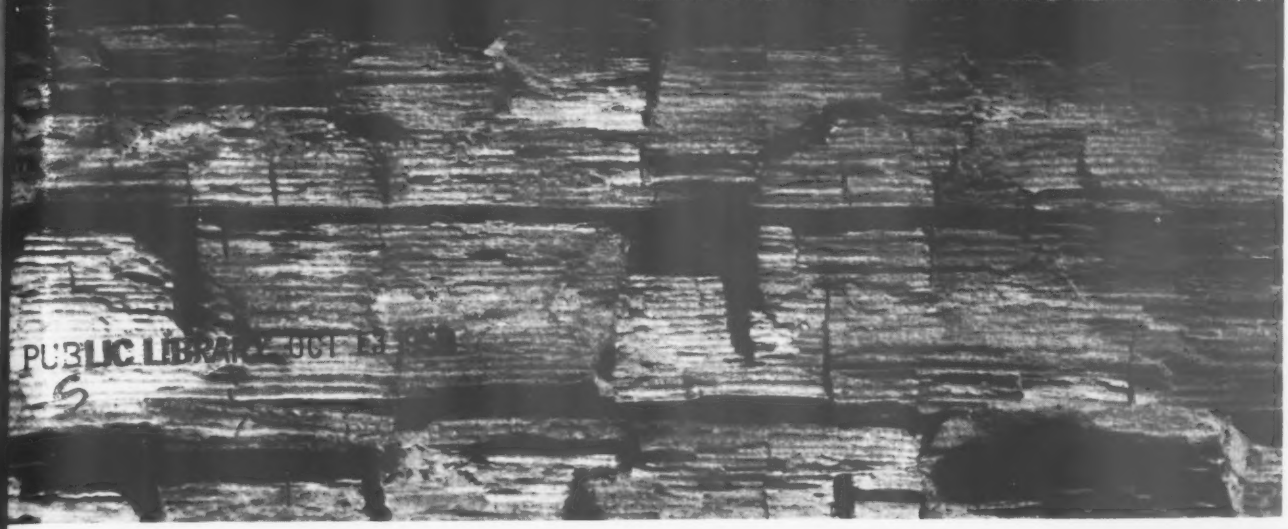
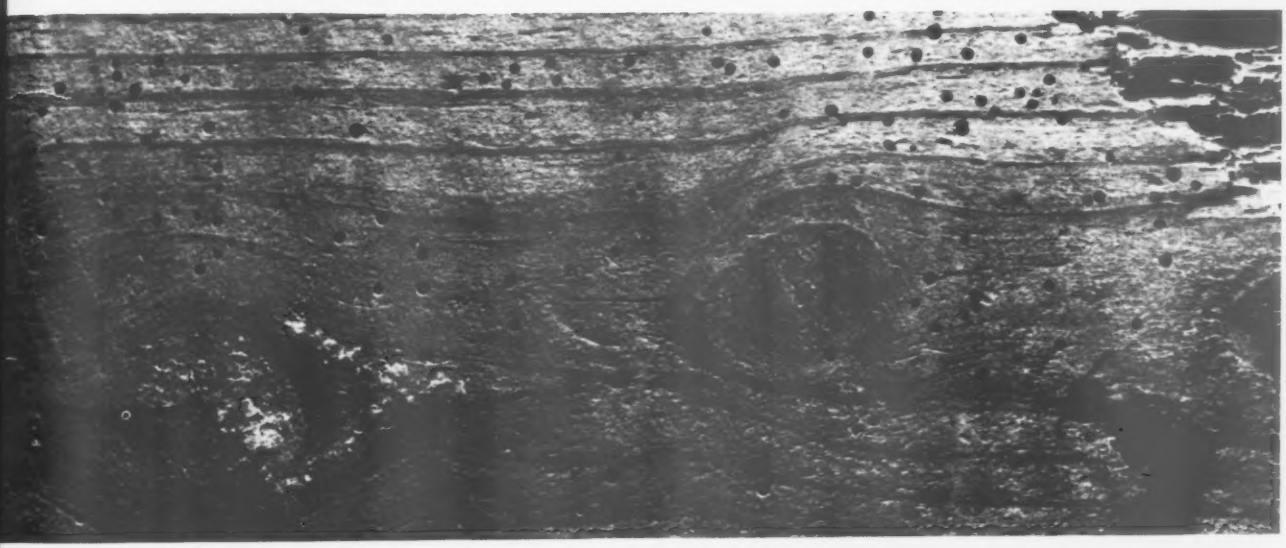
The Architects' Journal

September 25, 1958. Vol. 128 No. 3317. One shilling. Registered as a newspaper





PESTCURE LIMITED

This week's A.J. front cover shows cuboidal fracture of Dry Rot and natural size exit or flight holes of Furniture and Death Watch Beetles.

SURVEYS AND SERVICE

E. H. B. Boulton, M.A., Diploma in Forestry (Cambridge), Fellow of the Institute of Wood Science, Technical Director of the Timber Development Association for fourteen years, University Lecturer at Cambridge for thirty-two years.

Carries out full structural surveys in buildings for wood-destroying Fungi and wood-boring Beetles.

• • •

Specialist treatment is carried out by teams of Technicians, trained by Mr. Boulton, who know how much cutting away is necessary before treating with Insecticide for Beetle damage; this ensures that a full structural inspection is made of the condition of the timbers.

For Dry and Wet Rot our Technicians carry out a heat and chemical treatment, and will instruct the Builder how far stripping out is necessary before this specialist work is done under guarantee.

DRY ROT (Merulius lacrymans)

FRONT COVER top photograph

" Dry Rot " which attacks damp timber, is caused by a fungus, Merulius lacrymans, which reproduces by means of millions of spores orange in colour. These spores act like seeds, and are spread by currents of air and vermin. They are capable of germinating in favourable conditions even after lying dormant for five years. When the moisture content of timber is above 20 per cent., any " dry rot " spores falling on it will germinate and send out microscopic rootlets, called hyphæ. These penetrate the wood and feed on the cellulose of the cell walls, causing shrinkage and finally leaving a dry crumbling mass of rotten wood. As growth continues, the hyphæ form thick root-like strands that travel long distances in search of more timber to feed upon. These water carrying tubes travel through plaster, stone and brickwork and mortar, exuding moisture on to dry or seasoned wood until it becomes damp enough for the hyphæ to attack and break down the cellulose and spread throughout the building. The strands and rootlets can remain alive for a very long time, even after dry conditions have been restored, and can break up into small fragments, each of which can become a fresh source of infection. If there is any lime in the mortar or chalk in the water, sodium fluoride should be avoided as it only precipitates and adds more water to the affected area. Although Merulius lacrymans is the true " dry rot " fungus, other fungi—particularly Poria vaporaria with white fluffy growths, and Coniophora cerebella with black strands—are also active destroyers of wood; but they are all killed completely by

PESTCURE DRY ROT SOLUTION

Pestcure Dry Rot Solution is a colourless liquid that kills " dry rot " without staining woodwork. It may be used both inside and outside buildings for sterilization and preservation, and being a water base, paint or distemper can be used within a few hours of treatment by Pestcure.

OFFICIAL APPROVAL

Tested by the Forest Products Research Laboratory, Department of Scientific and Industrial Research.
REPORT AVAILABLE—please apply to 1a, CAVENDISH SQUARE, W.1.

FURNITURE BEETLE

(Anobium)

FRONT COVER centre photograph

ATTACKS ALL TIMBERS. No longer confines its attacks to furniture, but is found in roofs, floors, timber yards, etc. The beetles emerge and lay their eggs during June, July and August. The larvæ bore for two to three years in the wood. The eggs are laid in clusters of two or three and one female beetle can lay between forty and eighty eggs and is capable of flying long distances, so it will be appreciated how dangerous it is to delay treatment of this pest.

DEATH WATCH BEETLE

(Xestobium)

FRONT COVER bottom photograph

BORES IN HARDWOODS, OCCASIONALLY FOUND ATTACKING SOFTWOODS. The beetle eats its way out during April, May and June, mates and lays its eggs on the unpolished surface of the wood. If these eggs are allowed to hatch and start boring into the timber, they can remain in the larval stage as long as ten years eating and destroying the wood all the time before emerging as a beetle to start the life cycle all over again.

TREATMENT

YOU KNOW YOU HAVE BEETLE DAMAGE when you see piles of sawdust-like deposit on floors and see signs of the exit holes made by the beetle eating its way out of the wood. All these beetles can fly, so it is impossible for anyone to guarantee a cure. A constant watch and IMMEDIATE treatment is the best safeguard, or exclusive use of treated timbers. Timbers that are attacked should be examined by our experts to make sure that they are capable of carrying their load before treatment. If they have to be replaced, a brush application of PESTCURE beforehand will keep the new timber immune from attack.

Every beetle infestation presents its own problem and it is useless to spray insecticide on to badly perforated timber without first cutting away down to sound wood. All soot, dirt and frass should be removed by our industrial vacuum method.

Pestcure Plus is the name we have given to the new formula which we now use exclusively for all beetle treatments.

For all polished surfaces and furniture we supply a special PESTCURE POLISH which is a preventive against beetle infestation as well as a cure.

