvanised steel or copper, and are fitted with Mobrey magnetic level controls.

ORBIT MOTOR REDUCTION UNIT

Developed to meet the demand for higher torques, **Adan Hydraulics Ltd.** have introduced a motor/gearbox unit employing the well-known Danfoss Orbit motor specially designed to take advantage of its high torque characteristics.

The units comprise a 5:1 planetary gear reduction unit in conjunction with any of the range of Orbit motors and are capable of developing up to 8 h.p. at speeds from 40 to 200 r.p.m.

The compact construction is such that the main casing is only 7″ dia. and the output shaft of 2⅜″ dia. is supported by substantial needle and ball bearings permitting considerable radial loads to be carried, e.g., direct mounting of sprockets, pinions, winch and conveyor drums, wheel hubs, etc.

Applications for these units are numerous, including vehicle transmissions and drives for winches, extruders, slewing gears, augers, drills and conveyors.

AMBULANCE RAMP

A Portable Adjustable Folding Ramp, mounted on wheels, has been designed and produced by **Acmeflooring Ltd.** to facilitate transferring patients from ambulances to ground level and vice versa.

The Ramp is 3 ft. 6 in. wide and fully adjustable to accommodate varying levels in ambulance floor heights. The walk-way of the Ramp is coated with a matt finish anti-skid surface which has a high coefficient of friction. The first ramp to the above specification was supplied to the Royal National Orthopaedic Hospital, Stanmore.

DYNAJET KINETIC GUN

Blocked pipes, from domestic installations to oversize exterior drains, can be cleared of all obstructions immediately, completely and safely using the Dynajet Kinetic Gun which exploits the Hydraulic Kinetic principle by having an impact of compressed air released directly onto a column of water. The energy waves created travel at 4,000 ft. per second and dislodge

and clear all obstacles in their path. To operate, a gauge indicated pressure of from 10 to 200 lbs. per sq. in. is selected. This can be obtained either by manual pumping or from a cylinder of compressed air. A safety valve insures against over-pressurisation, and a device on the trigger makes accidental discharge impossible. The speed at which the shock waves travel is such that stacks and vents are by-passed and bends and corners instantly traversed. The **Dynajet** Kinetic Gun is now supplied direct from the Manufacturers, 2a, Maygrove Road, N.W.6, at the price of £55 and is delivered complete with a large range of industrial accessories and a locking carrying case.

BUILDING BOARD IN SPECIALISED APPLICATION

Venesta Instant Building Board is a laminate of either hardboard or asbestos panels with an expanded polystyrene core. The material is light in weight, rigid and has good thermal insulation properties. It was this last characteristic which interested the firm of Smiths Instruments, of Bishop's Cleeve, near Cheltenham, who manufacture instruments for the motor and aircraft industries amongst many others. Delicate instruments require careful handling at certain stages of their manufacture, particularly in the final setting before they are sealed from the atmosphere.

It was in the construction of clean air rooms and temperature controlled workshops that Venesta boarding came into its own, and it has obvious uses in the fields of hospital theatres and sterile areas.

At the Smiths' factory, which employs 3,000 skilled operators, there are five separate rooms concerned with differing grades of clean air and controlled temperature. In order to obtain purified air, which minimises the amount of dust, a certain amount of heating is required and this is where the heat insulating qualities of walls and ceilings are important. Humidity is another aspect of importance. Warmed air is free of moisture which causes rust and, again, the minimum amount of thermal loss is required. Rusting is something which affects almost every engineering concern and heat insulated workshops constructed from Instant Building Board are cheap and easy to construct.

At Bishop's Cleeve, the special clean air room is constructed almost entirely of laminated boarding for both walls and ceiling. The boarding is coated with Melamine or painted to minimise the acidities in the glues and has proved satisfactory in the first six months of operation under very exacting conditions.

Venesta boarding is also used in the standard workshops where temperature control only is required to minimise rusting. Here standard air conditioning units pump in filtered air at a fixed temperature. The insulation has a *U* value of 0·2 and, because of the rigidity of the boards, walls and ceilings can be erected easily in comparison with steel structures. The standard panels are simply dropped into slotted frames and the joints taped over. The cost is also very much lower than steel which offers little in the way of heat insulation. The range of Venesta Building Boards is made by **Venesta Manufacturing Limited**, West Street, Erith, Kent, and is available through usual building trade outlets.

A NEW PORTABLE OXYGEN ANALYSER FROM SERVOMEX

Servomex Controls Ltd., of Crowborough have introduced a new battery powered portable—type OA 150—to supplement their range of oxygen analysers. The new instrument has two switched ranges, 0–25% and 0–100%, with an accuracy of ±1% f.s.d. on each range.

Simplicity of operation is a key feature of the instrument, the main controls consisting of a range selector switch and an operating key. The reading is presented on a built-in indicating meter. The selector switch has further positions in which the battery voltages and correct circuit adjustment may be checked, using the same meter. A graphic display on the front panel makes the operating and checking procedure very obvious, and symbols are used wherever possible in place of words which makes the instrument suitable for overseas markets.

The analyser may be used with flowing or static samples, the reading being unaffected by sample flow rates within the range 0–150 ml./minute. A sintered glass disc filter and valves for adjusting the analyser and by-pass flows are built into the instrument, and a hand aspirator and drying tube are included as standard equipment.

The analyser uses the same measuring cell as previous Servomex oxygen analysers. A quartz dumb-bell is suspended on a platinum filament in a non-uniform magnetic field. It experiences a torque proportional to the magnetic susceptibility of the sample gas, and this is measured by maintaining an equal and opposite restoring torque produced by current flow in a single turn coil mounted on the dumb-bell. A light source, twin photocell, and difference amplifier maintain the null-balance condition automatically. The output meter measures the restoring current, which is directly proportional to the oxygen content. Silicon photocells and transistors are used and the instrument is extremely rugged and reliable. A temperature compensating system maintains the specified accuracy over variations of ± 5°C.

The measurement is virtually unaffected by all common gases other than oxygen, and the instrument may thus be checked on nitrogen and oxygen or air, and subsequently used to measure mixtures including, for example, nitrous oxide, carbon dioxide or hydrogen.

Cheap, readily available batteries are used, and the instrument will tolerate large changes of battery voltage. Although the instrument is very compact—overall dimensions, length 12″ (30·5 cm.), width 8″ (20·3 cm.), height 8½″ (21·6 cm.)—the construction allows easy access to all components. The nett weight is 17 lbs. (7·7 Kg.) including batteries and accessories.

MICRO-KATHAROMETER

Also from **Servomex Controls Ltd.**, a micro-katharometer of novel design which has been developed by the Instrumentation Department of the Distillers Company. The device is used as a detector for gas chromatrographs. It has a sensitivity and response speed not previously achieved in thermal conductivity detectors. Used under suitable conditions, its performance approaches that of flame ionisation and argon detectors. It is designed for use with capillary columns, but is equally effective when used with larger ones.

MEDICAL THERMOCOUPLES

Spembly Technical Products Limited of Trinity Trading Estate, Sittingbourne, Kent, announce the first of a new range of miniature mineral insulated thermocouples to meet the requirements of the medical field. To date, a number of hypodermic single and multi-unit thermocouples have been developed for the measurement of muscle temperature, whilst others have found application in diathermy and stomach

mucosal measurements. These thermocouples have the advantages of robustness and flexibility, particularly in connection with catheterisation, and a very fast response to small temperature changes. In addition, since they are encased in a stainless steel sheath, they are ideally suited for surgical work. They can be sterilised by standard techniques and implanted in living tissue and organs without harmful effect. A further feature is the high electrical insulation achieved between conductors and sheath, which gives added safety when used in conjunction with other electrical equipment. Spembly Technical Products also offer a range of simple indicating instruments for use with these thermocouples.

PM31 LIQUID-TILE

Liquid-Tile is a heavy duty flooring material which seeks and fills surface irregularities with self-levelling action. It bonds overnight to concrete, steel or wood and forms a tough, impervious tile-like finish. An economical, highly protective tile-like finish, Liquid-Tile fills and levels cracked, pitted, spalled and uneven surfaces. Its smooth, impervious surface is easily cleaned of oils, greases, corrosive and fermenting liquids. It provides a seamless sanitary floor which meets the most exacting requirements of hospitals and laboratories.

It is a thermosetting free flowing compound which hardens catalytically overnight. It combines excellent flexibility with outstanding resistance to abrasion, chemicals, water, oils, solvents and heavy-duty traffic. Twenty-four-hour immersion in the following chemical reagents did not affect the surface: 10% Acetic Acid; 10% Lactic Acid; 10% Nitric Acid; 50% Sulphuric Acid; 20% Caustic Soda; Toluene. For further information please contact Flooring Department Manager, **Porce-Master Chemical Co. Ltd.,** 261, Goldhawk Road, London, W.12.