Specialists in the eradication of Dry Rot & Woodworm

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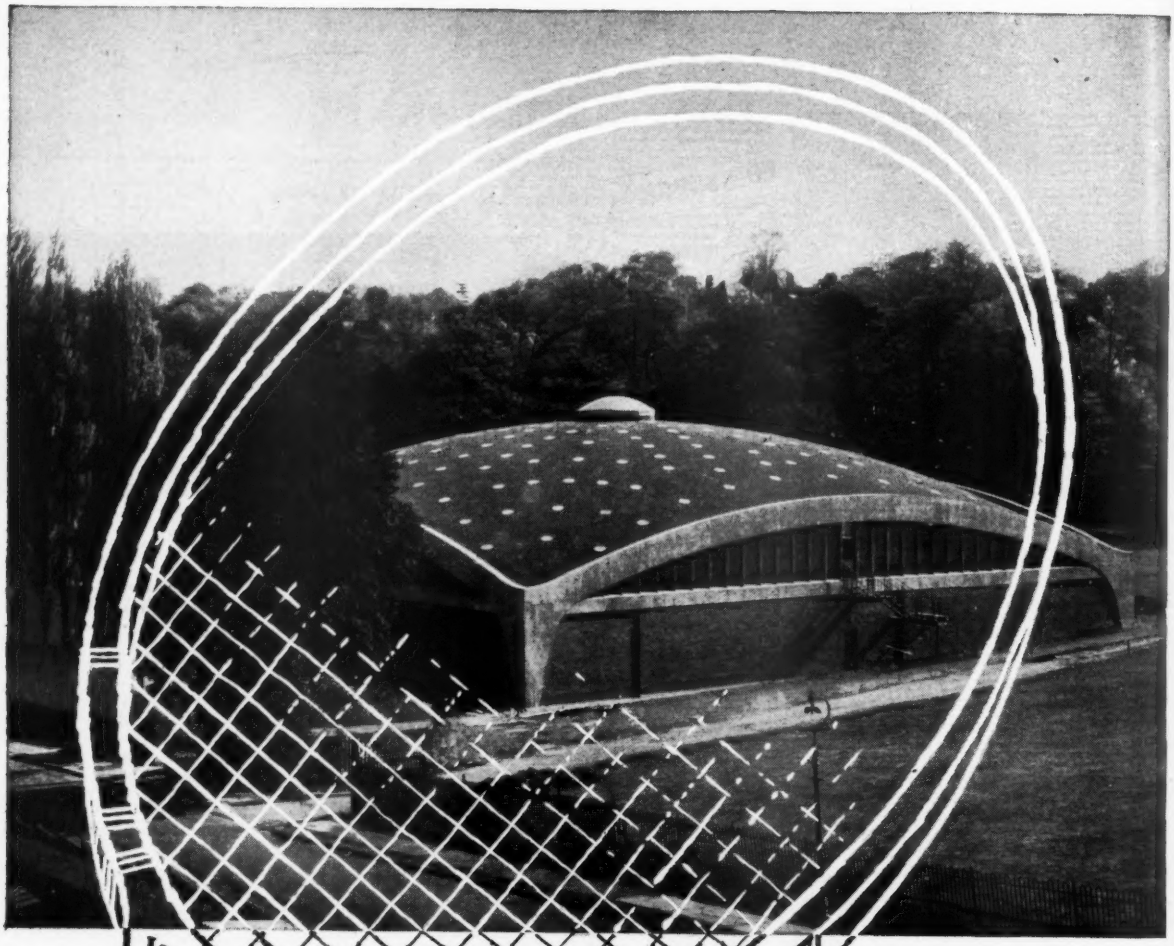
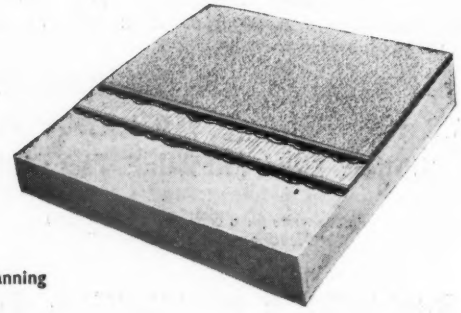


Consulting Engineers
C. J. Pell & Partners.
Main Contractors
W. H. Gaze & Sons Ltd.
In conjunction with Formcrete.

ANDERSON
at Wimbledon



The largest concrete dome in Great Britain forms the roof of the new covered courts at Wimbledon—spanning 175 feet and covering an area of 15,000 square feet. An Anderson two layer waterproofing system finished in green stone chippings was specified for this building, one of the most important sporting buildings in the country.

D. ANDERSON & SON LIMITED.

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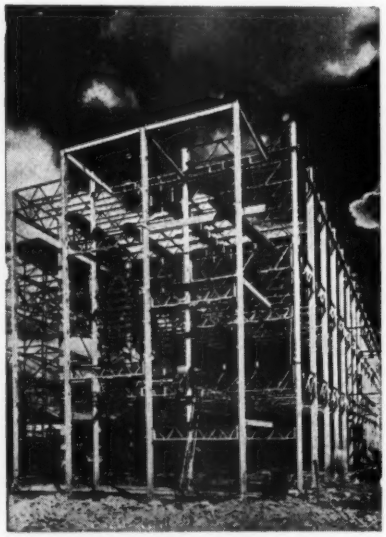
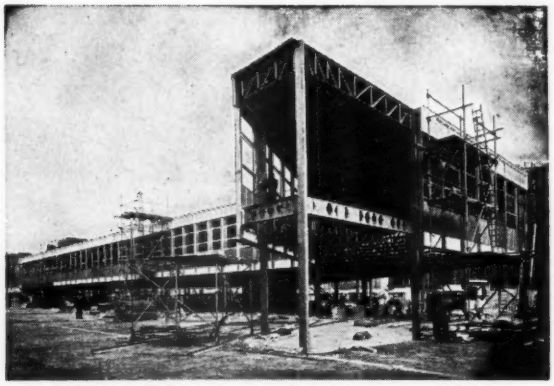
JN/B64

structural steelwork

THE BOWATER PAPER CORPORATION LIMITED. The Architects for the new Office Blocks at both Mersey and Northfleet designed for Lattice Steelwork on a modular grid which allowed service lines to be run between floor and ceiling and gave complete flexibility for internal arrangements.

Architects: Messrs. Farmer & Dark.



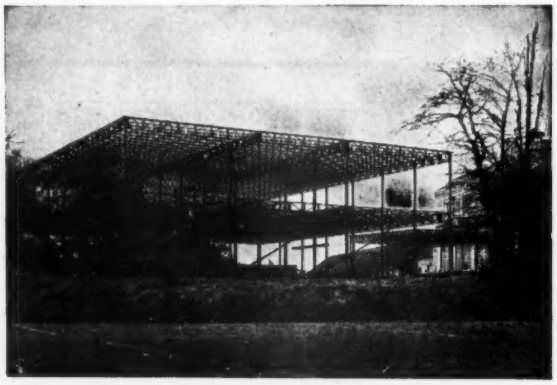


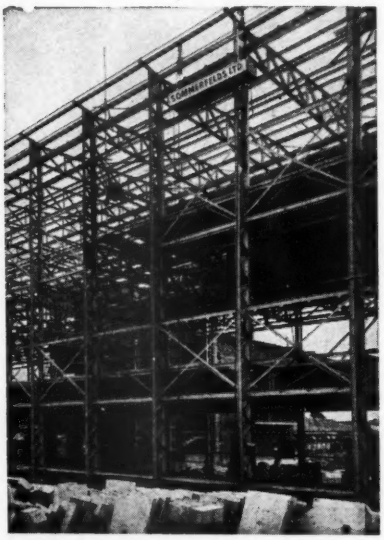
B.E.A. For this B.E.A. Building, speed was the essence of the Contract. Sommerfelds designed the Steelwork and from unloading the first lorry on site to the completion of a 250 ton steelwork erection took three weeks.

General Contractors: Messrs. Richard Costain Limited.

YORK. For the City of York a Grammar School. Sommerfelds designed the Steelwork on a 3ft. 4in. modular grid allowing complete freedom for the Architect to use curtain walling and internal arrangements.

Architect: E. Firth, F.R.I.B.A., A.M.T.P.I., City Architect.





I.C.I. For I.C.I. a Laboratory Block. A multi-storey building with a height to eaves of 44ft. and uninterrupted spans of 50ft. on each floor. Deep Lattice Beams and light stanchions were used with considerable saving in steel requirements.

Architects: Messrs. J. Douglass Matthews & Partners.

Sommerfelds LTD. WELLINGTON · SHROPSHIRE TEL 1000

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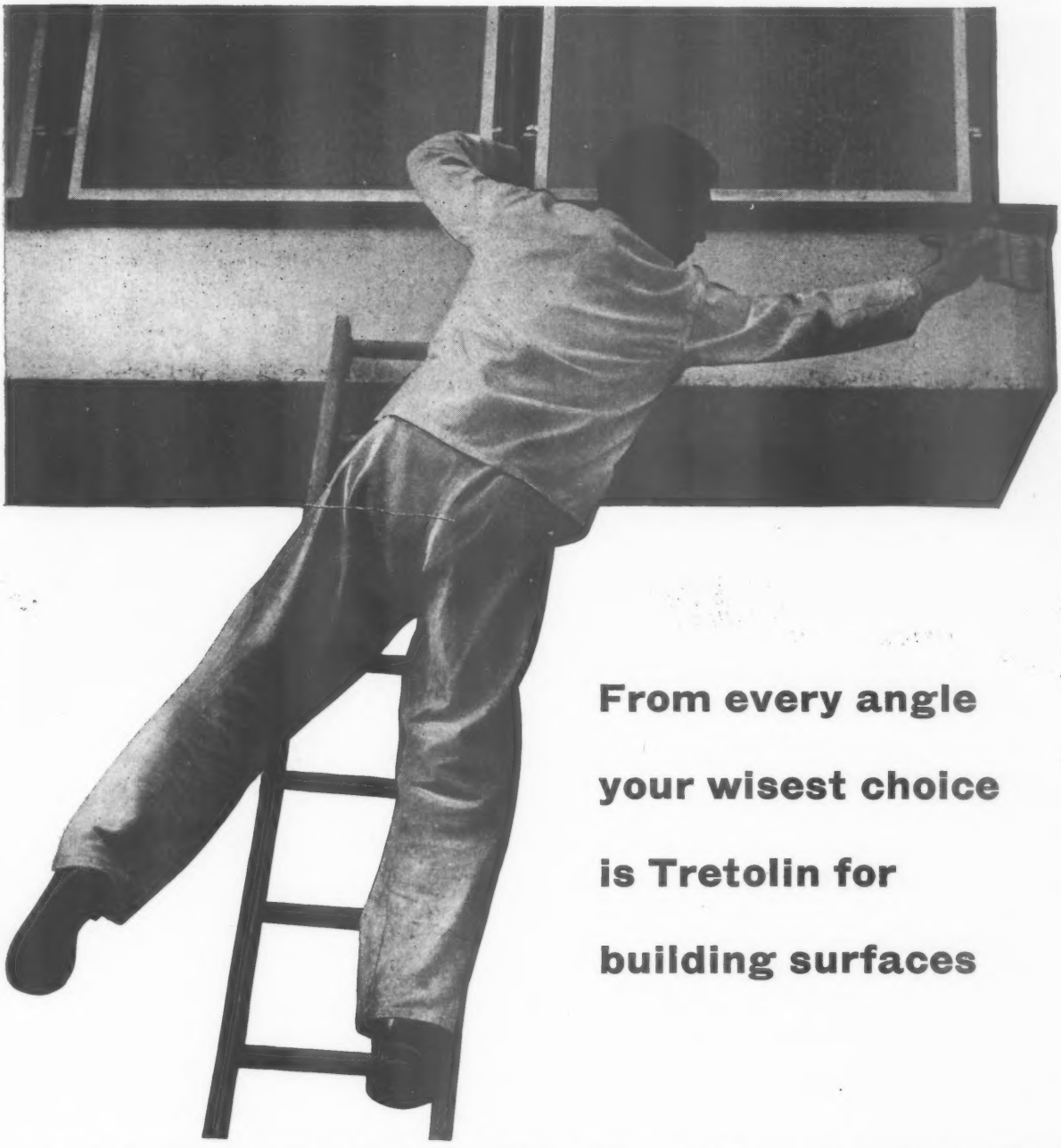