INDUSTRIALISED CONSTRUCTION IN HOSPITALS

The use of "industrialised" construction, i.e., using almost entirely factory-made structural components, is essential, say the Government, if all the hospitals, schools or housing which the country needs so urgently are to be built within a short period. Most architects and engineers agree with this view, but whereas there are numerous different systems of "industrialised" construction for domestic buildings, these are basically quite unsuitable for the building of hospitals where much larger spans and open areas of floor space are necessary for wards, etc., and where the provision, through the structure, of the very complicated systems of service pipes, plumbing and ventilation ducts peculiar to hospitals can be met at all stages of design and construction.

A new construction method called Arbigrill has been designed specifically to meet these problems and at a cost which is well below that set as the maximum by the Ministry of Health. Arbigrill construction is designed throughout on a 2′ horizontal and 1′ vertical module to meet the recommendations of Government departments, and conforms to all Codes of Practice, including fire protection.

The structure is based on a steel frame with precast concrete floors and stairs, all of which are supplied by the same Group of Companies, thus assuring co-ordinated deliveries essential to a rapid erection programme on the building site. The *specially fabricated steel beams are provided with shear connectors* stud-welded to the top flange to act compositely with the concrete floor to achieve maximum economy of design. The beam webs are provided with large diameter holes pitched on the 2′ module.

The precast concrete flooring is of a grill pattern, again on the 2′ module, cast in large pieces of over 130 sq. ft. to ensure speedy erection on site using normal lifting capacity cranes. Since this grill pattern aligns with the steel beam web holes, almost any arrangement of service pipes can be accommodated, even at a late stage of construction. Large holes in the floors for main ducts can easily be provided.

Permanent plywood shuttering pieces drop into rebates in the top of the precast concrete grid, to facilitate the laying of a top concrete screed, which could also form the floor finish. Alterations to service layouts can thus be made, even at an advanced stage of construction or later, with the minimum trouble and cost.

Suspended ceilings of any type may be fixed, but for those areas where no services are required, the underside of the concrete floor will offer a pleasing finish, merely by applying a coat of paint.

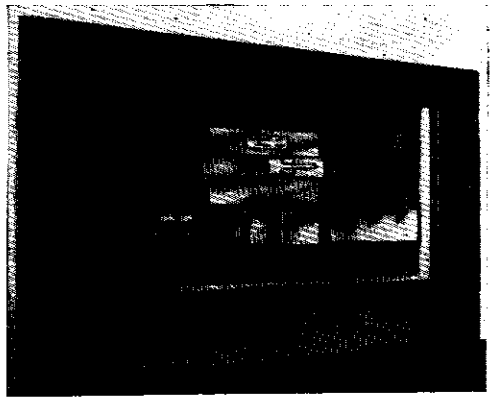
Arbigrill offers the architect a wide flexibility for planning and a free choice of materials for wall cladding, internal partitions, column casings, ceiling and floor finishes, all of which can be of "dry" fabricated construction for speed of erection.

Both the architect and the services engineer know at all stages of design and construction precisely where, and within what limits, services can be placed. This can lead to a substantial saving of time at the design stage.

The Arbigrill method of construction is marketed by Redpath Brown & Co. Ltd., a member of the Dorman Long Group, and a prototype building can now be seen by arrangement at their Greenwich Works. The consulting structural engineers are Alan Marshall & Partners. An illustrated brochure is available from **Redpath Brown (Arbigrill Division)** at their London office, 3, Duncannon Street, W.C.2.

NEW BROADBENT WASHER

Exhibited at the International Laundry Exhibition was the new double door **Thomas Broadbent** Barrier type 375 lb Washer-Extractor-Conditioner, specially designed for hospitals, with a unique system for sealing the machine against the entry of contaminated air to give a high degree of isolation at this vital stage in hospital laundry work.



The Broadbent Troy, rigid or flexibly mounted, gives considerable saving of supplies and conditioning to the ideal moisture content for rapid finishing. It saves floorspace, taking the place of three machines, and ensuring dry floors.

FORMICA CREATE CHIPBOARD SERVICE

THE first comprehensive wood chipboard service in this country has been created by **Formica Ltd.** to assist architects and builders in specifying and obtaining construction materials which conform to the statutory building regulations. It is the Formica Pre-Finished Board Service, which includes Formica wood chipboard pre-finished to the requirements of the building regulations and, where appropriate, the boards have been tested by an independent testing authority, such as the Fire Research Station. Formica Ltd. holds the certificates from these authorities proving the boards.

Complementary to this service are the Formica wood chipboard handbook and the marking of the boards for easy identification on site. The handbook gives comprehensive details of Formica wood chipboards, prices and identification of the boards, their compliance with British Standards Codes of Practice and conformity to statutory building regulations. Also included are technical information sheets describing the boards and the range of applications, specifying the correct method of installation and showing facsimiles of certificates from independent testing authorities where appropriate. These handbooks are available to architects, builders, and local planning authorities. Planning authorities will therefore be aware, when building plans are submitted, where and how Formica products comply with the building regulations, and also how their building inspectors can recognise them on site.

The joint use of the pre-finished board service and the handbook ensures that the builder can avoid both on site finishing and the necessity of proving to the local planning authority that the materials specified do conform to building regulations. It is essential that the boards are then installed by the methods specified in the technical information sheets.

The pre-finished board service offers ten finished boards initially, which are available through Formica distributors on a three week delivery basis. Other finishes will be added to the range as development work on pre-finished boards proceeds.

The boards now available are:

Flame Retardant Class O—Formica wood chipboard faced on one or both sides with $\frac{1}{4}$" "Asbestolux", giving the Class O Spread of Flame classification required under the building regulations (for suspended ceilings, walls in institutions, etc.).

Flame Retardant Class 1—Formica wood chipboard coated on one or both sides with flame retardant paints by Pearl Paints Ltd., giving the Class 1 Spread of Flame classification required under the building regulations (F.R.S. Report No. 3449) (for certain suspended ceiling systems, in large rooms in small residential buildings, and on walls and ceilings in any other construction, other than where an alternative classification is allowed).

Fire Retardant—Formica wood chipboard specially manufactured in 22 mm. thickness to arrive at a resistance of one half-hour to fire penetration (for partitions).

Thermal Insulation—Formica wood chipboard giving thermal insulation required for roof deckings, roof linings, the internal side of external room walls, and for the underside of floors where exposed permanently to the external air. The boards are faced on one or both sides with aluminium foil, and also have a surface Spread of Flame certificate to Class 1 and resistance to moisture.

Waterproof—Formica wood chipboard coated for internal applications with Hevikote by Coal Products Ltd., a two-pack epoxy resin/pitch coating which is impermeable to water.

Rot and Insect Proof—Formica wood chipboard proofed against attack by the long horn beetle, a requirement in certain areas for roof structures. The boards are dipped in a Rentokil product, which has the equally important effect of rendering the boards proof against wet and dry rot. The treated chipboard can be painted, varnished or sealed.

Machined—Formica wood chipboard machined to suit varying requirements. It is a requirement of the building regulations that in certain applications boards must be grooved and jointed with a loose tongue to achieve resistance to fire penetration.

Polyurethane Coated—Formica wood chipboard coated with clear polyurethane for flooring applications. There are four grades of polyurethane coated boards, sealed, semi-finished, domestic and industrial.

Heavy Duty Building Grade—Formica chipboard in the 18-mm. thickness is recommended for suspended flooring. Boards have been tested and been found to comply with recommended requirements for both impact and static point loads, which are to be incorporated into BS 2604, for chipboard.

Edge-lipped—Formica wood chipboard edged with wood strip to provide ready-to-install reinforced shelving.

Wood Veneered—Formica wood chipboard faced with a range of 31 wood veneers for decorative purposes.

The pre-finished board service also provides boards treated with more than one of the finishes listed, such as flooring grade boards treated against rot and insect attack, with a waterproof coating on the underside and polyurethane on the face surface.

HOSPITAL CONTRACTS FOR STORAGE UNITS

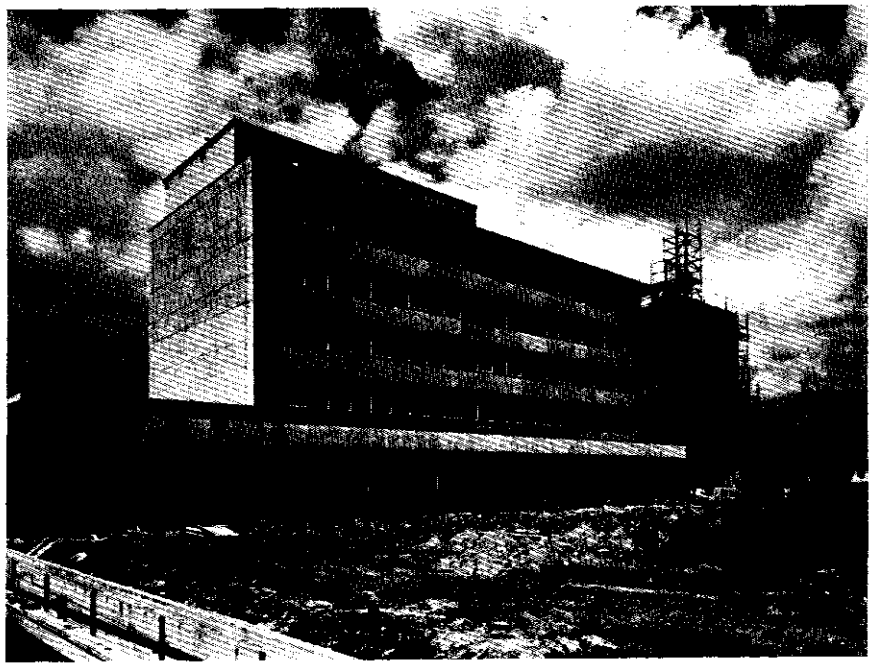
One of the biggest planning operations ever undertaken in the furniture manufacturing industry has been completed by the Pontefract factory of Wilkinsons (Bradford) Ltd., a member of the Meredew group of companies. It involves the making and assembling of components for storage units for the hospital building programme in Great Britain. Wilkinsons (Bradford) Ltd. have been selected to manufacture these units by the Ministry of Health for the programme years 1966/1967. All Regional Boards and architects responsible for particular projects have been notified.

Where laminated finishes are required, Formica decorative laminates will be used. Plastic liners and trays for the range will be manufactured by Thermo Plastics Ltd., of Dunstable, who have co-operated in the early development studies and have already undertaken initial tooling. Functional requirements of hospitals were taken into account by Ministry of Health Study Groups in formulating what is certainly the most complete range of storage furniture ever designed.

Basically, the main components are: four different depths of carcases with alternative choice of doors and shelves or drawers. These units can be fitted to floor or wall; worktops either free standing or for the tops of carcases and complete assemblies. These are assembled at the factory to form individual items or complete storage groups. All units are dimensionally co-ordinated.

In order to ease the task of ordering, Wilkinsons have produced a comprehensive catalogue based on the Ministry of Health Compendium which sets out the simple code references for all components, expressing their dimensions in terms of height, width and depth, and a single reference for each complete assembly. The catalogue is immediately available from **Wilkinsons (Bradford) Ltd.**, Monk Hill, Pontefract.

GEORGE ELIOT MATERNITY UNIT NEARS COMPLETION



THE new Maternity Unit for the George Eliot Hospital is nearing completion. The Unit is being constructed for the Birmingham Regional Hospital Board by W. H. Jones & Son Ltd., a member of the Costain Group. The contract comprises a central five-storey block which houses the wards with 104 beds, nurseries, administrative offices and a training school.

Also included in the Unit is a single-storey podium with reception area, operating suites, an ante-natal clinic and other special departments. Parking for over 100 cars is provided adjacent to the Unit.

Features of the construction are the extensive use of Cornish granite cladding panels; complex electrical services incorporating nurse call switches, radio, TV, and a high-frequency communication system, and special air conditioning ducts for the theatre suites and areas of special care to eliminate dust traps and facilitate maintenance.

Residential accommodation for the staff of the new Unit is being built nearby under a further contract negotiated with the Hospital Board, valued at £110,000. Work started late last year and comprises a matron's bungalow; a composite block of 2 two-storey houses and four flats; a two-storey sisters' block with 20 bed-sitting rooms; a third block of 14 bed-sitting rooms for other trained staff and 6 garages. The Regional Hospital Board Architect for both schemes is C. Rosser, A.R.I.B.A., Dip. Arch.

MECHANICAL SERVICES AT CENTRAL MIDDLESEX

MECHANICAL services for a new maternity block at the Central Middlesex Hospital, Acton, are now being installed by H. J. Cash and Company Limited as the result of a £22,000 contract awarded by the North West Metropolitan Regional Hospital Board. The block, consisting of a maternity ward and an ante-natal clinic, will be fitted with six different types of mechanical service, including heating, hot and cold water supplies, fire mains, steam and condensate services and ventilation.

The heating supply for the new block is being taken from the existing low-pressure hot water system and routed to various sections of the block to serve radiators, wall panels and convectors. This sytem will be automatically controlled by modulating three-port mixing valves.

Provision of the hot water services involves the installation of a 100-gallon calorifier, together with circulating pumps and automatic controls. The primary heating circuit of the calorifier will be supplied by steam from the existing block. Existing services within the hospital will also feed the cold water services and fire mains, which are installed throughout the new block.

Steam will be supplied from the existing services to sterilising equipment throughout the building. Condensate from this service will be returned to the plant room and subsequently to the existing condensate main.

Roof extract fans will ventilate the new block which has been designed by Hammett and Norton, the architects, in conjunction with Wingfield-Bowles and Partners, consulting engineers. Main contractor is W. J. Simms, Sons and Cooke Limited.

STUDY AND INSTRUCTION COURSE—PLASTICS IN BUILDING DESIGN AND CONSTRUCTION

Scope and Purpose of the Course

THE Course is designed to equip senior architects and engineers with a working knowledge of the fundamental technology and terminology of plastics materials and their processing and fabrication; where plastics have an application in building design and construction and areas in which these might be extended, including the economics of plastics in use and current developments abroad, engineering and architectural design with plastics, weathering, durability and fire performance characteristics of plastics, and the organisation of the plastics industry and sources of information on plastics. Only engineers and architects will be accepted for this course, the number of participants being limited to twenty.

The Course commences at 9.45 a.m. on Tuesday, 13th September, and ends at 5 p.m. on Thursday, 15th September. It will be held in the Beaumont Hall, University of Leicester, in the University's Botanic Gardens. The fee for the Course is 25 guineas, which includes residential accommodation at Beaumont Hall, breakfast, lunch and dinner (with wine), morning coffee and afternoon tea, all costs involved in evening activities as outlined below, including transport on both evenings as necessary, and lecture notes suitably bound for annotation during sessions and subsequent reference.

On the Tuesday evening there will be a 2-hour visit with commentary to the University of Leicester Engineering Building (Stirling and Gowan—Reynolds Award, 1963). On Wednesday evening members may attend a performance at Leicester's Phoenix Theatre (designed by Stephen George, Leicester City Architect, and completed in 1963) after which a private cheese and wine party will be held in the theatre itself. Glen Gorse Golf Club is about a mile away from Beaumont Hall and arrangements have been made with the Club Secretary to extend visitors' playing facilities and use of the bar to Course members. The Leicester Squash Club is 1½ miles from Beaumont Hall on the London Road and will also be open to Course members provided advance notice is given of intention to play. There will be no bar facilities at Beaumont Hall. There may be some study or reading requirements for up to one hour each evening.

Among lecturers who have agreed to speak are: Dr. J. R. Crowder, B.Sc., Ph.D., F.Chem.Soc., Richard Fitt, A.R.I.B.A., R. H. Greensmith, A.M.I.Mech.E., Professor Z. S. Makowski, Ph.D., A.M.I.C.E., R. G. B. Mitchell, A.P.I., Arthur Quarmby, Dipl. Arch., A.R.I.B.A., R. G. L. Welham, M.A.

Registration forms and other details may be obtained from the Chief Consultant, Polyplan Ltd., 97, Princess Road, Leicester.

Abstract of Reports

SOUTH SOMERSET HOSPITAL MANAGEMENT COMMITTEE

The Annual Report for 1965 by the South Somerset Hospital Management Committee was published on 21st June this year.

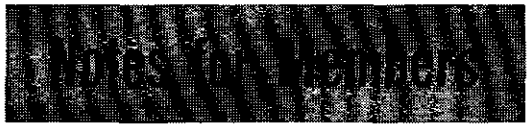
During the year the exterior of the New Maternity Unit was completed, and now the building and installation work of the interior is beginning to mould itself and should be ready for commissioning late in 1966. The provision of this unit will mean the closure of the Maternity Unit at Crossways, Yeovil, which is needed by the Borough Council of Yeovil to enable road improvements to be carried out at the five crossroads. The other unit to be closed for maternity services will be Balidon Maternity Hospital, Yeovil; this unit was first opened in 1951, and has met the needs of the general practitioners over a wide area, especially after the closure of the five maternity beds at Crewkerne Hospital.