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Although versatility is claimed for many coatings, Tretolin, for the painting of *building surfaces*, really merits this description. Tretolin is not only the ideal paint for asbestos cement but is equally efficient and durable on concrete, brickwork and other surfaces.
Tretolin's performance under both interior and exterior conditions, or when exposed to chemical attack is unequalled and no sealers are required. It is available in a wide range of selected B.S.2660 colours and a series of one-coat roofing shades. Make Tretolin your first choice—it will be your wisest!

We shall be glad to send a set of Tretolin specification sheets for your files.

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For direct application to Asbestos-Cement, Concrete, Cement Renderings, etc.

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A WARNING

Febmix Admix and Febmix DeHydrated Mortar Plasticisers should only be used with Portland Cement and Rapid Hardening Cement, the user being thus protected by the fact that these cements conform to British Standard and produce a mortar having good strengths. Under no circumstances should Febmix Admix or Febmix DeHydrated Mortar Plasticisers be used with the so termed Masonry Cements as cements of that type usually have incorporated a high amount of chalk.

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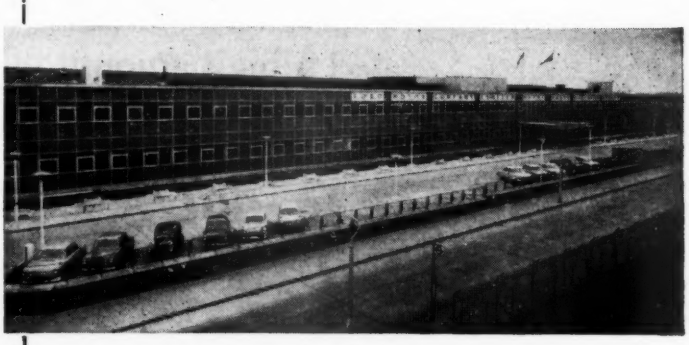
The newly completed Ford Parts Depot at Aveley, Essex, is designed in the most modern idiom of industrial architecture. It is therefore not surprising to find that the office block, including the canteen (illustrated above), is heated throughout by Crane Skirting Heating. This modern system uses heating panels in place of the conventional skirting to distribute warmth evenly at all levels without taking valuable floor space and without creating local 'hot spots'. The panels seen here are the 9-inch Type RC (Radiant-Convector). There is also **Type R (Radiant) which, in addition to the 6-inch size, has lately been made available in the 9-inch size for situations requiring additional heating surface.** The panels are in 2-ft. and 1-ft. lengths and are strongly made in cast iron for resistance to damage. Skirting Heating is the perfect modern method of space heating.

Once again, skirting heating by Crane



The frontage and office block of the Ford Parts Depot.
ARCHITECTS AND CONSULTING ENGINEERS: E. R. Collister and Associates, London, S.W.1
HEATING ENGINEERS: Brightside Heating & Engineering Co. Ltd., London, S.W.1

CRANE HEATING EQUIPMENT

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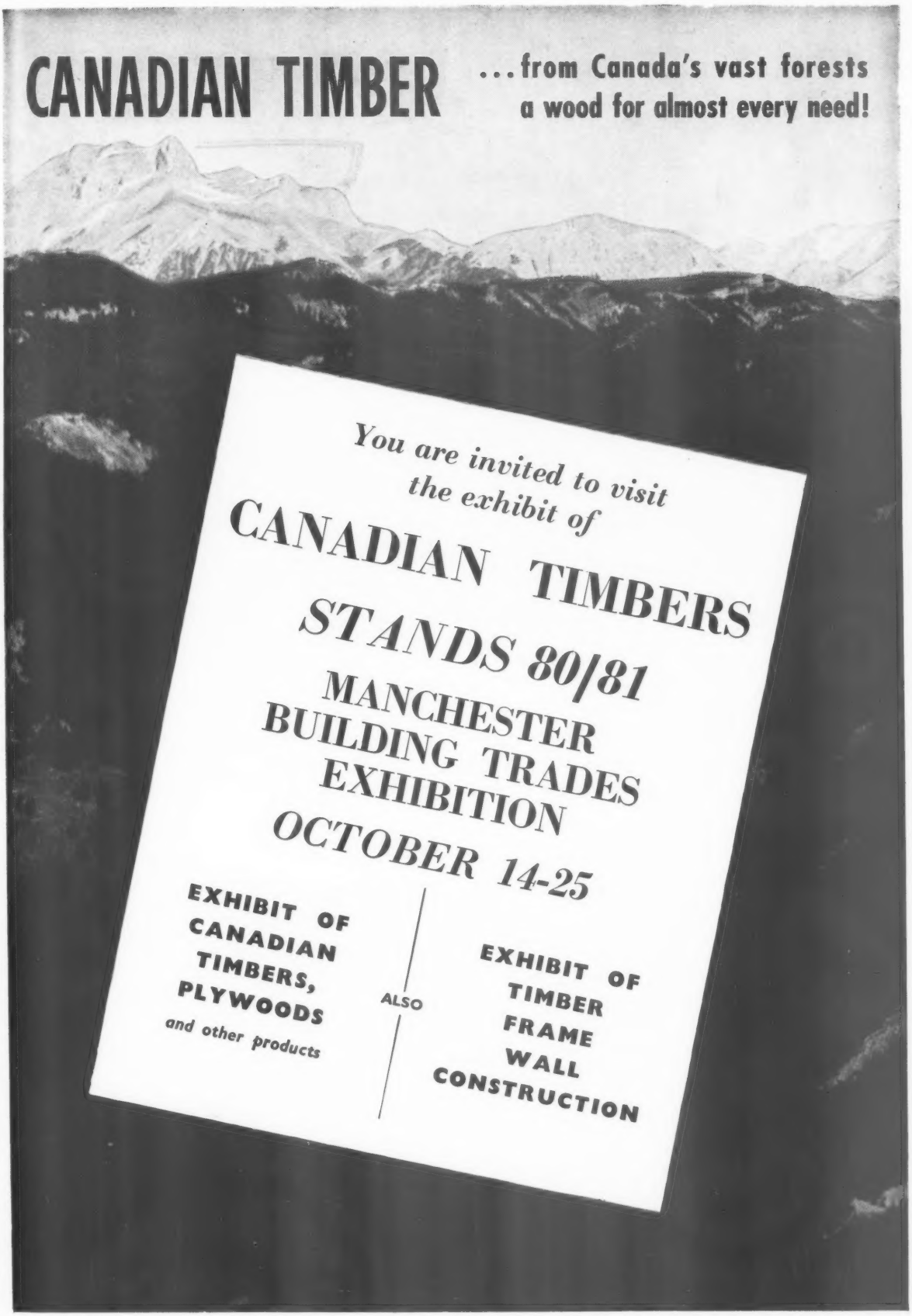
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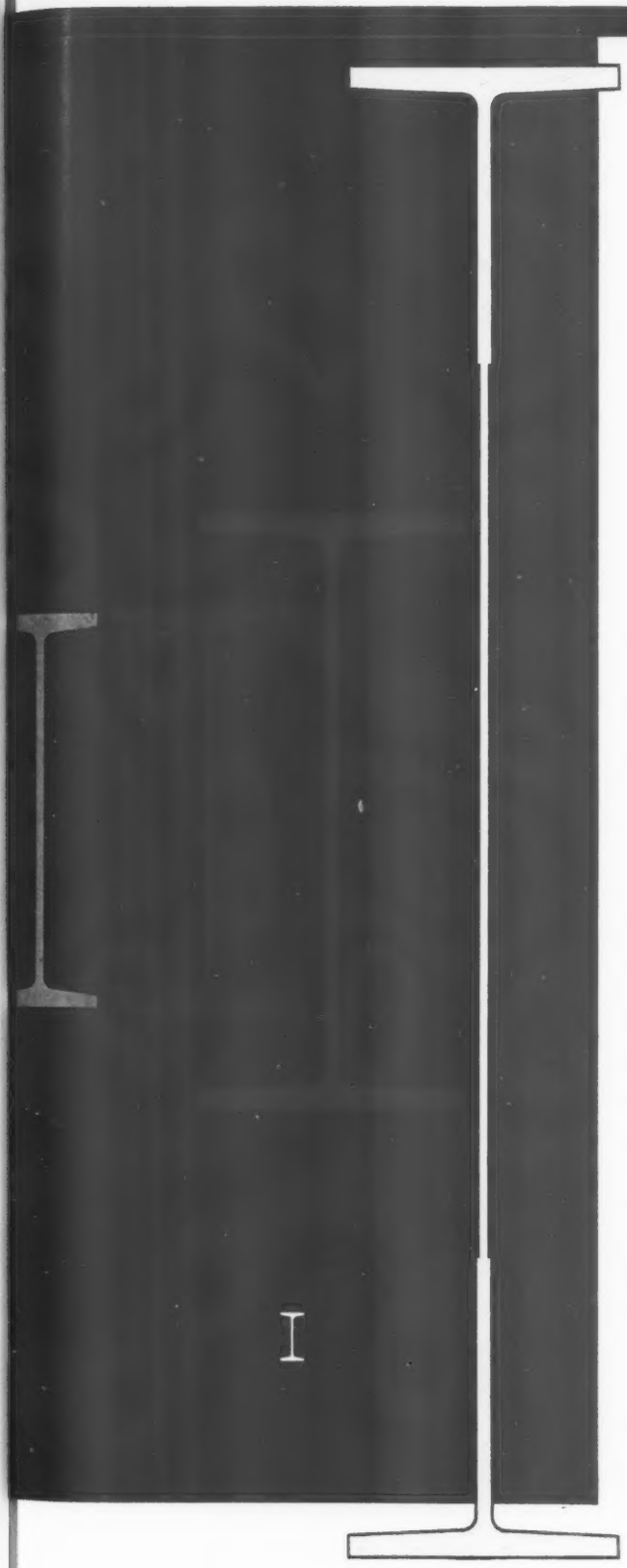

Extending the range of simplification

The new Dorman Long Universal Beam Mill is rolling beams having several times the load-carrying capacity of any previously rolled in this country: these are suitable for bridge spans or heavily loaded buildings without the need for additional flange reinforcement.