The Main General scheme of Yeovil is progressing, many of the properties on the island site have been acquired, and to accommodate our ever-increasing nursing establishment, advanced residential accommodation will be sited on the corner of Roping Road and should be ready for occupation in December 1966; at the time of this report it is anticipated that work on the 10-storey hospital will commence in 1968/69.

At Yeovil General Hospital a major change has taken place within the kitchen, which has been enlarged and modern equipment installed; this has been done to cope with the increased number of meals in relation to the new maternity unit. The X-ray Department has installed new equipment such as an "Autonome 6" tilting table with moving table top, reciprocating bucky diaphragm, and necessary attachments. New foul wash machinery has been installed within the laundry and a new floor laid in the Children's Ward.

Minor capital schemes for completion 1965/66, 1966/67, include a recovery room at Yeovil General Hospital, alterations and improvements to the Labour suite, sluices, etc. at Merthyr Guest Hospital, and a day room at Crewkerne Hospital; this latter project is being financed by the Crewkerne Hospital League of Friends.

Among other major capital projects is Summerlands Hospital, which will mean the building of accommodation for 89 beds, adaptation of present administrative block, and the demolition of the whole of the present buildings, excluding the front block. This project will commence in 1966. The other project under review is to provide an additional 56 beds at Verrington Hospital, Wincanton, due to the closure of Town View Hospital, Wincanton, by Somerset County Council, and finally the completion of the improvements to Merthyr Guest Hospital, Templecombe.



23rd ANNUAL CONFERENCE

The setting for the 23rd Annual Conference was The Guildhall, Portsmouth. It was in this magnificent building, the interior of which has been beautifully reconstructed because of War damage, that the Lord Mayor of Portsmouth, Councillor Clifford A. Worley, J.P. welcomed the representatives on behalf of the Corporation of Portsmouth. A very cordial welcome was followed by the opening of the conference by the President of the Institute.

The first session of "Engineering Management and Administration," given by J. F. S. Robinson, Portsmouth College of Technology, was a good start—a meaty subject which gave the representatives much food for thought. This was followed by "Protective Devices for Electrical Circuits" by H. Simmonds in which new methods were described.

The evening of the Wednesday saw a Civic Reception and Dance, at the invitation of the Lord Mayor and Corporation of Portsmouth, held at the Rock Garden Restaurant. This was a thoroughly entertaining social occasion, greatly appreciated by the Engineers, their wives and guests, and the Institution is indebted to the Lord Mayor and Corporation of Portsmouth for their gracious hospitality.

The Thursday morning session opened with "Critical Path Planning and Scheduling" by G. W. Ward. This was a new subject to some of the audience and created great interest. In the afternoon a talk on "Interior lighting design for Hospitals" was given by M. Wood-Robinson, British Lighting Council. New designs, styles and layouts were appreciated by the representatives.

On Friday, J. H. Sutherland, Engineering Division, Ministry of Health, gave a talk on "Planned Preventive Maintenance in Hospitals." Using a method of visual effect, by showing photographs of the results of no planned maintenance, he was able to impress his audience most effectively.

The afternoon session was "A Report on the work of the Hospital Engineering Research Unit" by W. Carson, Leader of the Unit. This contained much information, which will no doubt be of great use in the future.

At the Annual General Meeting, the undoubted highlight was the announcement made by the Chairman of the successful outcome of the application to the Board of Trade for Incorporation. This, after a considerable period of time elapsing since the application was made.

The 23rd Annual Dinner, held in the Guildhall, was a fitting occasion to end the conference. The customary toast to Her Majesty the Queen was made, and was followed by the toast of The Lord Mayor and Corporation of Portsmouth. Other toasts were The Institution of Hospital Engineers and "Our Guests."

St. James Hospital extended a cordial welcome to the Members of Council and their wives by invitation to dinner. This proved to be a very pleasant social evening.

St. Mary's Hospital invited the Engineers and their wives to a cocktail party.

The success of the social activities, arranged by a Sub-Committee of the Southern Branch of the Institution of Hospital Engineers, for the ladies accompanying the representatives, was assured by the diligence of purpose in arranging, and contributed in no small way to the success of the conference.

LONDON BRANCH

A meeting was held at the Westminster Medical School on 16th April when a paper was read by Mr. Frank Freeman, A.C.W.A., entitled "The Engineer and the Budget". Mr. Freeman described the whole machinery of funding individual groups, from the Ministry of Health and through the Regional Hospital Boards. The method of apportionment to each Group was shewn and the manner in which the Budget is divided over the many sub-heads of expenditure by the Group Treasurer. In view of the great success of Mr. Freeman's paper, it was proposed that he be asked to come again and talk on the new hospital costing system.

EAST MIDLANDS BRANCH

At a meeting held at the Sheffield Royal Infirmary on 30th April, a paper was read by Mr. W. C. Jeffries entitled "Job Getting and Placing".

At the meeting held at Lincoln County Hospital on 21st May, a paper was read by Mr. Dutton of Midland Industries, Ltd. His subject was fluid control by the less sophisticated types of equipment.

A meeting was held at the Boston General Hospital on 18th June when Mr. L. Mitchell of Lincoln gave a talk on "Pathology". He explained that in the time available it would not be possible to cover the whole field and so confined his comments to the department of Bio-Chemistry. Various types of equipment and procedures were described, the whole giving an interesting and informative picture of the working of the department.

GLASGOW BRANCH

Mr. John Cadenhead has been elected Honorary Branch Secretary replacing Mr. R. Urquhart.

WEST OF ENGLAND BRANCH

A meeting was held at Lyngford House, Taunton, when a paper was read by Mr. C. E. Watkins of Messrs. Royles, Ltd. on the theory of using "Flash Steam" in hospital situations. Mr. S. Oaks was elected Chairman of the Branch with Mr. F. P. Smeardon as Vice-Chairman. Mr. P. Jackson continues as Honorary Branch Secretary.

SOUTHERN BRANCH

The 115th meeting of the Branch was held at the Royal South Hants Hospital when the officers were elected for the current year. The Branch formed a sub-Committee under the Chairmanship of Mr. A. M. Jones to assist and advise Headquarters on the organisation of the 1966 Conference to be held at Southsea. Their valued services were rewarded by a most successful and happy occasion.

WELSH BRANCH

A meeting was held on 7th May under the Chairmanship of Mr. J. G. Morgan when resolutions for submission to the Annual General Meeting were approved.

YORKSHIRE BRANCH

The resolution of the Branch that the Annual Conference and Annual General Meeting for 1968 should be held at Sheffield was unanimously approved by the members at the 1966 Annual General Meeting held in The Guildhall, Portsmouth.

A meeting was held at Seacroft Hospital, Leeds, on 12th March when Mr. J. D. Lewis delivered a lecture on "Planned Preventive Maintenance."

The April meeting was held at Huddersfield Royal Infirmary when a talk was given by Mr. N. Milnes on the commissioning of the new General Infirmary at Huddersfield.

H.S.E. SURVEY ON INCINERATORS

Engineers in the Health Service are urgently requested to give their full support to the survey on incinerators by completing and returning the forms which were attached to Hospital Service Engineering No. 4. It is important that a balanced sample be received in order to formulate a more accurate method of sizing incinerators than exists at present. The samples received to date have been predominantly from "large" mental hospitals, completed surveys from all other types of hospitals (including mental illness below 1,000 beds) are urgently required.

R. Findley Daglish, who was Superintendent Engineer to the Uxbridge Group H.M.C., is now with Turney Turbines of Station Road, Harrow. His duties include export and work in connection with hospitals.

Abstracts of information supplied by the British Standards Institution

REVISED BRITISH STANDARDS

B.S. 861:——Air-break switches and isolators

861: Part 2: 1966 Switches and isolators for voltages not exceeding 660 volts and currents up to 800 amperes a.c. 10s

A.C. switches and isolators for 240, 415 and 660 volts. Current ratings: Class 1, 300-800 amperes; Class 2, 60-800 amperes; switches for motor isolation, 15-800 amperes. Ratings, construction, performance, test requirements. Appendices on temperature measurement and determination of short-time current.

B.S. 1041:——Code for temperature measurement

1041: Part 4: 1966 Thermocouples 10s

Selection of appropriate thermocouple temperature measurement method. Appendix covers instruments for use with thermocouples.

B.S. 1133:——Packaging code

1133: Section 6: 1966 Temporary protection of metal surfaces against corrosion (during transport and storage) 30s

Guidance on cleaning and drying of metal surfaces prior to the application of temporary (i.e. easily removable) protectives against corrosion and on selection and application. Performance specifications for eight types of protective together with methods of test.

B.S. 2616: 1966 Milk can washing machines 4s

Construction and design, performance requirements, method of test.

B.S. 2791: 1966 Aluminium conductors in insulated cables 5s

Requirements for aluminium stranded and solid conductors of both circular and shaped sections in insulated cables.

AMENDMENT SLIPS

Please order amendment slips by quoting the reference number (PD...) and not the B.S. number.

Ref. No.

B.S. 37:——Electricity meters

Part 3: 1953 Single-phase 2-wire prepayment meters. Amendment No. 1 PD 5787

B.S. 148: 1959 Insulating oil for transformers and switchgear. Amendment No. 2 PD 5772

B.S. 743: 1951 Materials for damp-proof courses. Amendment No. 2 PD 5764

B.S. 843: 1964 Thermal-storage electric water-heaters (constructional and water requirements). Amendment No. 1 PD 5785

B.S. 864: 1953 Capillary and compression fittings of copper and copper alloy for use with copper tube complying with B.S. 659 and B.S. 1386. Amendment No. 3 PD 5754

B.S. 1016:——Methods for the analysis of coal and coke

Part 13: 1961 Tests special to coke. Amendment No. 2 PD 5768

B.S. 1290: 1958 Wire rope slings and sling legs. Amendment No. 2 PD 5755

B.S. 1542: 1960 Equipment for eye, face and neck protection against radiation arising during welding and similar operations. Amendment No. 3 PD 5776

B.S. 1564: 1949 Pressed steel sectional tanks (rectangular). Amendment No. 1 Price 3s PD 5792

B.S. 3093: 1959 Latex foam rubber hospital mattresses. Amendment No. 1 PD 5760

B.S. 3826:——Silicone based water repellents for masonry

Part 1: 1964 for clay brickwork. Amendment No. 1 PD 5756

B.S. 3869: 1965 Rigid expanded polyvinyl chloride for thermal insulation purposes and building applications. Amendment No. 1 PD 5778

ELETTRA SOUND SYSTEMS MOBILE EXHIBITION

Hospital Equipment Demonstration Tour

Marconi Marine's demonstration vehicle, which for the past 18 months has travelled over 12,000 miles throughout Britain and the Continent taking the latest marine communications equipment and electronic navigational aids right to the client's doorstep, has completed a major refit in readiness for a tour, commencing on 11th August, during which a comprehensive range of Elettra Sound Systems equipment for hospital intercommunications and entertainment purposes is being shown to hospital interests throughout the country.

During August the tour covers Winchester, Bristol, Cardiff, Birmingham and Liverpool. Crossing the border into Scotland the vehicle is scheduled to visit Glasgow from 5th to 9th September and Edinburgh on 13th September. The return journey south will include calls at Newcastle upon Tyne, 15th and 16th September, Sheffield, 19th September, Manchester 20th and 21st September and Leeds 22nd and 23rd September, returning to Chelmsford on 24th September.

The vehicle's installation of Elettra Sound Systems equipment for hospitals include examples of a patient/nurse calling and entertainment system with two-way speech communication, patient/nurse luminous and audible calling and entertainment systems using both conventional and solid state switching, and a patient/nurse luminous and audible calling system in which no ward cabling is required.

Also on display are an entertainment rack, record player and tape recorder, a fully operative 'Mimcall' radio paging system, a 'Radiomic' complete with a portable sound reinforcement demonstration unit, a television aerial distribution system, a 'Viking' loudhailer, a 'Stentor' portable public address and loudhailing system, both valve and transistorised amplifiers, loudspeakers of various types, an electronic stethoscope and speech aid equipment. All the equipment is, of course, in full operational order and can therefore be demonstrated in use.

PAINTING & VARNISHING PLYWOOD

A new leaflet giving some simple advice on painting and varnishing plywood for use outdoors or in humid surroundings has been published by the makers of Cresta WBP bonded and woodworm proof plywood, United Africa Company (Timber) Limited.

(*Continued from page 101*)

have the severe restrictions on eating and drinking which must be imposed on the patients treated with the artificial kidney. The staff and facilities can treat new patients and do not have to be tied to the continuing treatment of the same patients, as is the case with artificial kidneys. Thus St. Mary's will transplant about 30 patients this year and will be able to do at least a further 30 next year without any increase in the facilities.

The Hospital feels that their transplantation efforts are rather overshadowed by the attention given by the press to artificial kidney machines, and this rightly or wrongly, they feel, militates against their obtaining finance which they badly need and find difficult to procure. They hope for a wider public understanding of the present results attainable and claim these results are improving all the time, but they want a much larger research programme behind the clinical one.

READING AND DISTRICT HOSPITAL
MANAGEMENT COMMITTEE
HOSPITAL ENGINEER

Applications are invited for the post of Hospital Engineer at Battle Hospital, Reading. To be responsible to the Group Engineer for the operation and maintenance of engineering services at the hospital where major development is proceeding.

Applicants should possess H.N.C. or H.N.D. in either Mechanical or Electrical Engineering with appropriate endorsements, and candidates must have completed an Apprenticeship in Mechanical or Electrical Engineering or have otherwise acquired a thorough practical training.

Salary Scale: £1,107 to £1,287.

Application forms and further particulars from Group Secretary, Reading and District Hospital Management Committee, 3, Craven Road, Reading.

THE UNITED OXFORD HOSPITALS

Applications are invited for the post of Assistant Engineer to the Cowley Road and Slade Hospitals. Salary scale £834 x 31 (8)—£1,082 per annum. Whitley Council Conditions of Service.

Applicants should have completed an apprenticeship in mechanical engineering, hold an Ordinary National Certificate, and have experience of the operation and maintenance of *steam boiler plant and* mechanical and electrical services.

Temporary accommodation may be available.

Applications, giving full particulars of age, qualifications and experience, together with the names and addresses of three referees, to be sent to the Establishment Officer, the Radcliffe Infirmary, Oxford, by 10th September, 1966.

MENDIP HOSPITAL, WELLS, SOMERSET

Applications are invited for the post of HOSPITAL ENGINEER at this Psychiatric Hospital of 850 beds. Salary £1,082 rising to £1,262 per annum. A house will be available at a moderate rent.

Application forms from the Group Secretary, Mendip Hospital,

ASSISTANT HOSPITAL ENGINEER

Applications are invited for the post of Assistant Hospital Engineer *at The West Hill Hospital, Dartford, where extensive re*development is taking place. Ordinary National Certificate in engineering or equivalent qualification required. Inclusive salary scale £909—£1,157 a year. Applications to the Group Engineer, Group Administrative Offices, Bow Arrow Lane, Dartford.

KING'S COLLEGE HOSPITAL
Denmark Hill, S.E.5

Applications are invited for the post of DEPUTY GROUP ENGINEER at a salary of £1,429 rising by annual increments to £1,614 including London Weighting.

This is a new post necessitated by the recent enlargement of the group of hospitals and offers excellent experience and career prospects in hospital engineering.

Candidates should have completed a thorough training in mechanical engineering and hold either the Higher National Certificate or Diploma in Mechanical Engineering, with endorsements in Industrial Organisation and Management and Principles of Electricity or Electro-Technology, or the City and Guilds Mechanical Engineering Technicians Full Technological Certificate, Part III, including Plant Maintenance and Works Service.

A sound knowledge of steam boiler plants and the installation and maintenance of electrical services, plant and equipment is also required.

***Applications, stating age, qualifications* and experience, together with the names of two referees, should be sent to the House Governor by 19th September, 1966.**

NORTH WEST METROPOLITAN REGIONAL HOSPITAL BOARD
NORTHWICK PARK HOSPITAL AND CLINICAL RESEARCH CENTRE
ASSISTANT RESIDENT SERVICES ENGINEER

required for mechanical and sanitary building services for new *Northwick Park Hospital project*, valued at approximately £13·5m. The site is on the border of Brent and Harrow. A Resident Services Engineer and an Assistant for electrical services have been appointed. There will be an opportunity for some interchange of responsibility between the mechanical and electrical assistants.

Salary scale (Site Engineer grade II) £1,679—£1,976 including *London Weighting*.

Appointment is for about seven years.

Candidates should preferably hold the Ordinary National Certificate in mechanical engineering, and should have served an apprenticeship in mechanical engineering and have had at least five years' experience as clerk of works or project engineer on engineering services.

Application forms from the Secretary, North West Metropolitan Regional Hospital Board, 40, Eastbourne Terrace, London, W.2, quoting reference 663, returnable by 15th September, 1966.

WEST BROMWICH & DISTRICT H.M.C.

Applications are invited for the post of ASSISTANT ENGINEER at Hallam Hospital. The post is non-resident and the duties cover the full range of Engineering Services. Salary scale £834—£1,082 per annum.

Applicants should hold an O.N.C. in Electrical or Mechanical Engineering.

Applications stating experience, age and qualifications, with the names of two referees, should be forwarded to the Group Secretary, West Bromwich and District Hospitals Management Committee, Edward Street, West Bromwich.