A great deal of plating and compounding of girders is thereby eliminated.

The range of simplification is still further extended by the availability of heavy Tee-sections cut from the large universal beams. Two such Tees, with a web-plate welded in, provide a deep plate girder of great load capacity.

The yellow section shows this construction; in red is the 36″ by 16½″ universal beam, in blue the 24″ by 12″, previously the largest rolled in this country, now available in three weights, and in grey is shown the largest of the B.S. sections, 24″ by 7½″. By way of contrast the little white section is the B.S. 3″ by 1½″, the smallest I section rolled by us.

DORMAN LONG

Architects:
Louis de Soissons, Peacock, Hodges & Robertson, London

Consulting Engineers:
R. T. James & Partners, London

Contractors:
Kirk & Kirk Limited, London

When the Warner Stand was built at Lord's Cricket Ground it was roofed with "BITUMETAL." "BITUMETAL" Aluminium Roof Deck ensures light clean construction, complete freedom from maintenance and a bright ceiling of attractive modern design. It also provides efficient insulation, and a durable weatherproof surface which can be laid in a range of natural colours.

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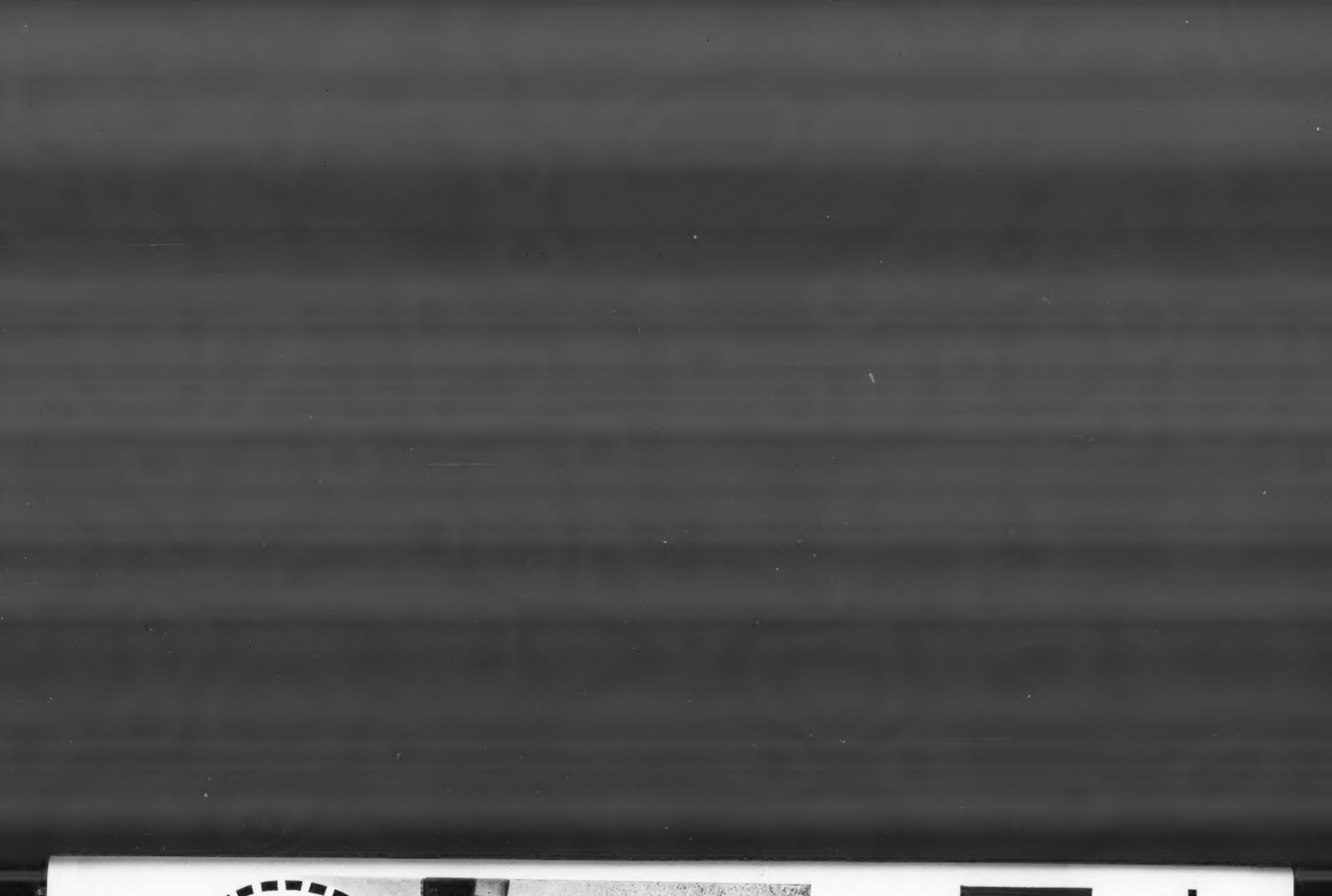

rising dampness?

SPECIFICATION

Damp Cellars and Basements.

Hack floor and walls, clean and damp surface and apply ½ in. thick rendering in two coats to walls, composed of 2½ parts clean sharp sand or fine granite chippings to 1 part cement (by volume) plus 5 lbs. Cementone No. 2 to each 1 cwt. cement; cove all angles and trowel to a smooth finish. Lay floor at thickness of ¾ in. to 1½ in. in one coat composed of same mix except that coarse hard aggregate should be used. Form watertight link-up between wall and floor rendering and cove floor and wall angle. (See Cementone No. 2 booklet for detailed sketches of application method.)

Approx. weight of No. 2 per yard super.

Walls	(¾ in.)	14½ ozs.
Floors	(¾ in.)	14½ ozs.
	(1½ in.)	1 lb. 13 ozs.

Where the pressure of incoming water cannot be reduced, or for sealing isolated pressure leaks, Cementone No. 8 Liquid Concrete Hardener can be used to quick set the cement, allowing renderings to be applied on to walls streaming with water or to plug and seal water bursting through cracks or open points.

Cementone No. 2 Waterproofing Powder, when mixed with cement, makes concrete or cement renderings 100 per cent waterproof. Mass concrete, basements and underground structures, renderings roughcast swimming pools and tanks can be constructed to withstand all moisture penetration by the simple addition of Cementone No. 2 Waterproofing Powder to the mix. Economical to use—permanent in effect. Full details sent on request.

number 2

WATER-PROOFING POWDER

YOU CAN DEPEND ON THE Cementone PRODUCTS

specially made for the job

THESE ARE JUST SOME OF THE WAYS

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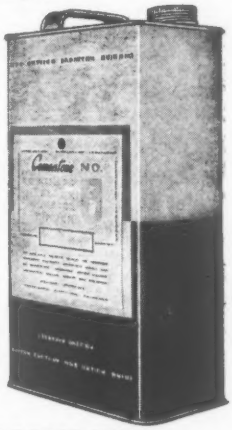
damp walls?

CEMENTONE NO. 3 STANDARD		CEMENTONE NO. 3 SILICONE TYPE.
Building Research Station test shows 5½ years plus: practical experience indicates 5-15 years.	LIFE OF TREATMENT	Estimated to be approximately five years.
Surface treated must be perfectly dry to be effective: rain immediately after application is not important.	APPLICATION CONDITIONS	Surface must be perfectly dry; and dry conditions must prevail for two or three hours after application.
Has a slight deepening effect.	EFFECT ON COLOUR OF WORK TREATED	Will not darken or change the colour of the surface in any way.
May be painted at a later date with Cementone No. 6. Ordinary paints should not be used.	LATER TREATMENTS	No difficulty about painting over at a later date.
Practically indefinite.	STORAGE LIFE	All Silicone Waterproofers have a limited shelf life: 12 months should be considered maximum.

Porous exterior walls of Brick, Concrete, Cement or Plaster can be effectively waterproofed against driving rain by the simple brush application of one of the Cementone No. 3 Waterproofing Liquids—Standard or Silicone. The merits of each type of waterproofer are given in the adjoining table to help you decide which product to use for any particular job.

number 3

WATER-PROOFING LIQUIDS



STANDARD OR SILICONE TYPE

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SOLVING MAINTENANCE PROBLEMS

Please see over

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dusty concrete?

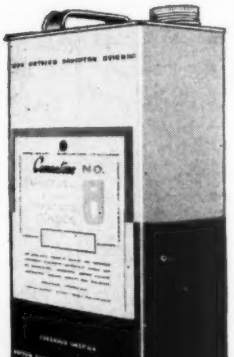
There are many causes of 'dusting' in concrete floors, but unless the floor is physically unsound and weak throughout when no surface treatment will be satisfactory, the cure is delightfully simple. Merely brush on Cementone No. 5 Liquid Concrete Floor Binder and, within hours, the floor will be transformed into a hard durable surface.