SURREY COUNTY COUNCIL
County Welfare Department

ENGINEER required at St. Anne's, Redhill, Surrey, a joint user establishment of over 400 beds.

Salary £1,082 x £36 (5)—£1,262 p.a. (subject to approved qualifications) and conditions of service in accordance with Whitley Council, Professional and Technical Council " B ". An additional £1 per week is payable for stand-by duties.

Application forms and details of duties from County Welfare Officer, County Hall, Kingston upon Thames.

ASSISTANT ENGINEER required for hospitals in the West Wilts Group. Applicants must have completed an apprenticeship in mechanical or electrical engineering and hold an Ordinary National Certificate in Engineering or an equivalent qualification. Preference will be given to applicants qualified in electrical engineering. Present salary scale £834 per annum, rising by annual increments to a maximum of £1,082 per annum. Two increments above the minimum may be payable for candidate with relevant experience since the completion of his practical training. Current driving licence an advantage. Applications, stating age, qualifications and experience, together with the names and addresses of two referees, should be sent to the Group Secretary, West Wilts Hospital Management Committee, St. John's Hospital, Bradley Road, Trowbridge, Wiltshire.

FOR EVEN THE MOST DIFFICULT WASTE

The New Scorer TYPE M Incinerators

M.4 SPECIALLY FOR THE DISPOSAL OF LIQUID AND THEATRE WASTE

Specially for use in hospitals, the Scorer Type 'M.4' incorporates separate troughed crematory hearth–gas or oil fired–for the rapid disposal of liquid or infected theatre waste. No leakage through charging door or into ashpit. Thus risk of cross-infection is reduced.

Showing the M.4 installed at a hospital in the North West of England

Scorer incinerators have increased their lead in design with the Type 'M' range. Sixteen sizes set a new standard in the effective disposal of even the most difficult waste without objectionable odours. Either town gas, bottled gas or coke can be used as auxiliary fuel—the Type 'M' is equally efficient with each, and highly economical. Other important features are the push-button ignition and 100% flame failure protection, based on flame rectification principle. The Type 'M' is designed for the simplest, speediest, most inexpensive fitting of replacement parts when necessary. Needless to say, it meets all the requirements of the Clean Air Act.

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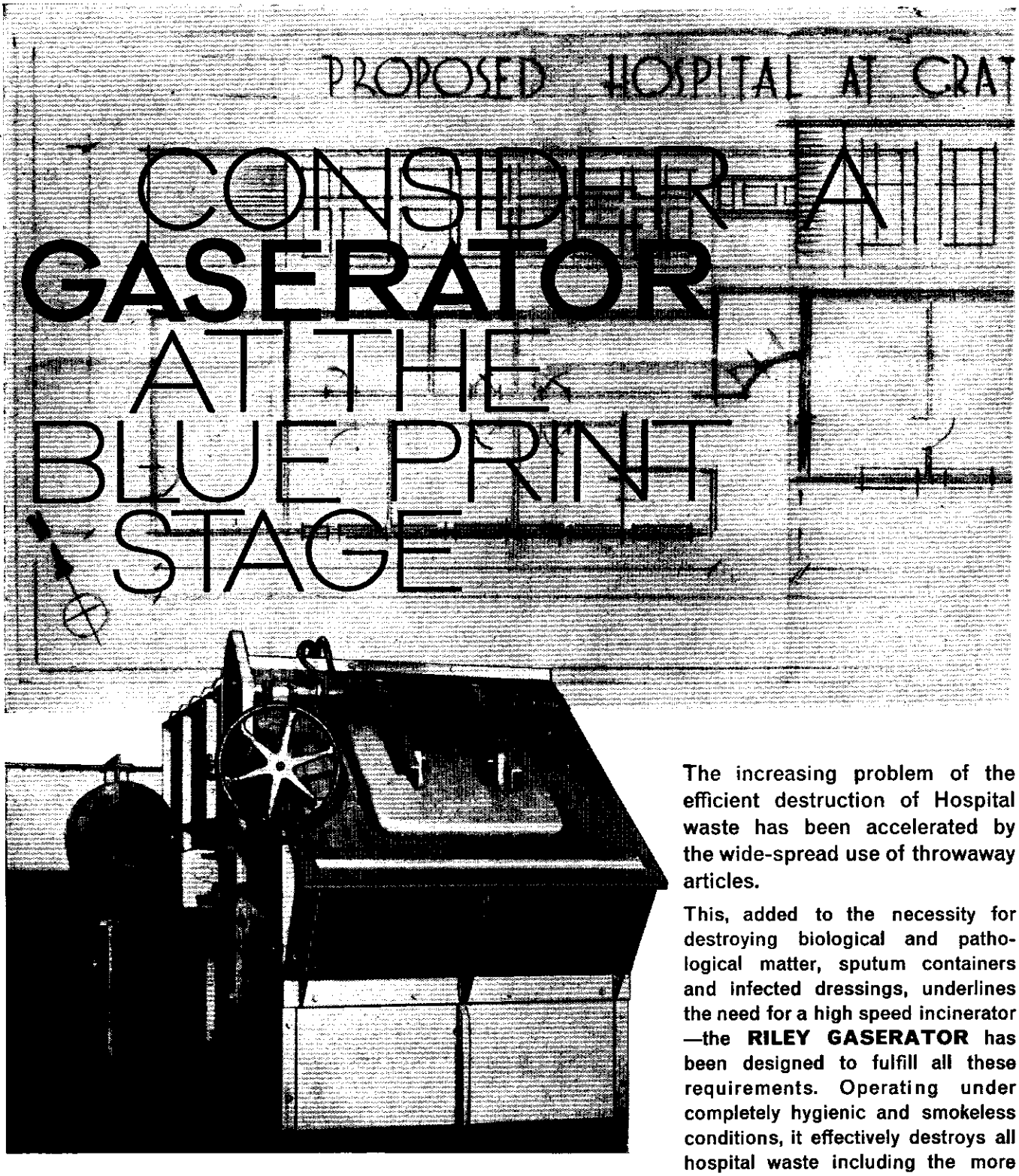

The increasing problem of the efficient destruction of Hospital waste has been accelerated by the wide-spread use of throwaway articles.

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Brochure G 649 for full technical information on this equipment

INFORMATION ON ALL ASPECTS OF INCINERATION FOR HOSPITALS & INDUSTRIAL USES

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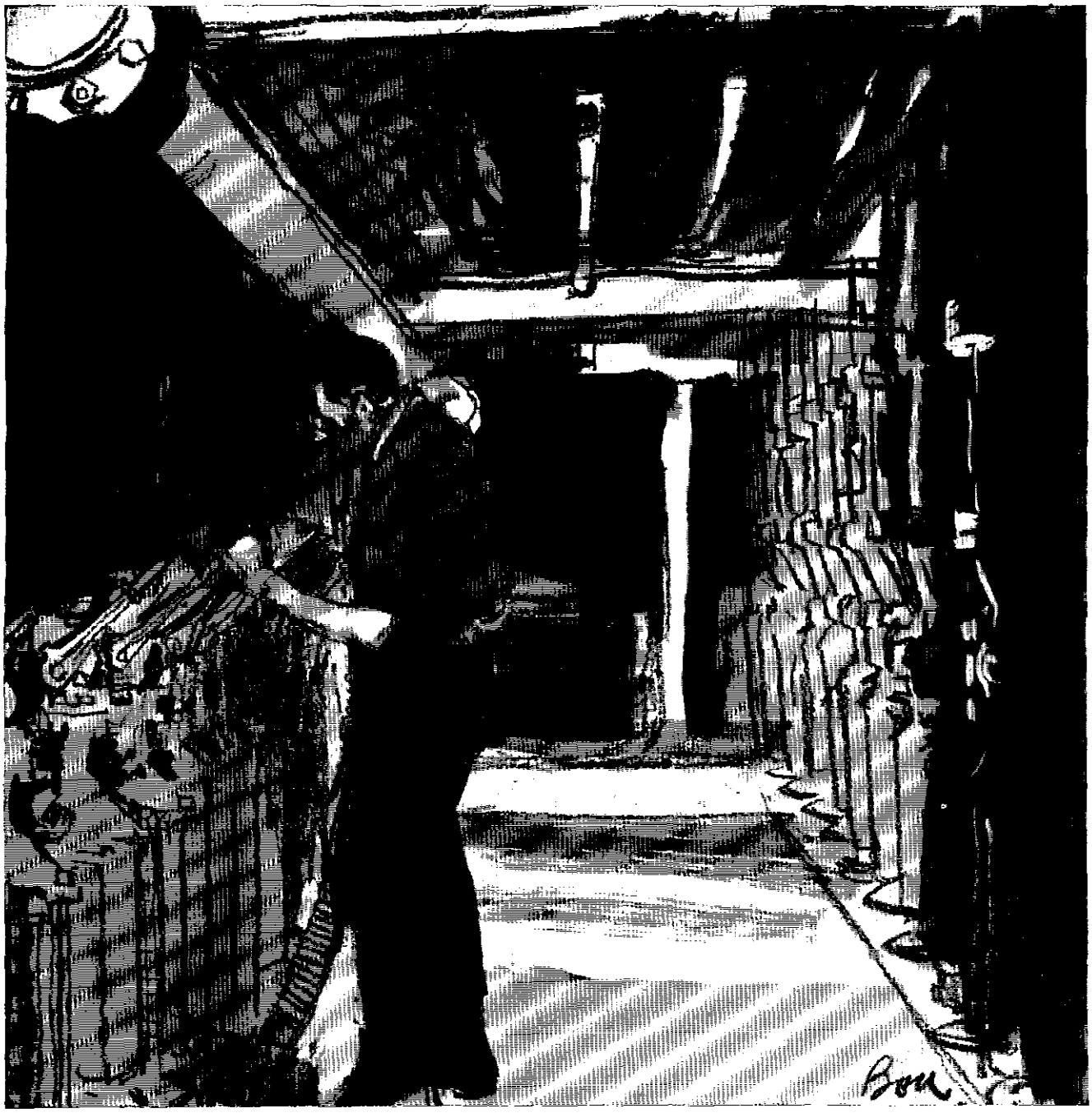

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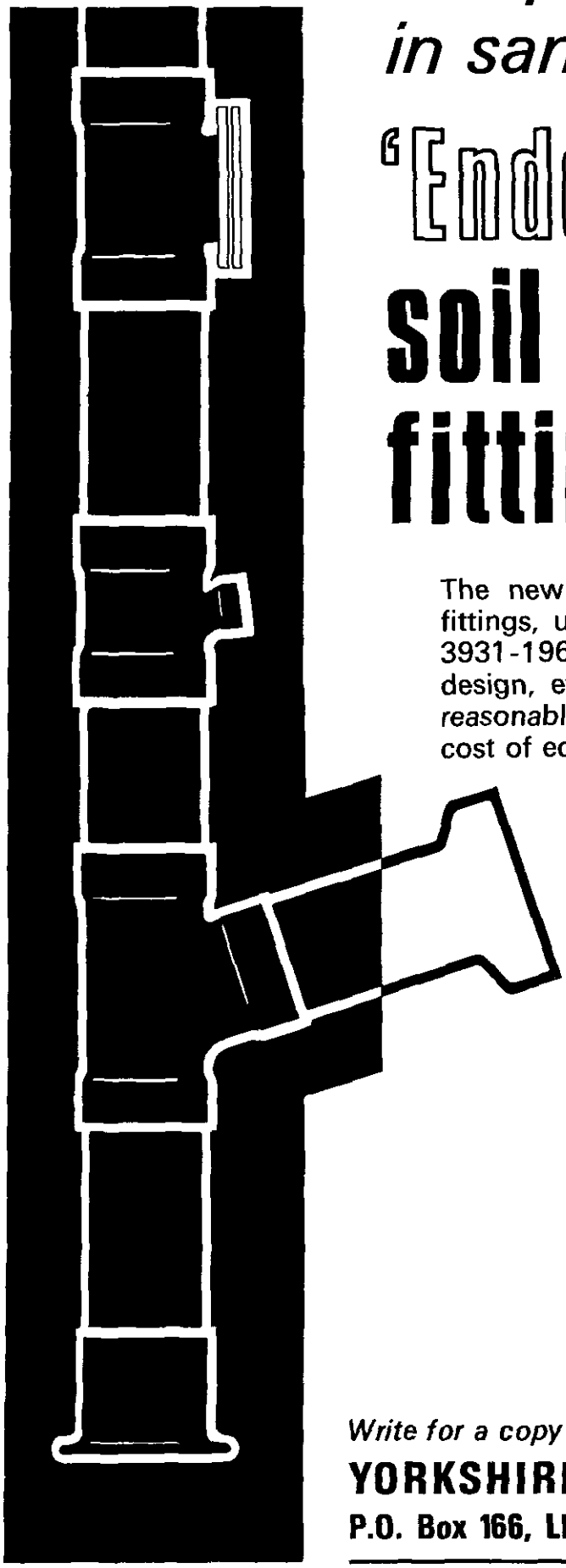

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The advantages of using copper are well known and these fittings are hydraulically formed to simple, streamlined design, correctly angled and with socket diameters made to close tolerances to permit capillary joints by end feeding with soft or hard solder.

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The A.P. GREEN GUIDE TO REFRACTORY MAINTENANCE

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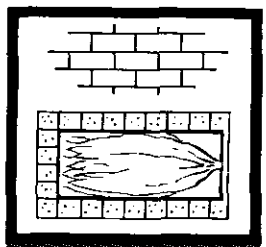
1 Use SAIRSET refractory cement for laying-up all types of firebrick. Protect new and existing brickwork with a coating of SAIRSET. Seal cracks—reduce risk of spalling and slag attack. SAIRSET is available in ½ cwt., 1 cwt., and 2 cwt. drums ready mixed. It should be in your maintenance store.



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2 Repair damaged walls with HYBOND plastic refractory. Can be used for small gaps or the complete wall or arch For extreme temperatures use HIGH ALUMINA PLASTIC. HYBOND is delivered in 1 cwt. cartons sliced ready for ramming-in.

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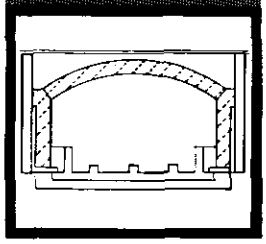
3 Avoid intricate brickwork and special shapes by lining with KAST-SET refractory concrete. Simply mix and pour. When an insulating refractory is required for furnaces use KAST-O-LITE. Monolithic linings are economical on fuel and simplify maintenance. A. P. Green refractory concretes are sold in 1 cwt. bags.



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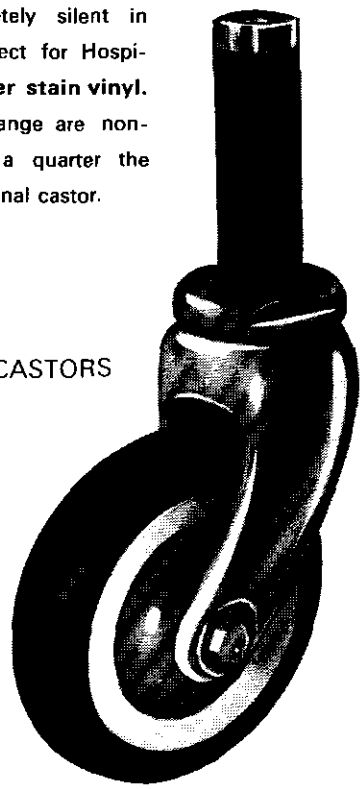

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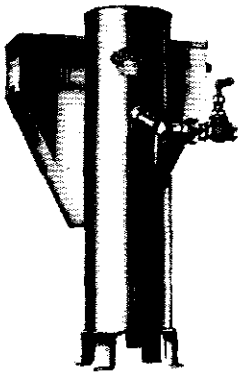

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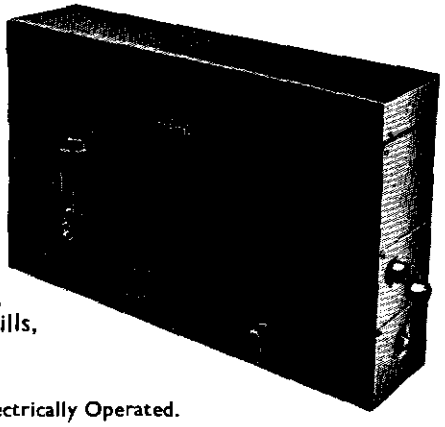