SPECIFICATION

First Day
Pour the Cementone No. 5 Liquid evenly over the surface of the paving, if necessary a watering can with a fine rose, can be used for distribution. Sweep the liquid backwards and forwards to ensure even saturation and avoid forming puddles.

Second Day
Apply a further coat as before. Two coats should suffice, but if the floor is abnormally dusty and porous a further coat is advisable applied 24 hours after the second coat.

Third Day
Swill the floor down with clean water and brush well.



number 5 concrete floor binder

YOU CAN DEPEND ON THE *Cementone* **PRODUCTS**
specially made for the job

Fullest details in the Cementone Handbook sent free on request.

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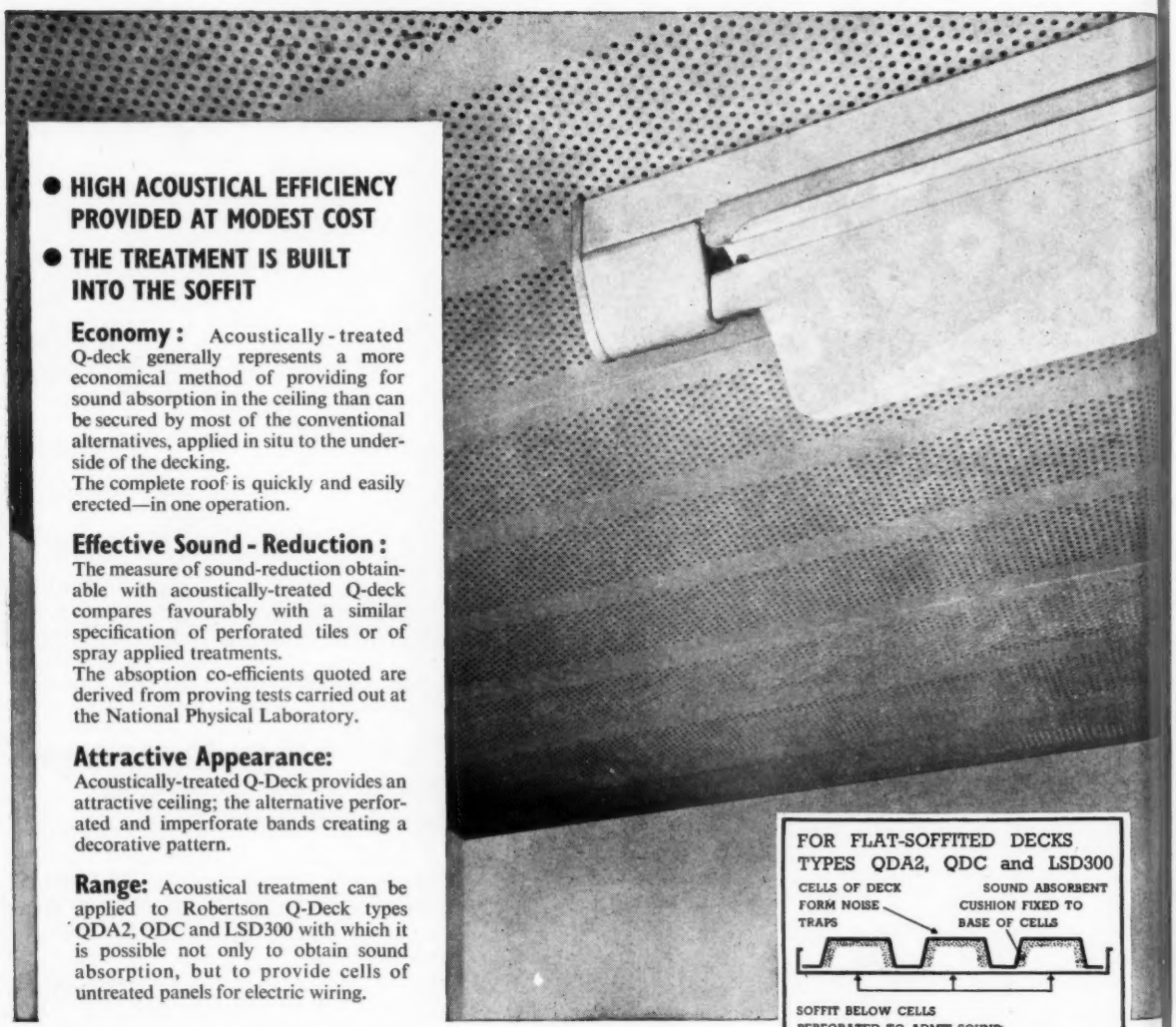
Another notable advance in Roof-Deck development

—ACOUSTICALLY-TREATED Q-DECK



- **HIGH ACOUSTICAL EFFICIENCY PROVIDED AT MODEST COST**
- **THE TREATMENT IS BUILT INTO THE SOFFIT**

Economy: Acoustically-treated Q-deck generally represents a more economical method of providing for sound absorption in the ceiling than can be secured by most of the conventional alternatives, applied in situ to the underside of the decking.
The complete roof is quickly and easily erected—in one operation.

Effective Sound-Reduction:
The measure of sound-reduction obtainable with acoustically-treated Q-deck compares favourably with a similar specification of perforated tiles or of spray applied treatments.
The absoption co-efficients quoted are derived from proving tests carried out at the National Physical Laboratory.

Attractive Appearance:
Acoustically-treated Q-Deck provides an attractive ceiling; the alternative perforated and imperforate bands creating a decorative pattern.

Range: Acoustical treatment can be applied to Robertson Q-Deck types QDA2, QDC and LSD300 with which it is possible not only to obtain sound absorption, but to provide cells of untreated panels for electric wiring.

FOR FLAT-SOFFITED DECKS TYPES QDA2, QDC and LSD300

SECTION THROUGH METAL DECK UNIT

FREQUENCY	ABSORPTION CO-EFFICIENT
125 C.P.S	0.25
250 ,,	0.50
500 ,,	0.75
1000 ,,	0.70
2000 ,,	0.50

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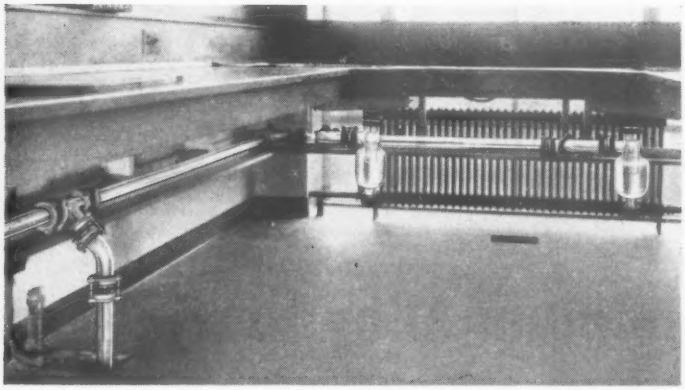

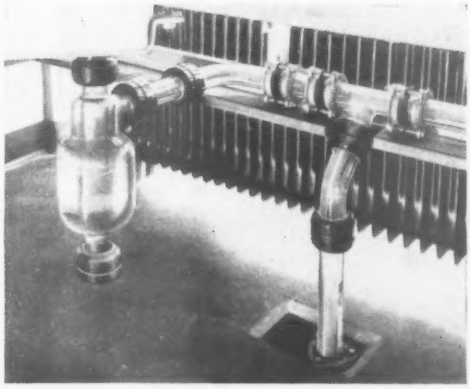

Photographs by courtesy of Nottingham Technical College.

The Q.V.F. system of Glass Sink Traps and Waste-Lines is ideally suited for installations in chemical, Pharmaceutical and Biological Laboratories. The transparency of the system allows any build-up of solids to be instantly detected—an important point where the efficient disposal of noxious liquids is of paramount importance.

In addition, the smooth surface of the glass minimises scale formation, and will withstand thermal shock of alternate flushing with boiling and ice-cold liquids.

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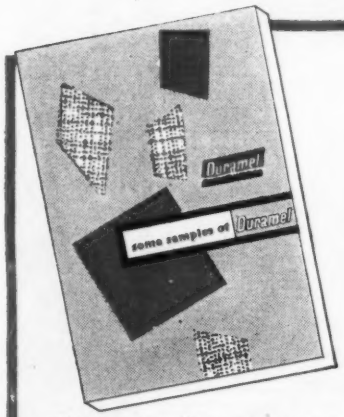
Duramel's versatility has long been recognised by its users, who include Municipal Authorities, Builders, Shopfitters and Coachbuilders. Wherever a need exists for tough, hygienic, heat and mild acid resistant surfaces, Duramel is the answer.

Duramel
THE PLASTIC-FACED PLYWOOD

The Melamine Plastic surface is bonded to first-grade hardwood plywood. It is waterproof, resistant to heat and mild acids, hygienic and wonderfully durable. Supplied in a range of colourful finishes, and plain white. In 3 standard thicknesses: ¼", ½" and ¾".

SIZES: 72" x 48", 84" x 48", 96" x 48", 36" x 24", 48" x 24".

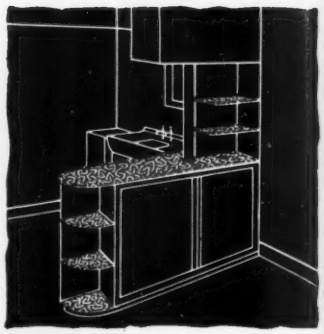


FREE— the new DURAMEL Sample Wallet

This handy wallet contains paper 'Linen' and 'Magic' patterns and an actual sample of Duramel. It is available on request.

For the name of your nearest distributor, write to the Sole Manufacturers:

F. HILLS & SONS LTD., NORTON ROAD, STOCKTON-ON-TEES.
TEL: STOCKTON 67141.

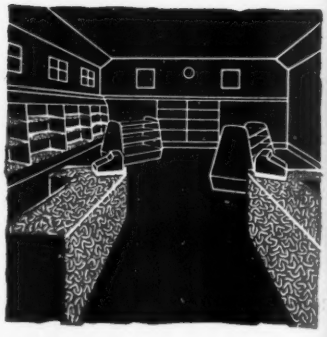


KITCHEN FURNITURE

Perfect for kitchen units, splash backs, sink units, Duramel is not easily marked or chipped.

WORK TOPS.

Hardwearing, mild acid resistant and easy-to-clean Duramel makes excellent worktops.

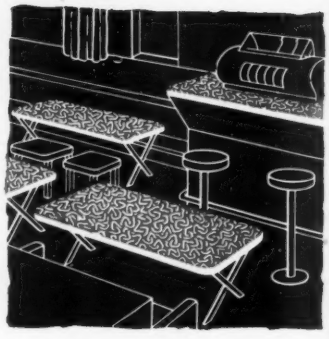


SHOP FITTING

Duramel makes wonderful counter tops and sides, partitions and display units.

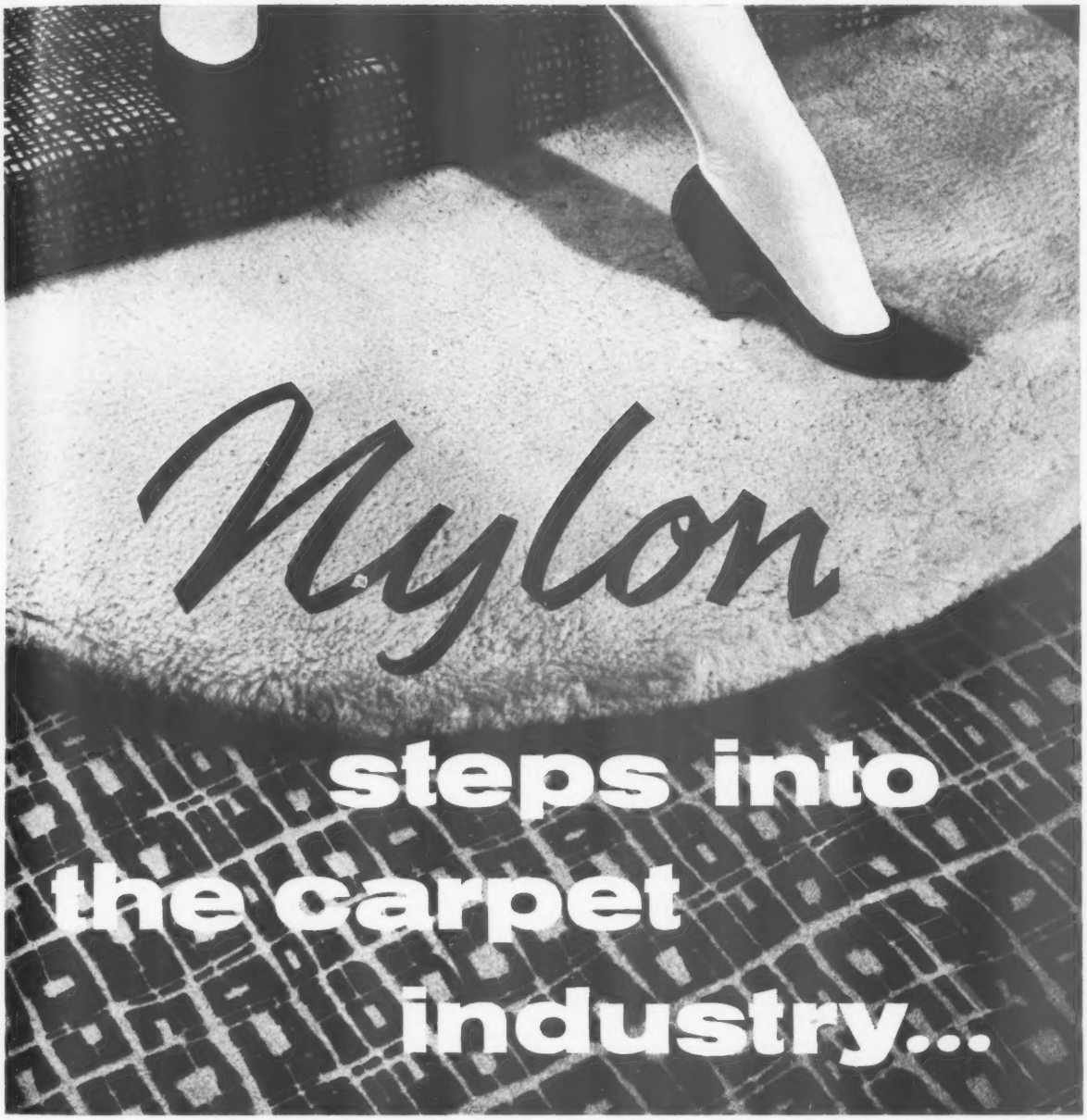
SHIPBUILDING

Duramel is now widely recognised as the ideal material for interior panelling, and furniture tops in ships.



CATERING

Gay Duramel tabletops in cafes are unmarked by fruit juices, food stains and hot plates.



Designs are by Ronald Grierson F.S.I.A.

shildon

100% WOVEN NYLON PILE CARPETS & RUGS

are being advertised this Autumn in local press and cinemas in specially selected areas throughout the country. Shildon carpets are a product of the Alfred Morris group of companies—the established leaders in the development of woven nylon. You can have Shildon Nylon Carpet built for any wear life you require. Nylon outwears every other carpeting fibre known. Shildon Nylon Carpet can also be produced in your own design.

Write for details to:

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19/23 WELLS STREET LONDON W1

LANgnam 5921

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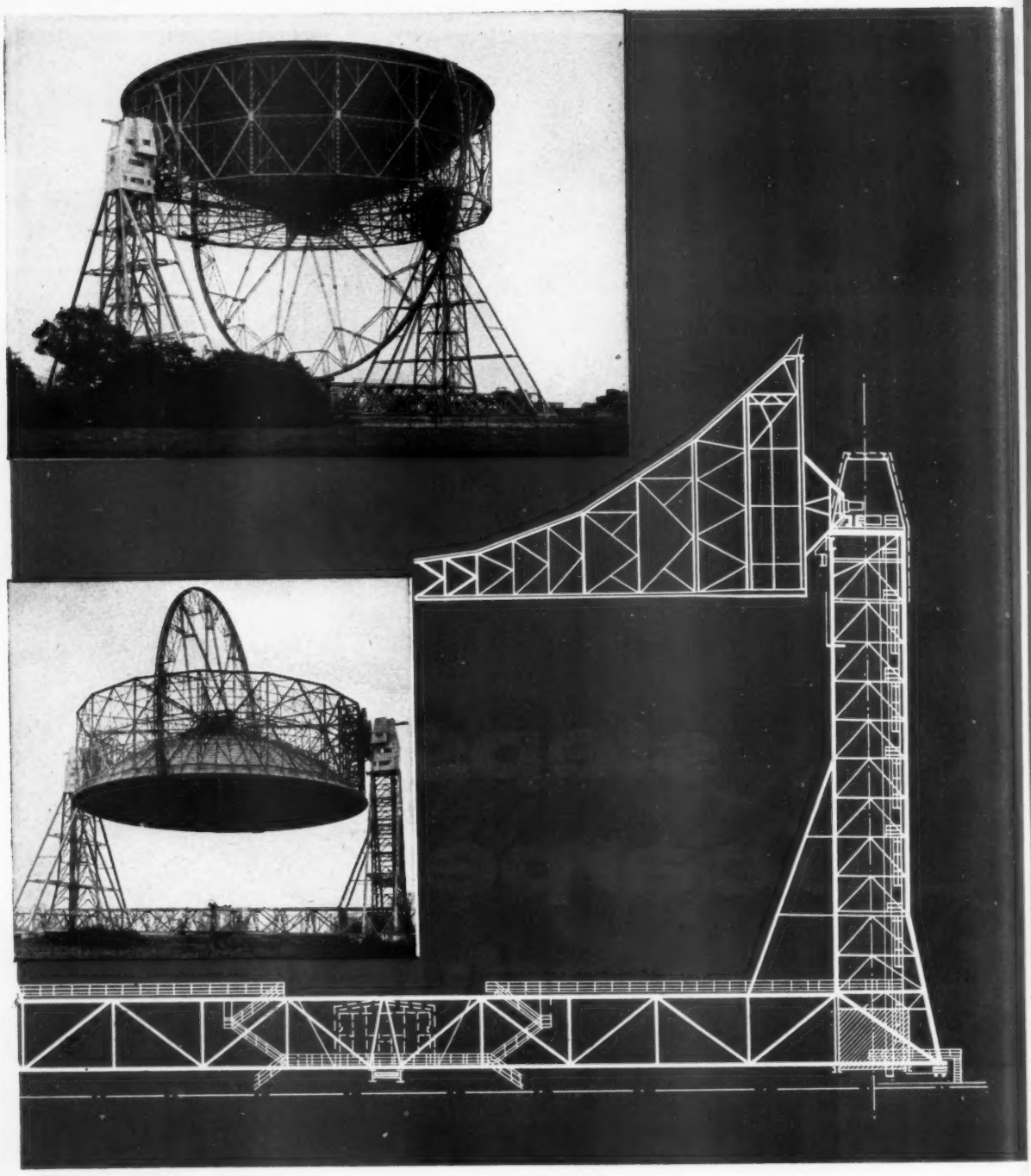

Radio telescope at Jodrell Bank built by United Steel Structural Company

Bowl diameter—250 *ft.*
Height of towers—180 *ft.*
Weight of structural steelwork—1,800 *tons*

Consulting engineers: Husband & Company

UNITED STEEL STRUCTURAL COMPANY LIMITED
SCUNTHORPE · LINCOLNSHIRE

USS 37

"Hailware" REGD.

MODERN
REFLECTOR
FITTING

THIS FITTING PROVIDES DIRECTIONAL LIGHTING DOWNWARDS TO THE WORKING PLANE. IN ADDITION IT ALLOWS UPWARD LIGHT TO BE REFLECTED BY THE CEILING GIVING DIFFUSED ILLUMINATION OVER THE WHOLE AREA.

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18, LOWNDES STREET · LONDON, S.W.1.