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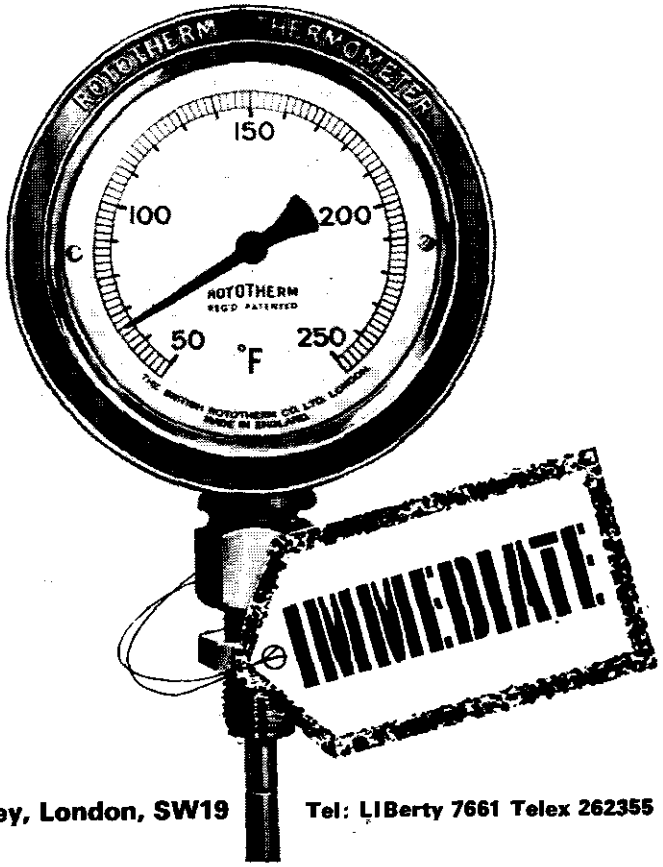

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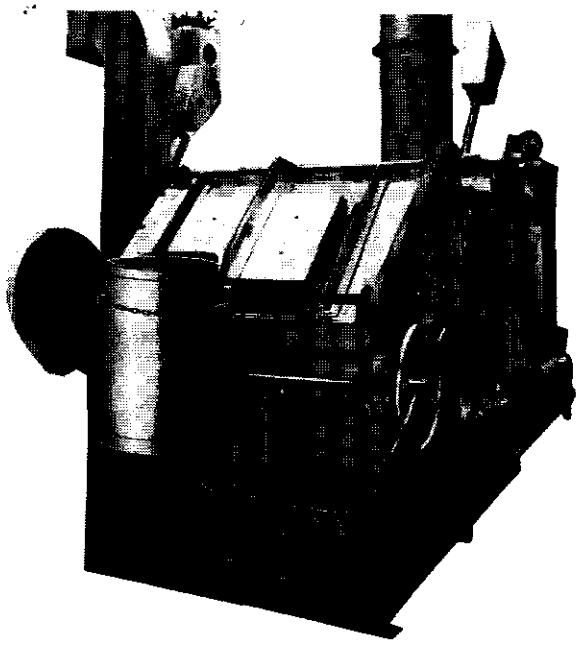

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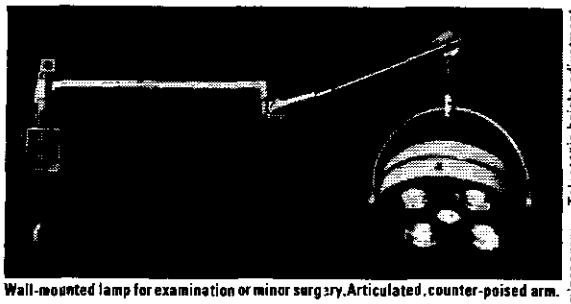

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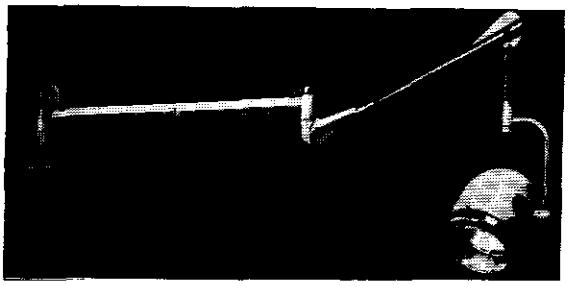

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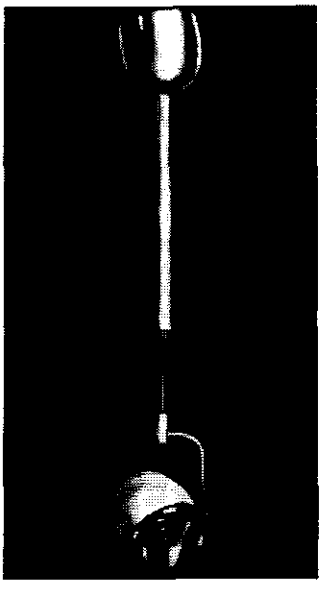

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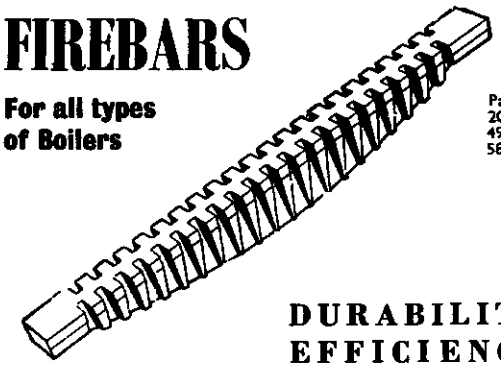

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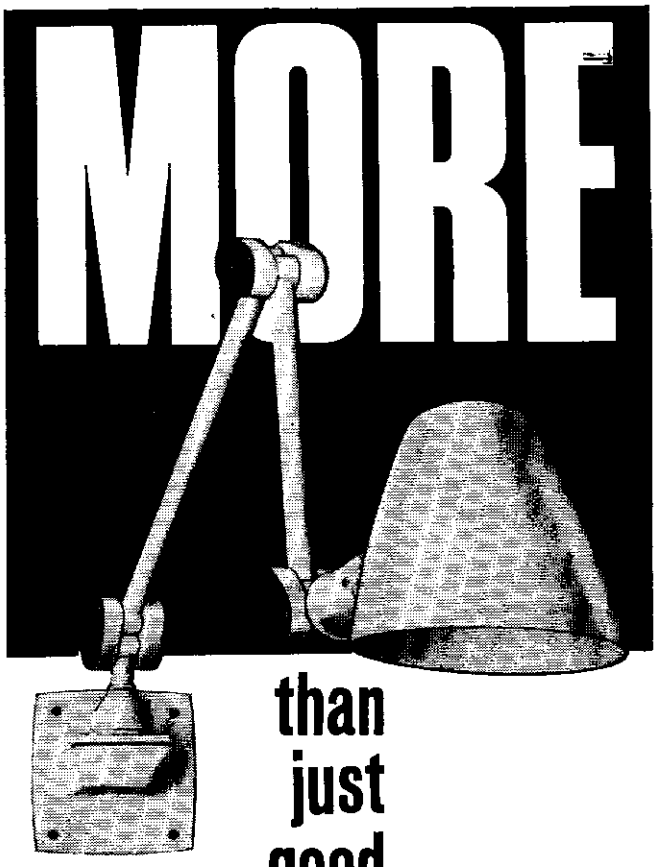

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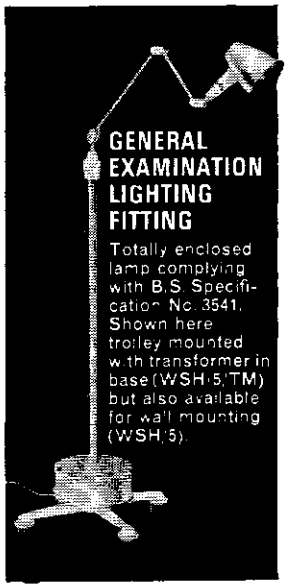

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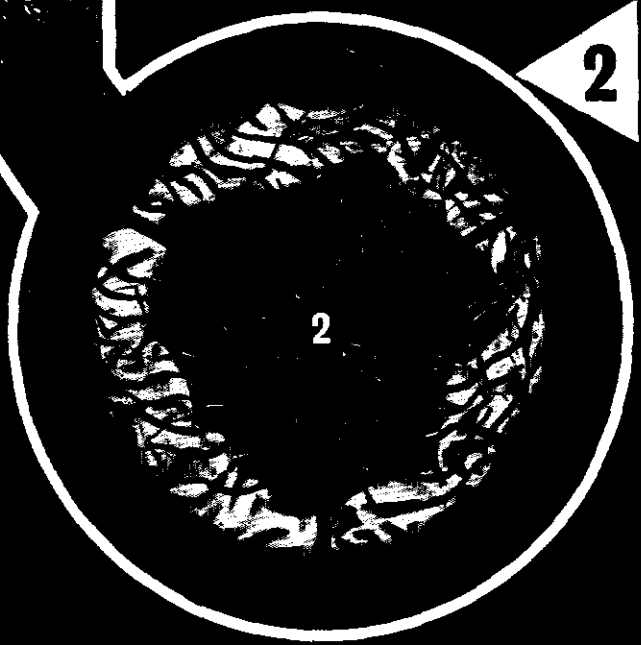

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To all Members

The service of Mr. C.D. Belton, O.B.E. as Secretary and Treasurer of the Institution ceased on 31st August, 1966.

His successor is Mr. J.E. Furness, who has now taken over Mr. Belton's responsibilities.

H.A. ADAMS,
Chairman.