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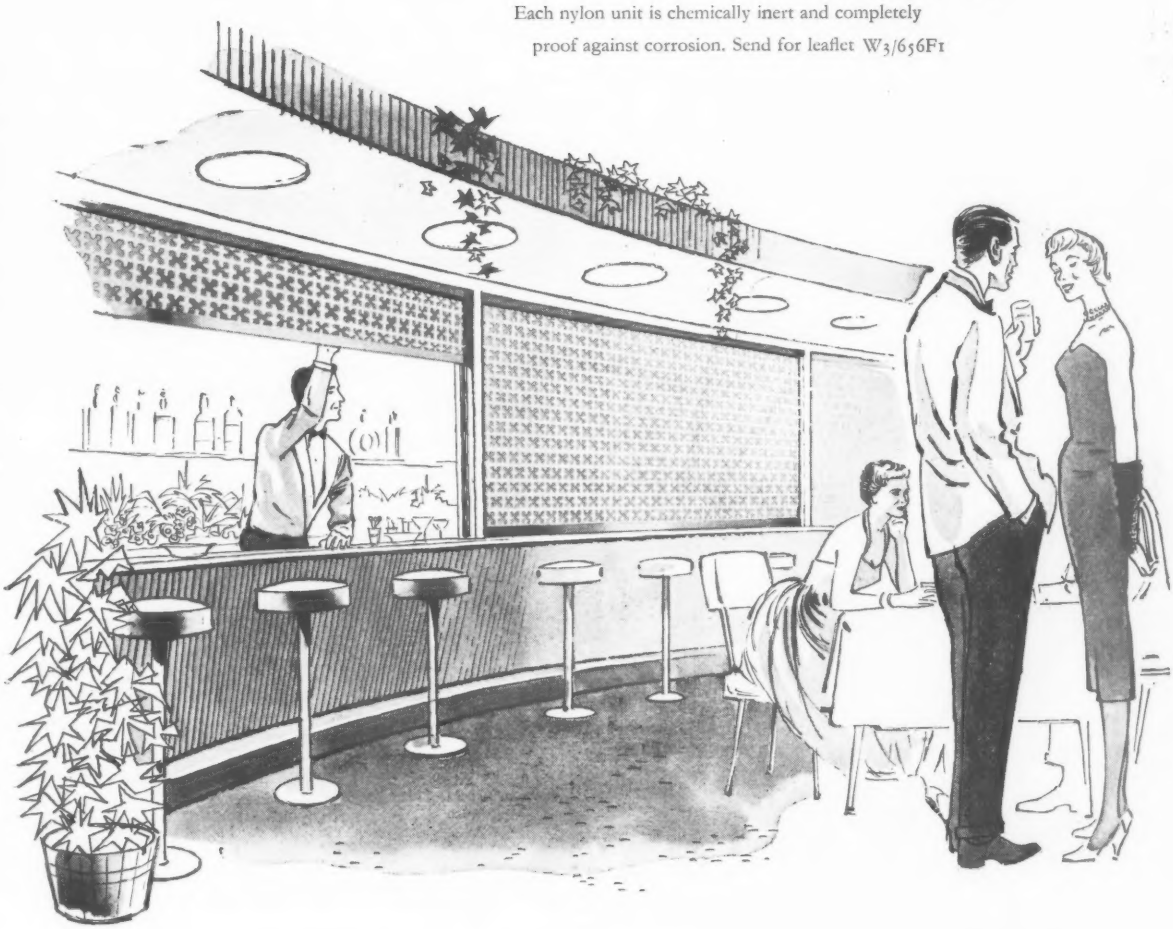
go to the West End

One last drink, and down comes the grille
on another evening's pleasure—until the next time.
Brady Nylon grilles are ideal for bars, shop-fronts,
arcades, and cloakrooms. They are constructed
throughout of translucent nylon units carried on metal rods
— a new development of the well-known Brady principle.
Each nylon unit is chemically inert and completely
proof against corrosion. Send for leaflet W3/656F1



G. Brady & Company Limited, Manchester, 4. Telephone COLlyhurst 2797/8/9.

BRADY FOR EVERY OPENING: BRADY ROLLING DOORS IN STEEL, WOOD AND ALUMINIUM
SLIDING SHUTTER DOORS . GRILLES IN STEEL, ALUMINIUM OR NYLON
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SLIDING DOOR GEAR . ALSO MANUFACTURERS OF BRADY LIFTS

THE DOORS COMMANDING THE WORLD'S LARGEST SALE—
London, Birmingham, Glasgow, Montreal, Port Credit, Hong Kong.

Stove & Bowden

Here is a lighting fitting which will do everything.
It is made of three basic parts with a diffuser which is **the largest single polystyrene injection moulding ever made for a lighting fitting.**
Developed in Canada, it is now manufactured here by Harris & Sheldon (Electrical) Ltd.

SOME OUTSTANDING LUVELINE FEATURES

- ✳ Can be used as separate fittings or in continuous lines.
- ✳ Ceiling-mounting or suspension is equally simple.
- ✳ Installation is easy and quick.
- ✳ Relamping and cleaning is simplicity itself, owing to the specially hinged diffuser sections.
- ✳ Surface brightness is low, but efficiency is high.

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Harris & Sheldon (Electrical) Limited

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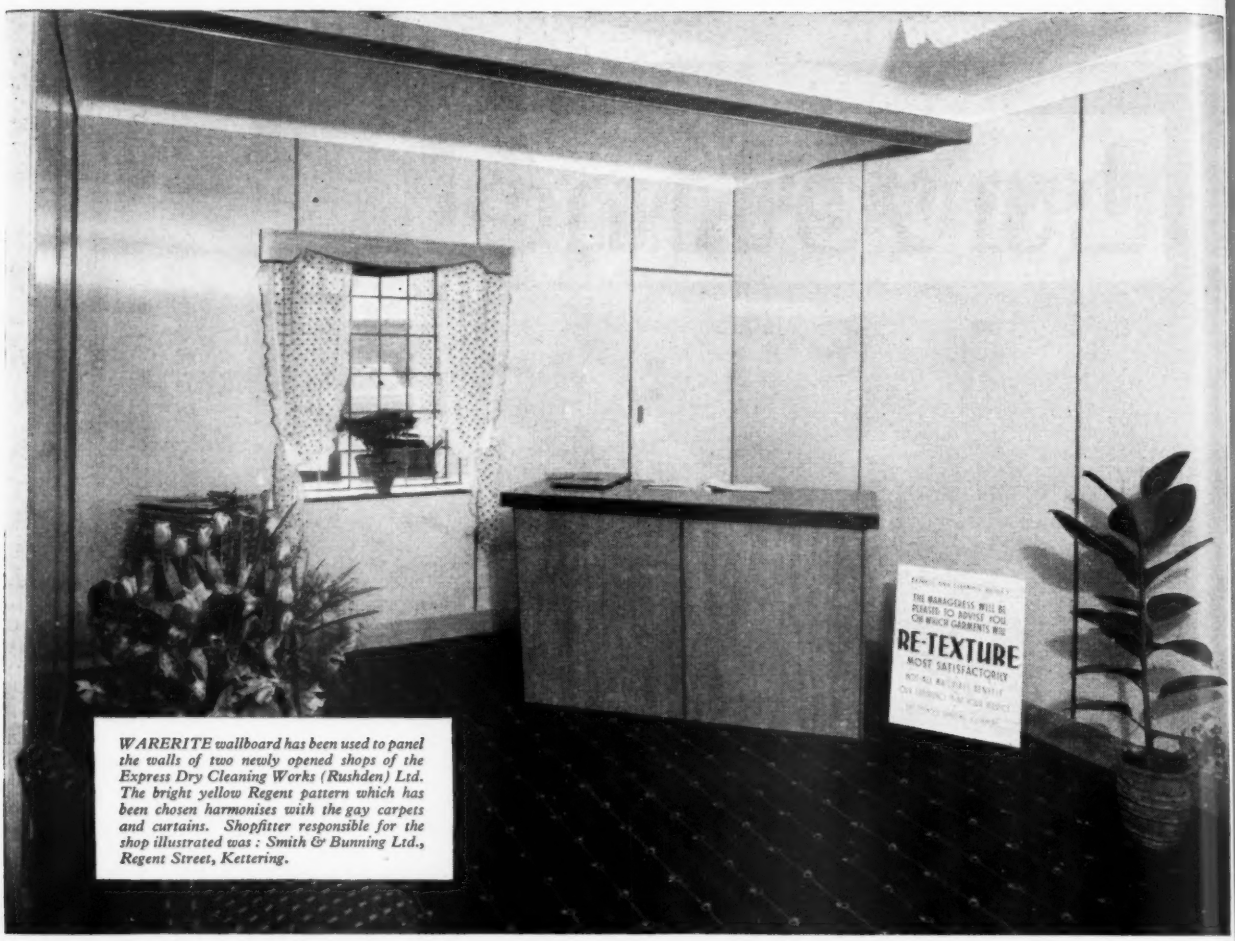
London Office: 46 GT. MARLBOROUGH STREET W1 Telephone GERrard 0869

Complete Lighting Specialists and
Manufacturers of Lighting Fittings and Control Gear



WARERITE wallboard has been used to panel the walls of two newly opened shops of the Express Dry Cleaning Works (Rushden) Ltd. The bright yellow Regent pattern which has been chosen harmonises with the gay carpets and curtains. Shopfitter responsible for the shop illustrated was : Smith & Bunning Ltd., Regent Street, Kettering.

For attractive, hardwearing vertical surfaces choose *New* WARERITE REGD. wallboard

Wherever decorative vertical or ceiling surfaces must be moisture-resisting, durable and easily cleaned, new WARERITE wallboard is the obvious and economical choice. Counter fronts, partitions, cupboard fronts and flush doors are typical applications. WARERITE wallboard can be screwed or pinned, or fitted into extruded jointing sections.

WARERITE *materials are supplied from stock in cities and towns throughout the country. Write for literature, samples and the name of your nearest distributor.*

WARERITE wallboard REGD.
IS IDEAL FOR VERTICAL SURFACES AND CEILINGS

• Wipes clean instantly • Easier construction at lower cost—no maintenance • Resistant to steam and moisture • Can be fixed with screws, or panel pins; cemented to wooden battens or fitted into frames • Standard boards 8 ft. x 4 ft. • Melamine-resin surfaced both sides

WARERITE wallboard **with the lovelier patterns!** REGD.

A product of BAKELITE LIMITED, 12-18 Grosvenor Gardens, London SW1. Tel: SLOane 0898
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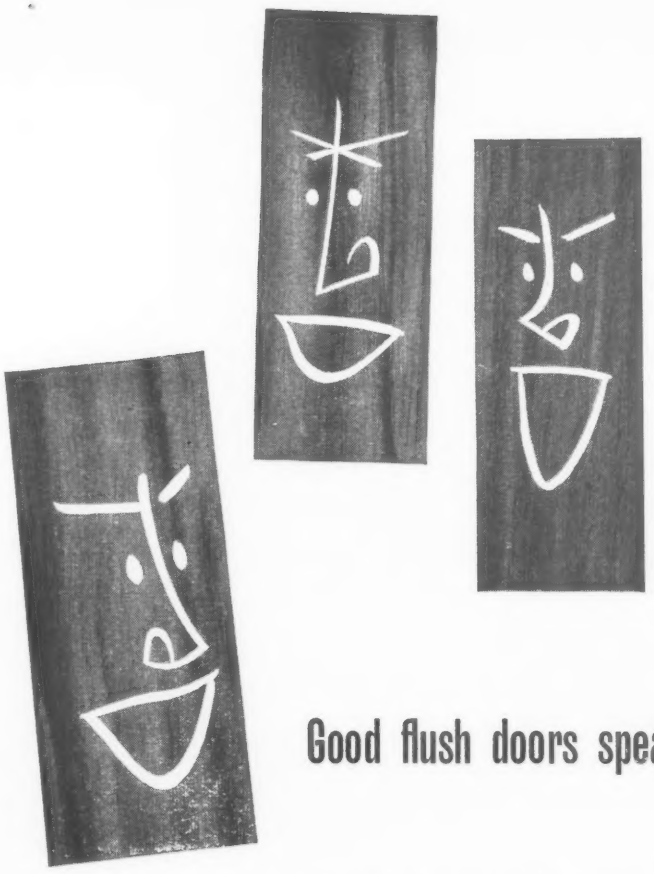

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There is no mistaking the outstanding high quality of Leaderflush flush doors wherever they are seen—it is a quality born of many years' experience in specialised manufacture—a quality which speaks for itself.

STOCKISTS:—LEADERFLUSH DOORS can be obtained immediately ex stock from the following officially appointed distributors for the area stated, as well as direct from the Works at Trowell, Nottingham.

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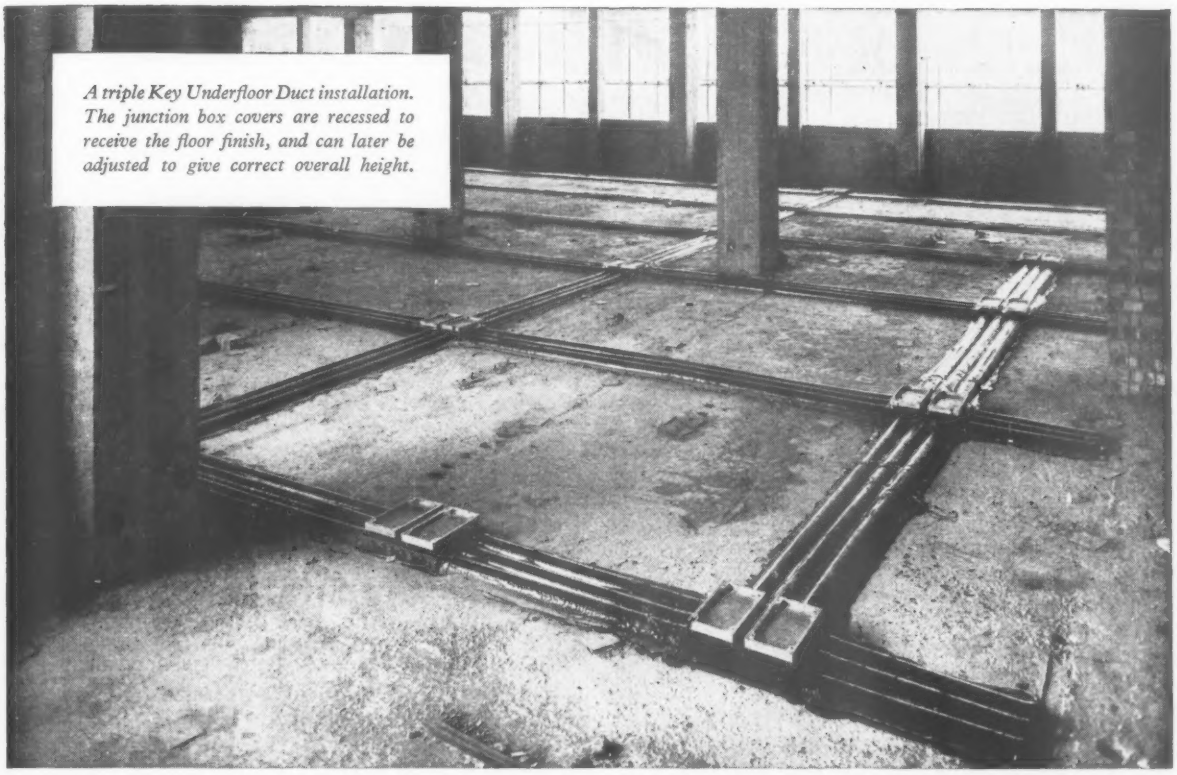
★ **THERE ARE OVER 2,000,000 LEADERFLUSH DOORS IN USE TODAY.**

Now and for the future—
Key Underfloor Duct
solves wiring problems economically



A triple Key Underfloor Duct installation. The junction box covers are recessed to receive the floor finish, and can later be adjusted to give correct overall height.

Electric power and telephone outlets can be installed and added as necessary when Key Fibre Underfloor Duct is used. On a materials plus labour basis the cost of installations is lower than any metal system. Because of their light weight and ease of cutting and fitting, Key ducts can be quickly laid. Since there is no necessity to pre-position outlets, the architect can install an underfloor duct scheme, and later fit outlets to suit the occupant's requirements. The fitting of these outlets is a quick and simple matter and the most complete range of fittings is available for lighting and telephone systems.

easy to lay—low cost
completely adaptable

KEY UNDERFLOOR DUCT
conforms with B.S. 815 and is the original Underfloor Duct System. Key have the widest experience of Underfloor Duct Systems in the U.K.

Speed the job—cut the cost with the

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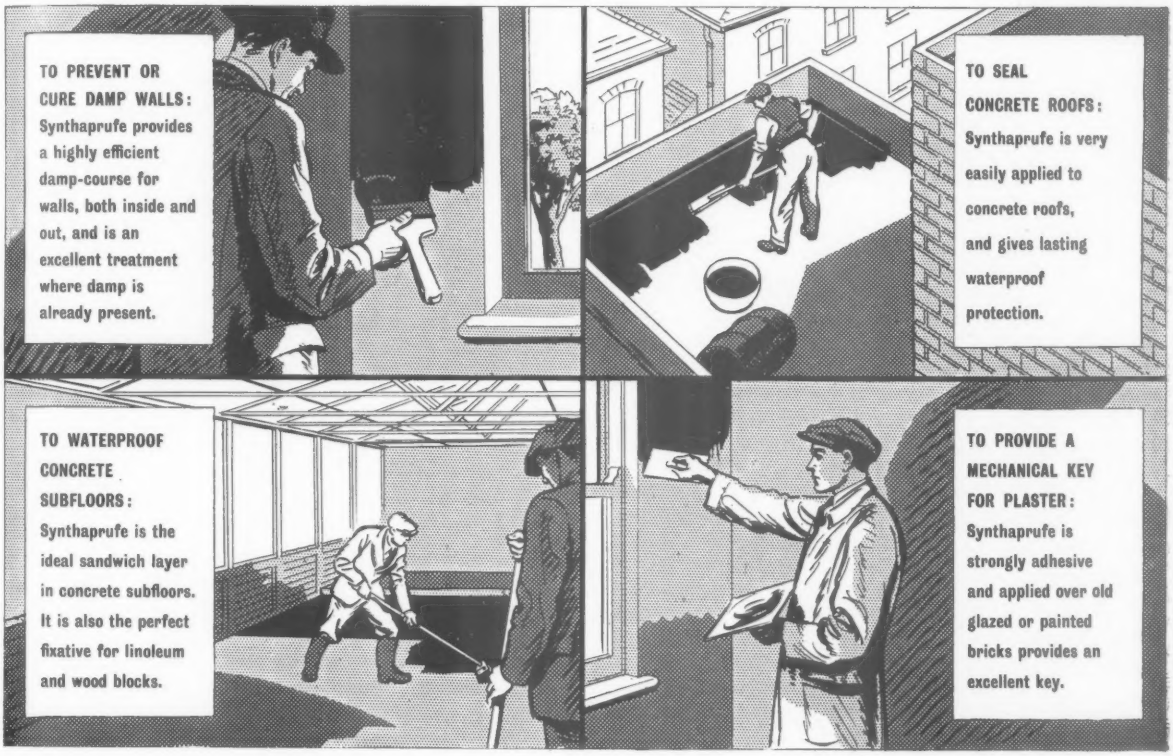
A brush-on waterproofing that contains **rubber**...

ELASTIC, ADHESIVE, IT MAKES AN IDEAL JOINTING



SYNTHAPRUFE is a waterproofing compound which can be applied cold by brush; its rubber content makes it strongly adhesive, and it sets quickly and forms a strong, elastic, moisture-proof film.

Most surfaces will take Synthaprufe—concrete, plaster, brick, metal or timber—and it is equally effective on old or new buildings.

Synthaprufe is also highly effective as a vertical damp-course on either external or internal surfaces, and is most valuable for treating damp in existing walls.

When applied over old and shabby glazed brick or painted brick wall surfaces (e.g. in hospitals, institutions and factories) Synthaprufe provides an excellent mechanical key for plaster finishes. This process obviates the noise, discomfort and expense of hacking.

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Synthaprufe offers the architect, builder, and engineer a waterproofing and jointing material of unusual efficiency and versatility, ready to use and easily applied.

Some special uses

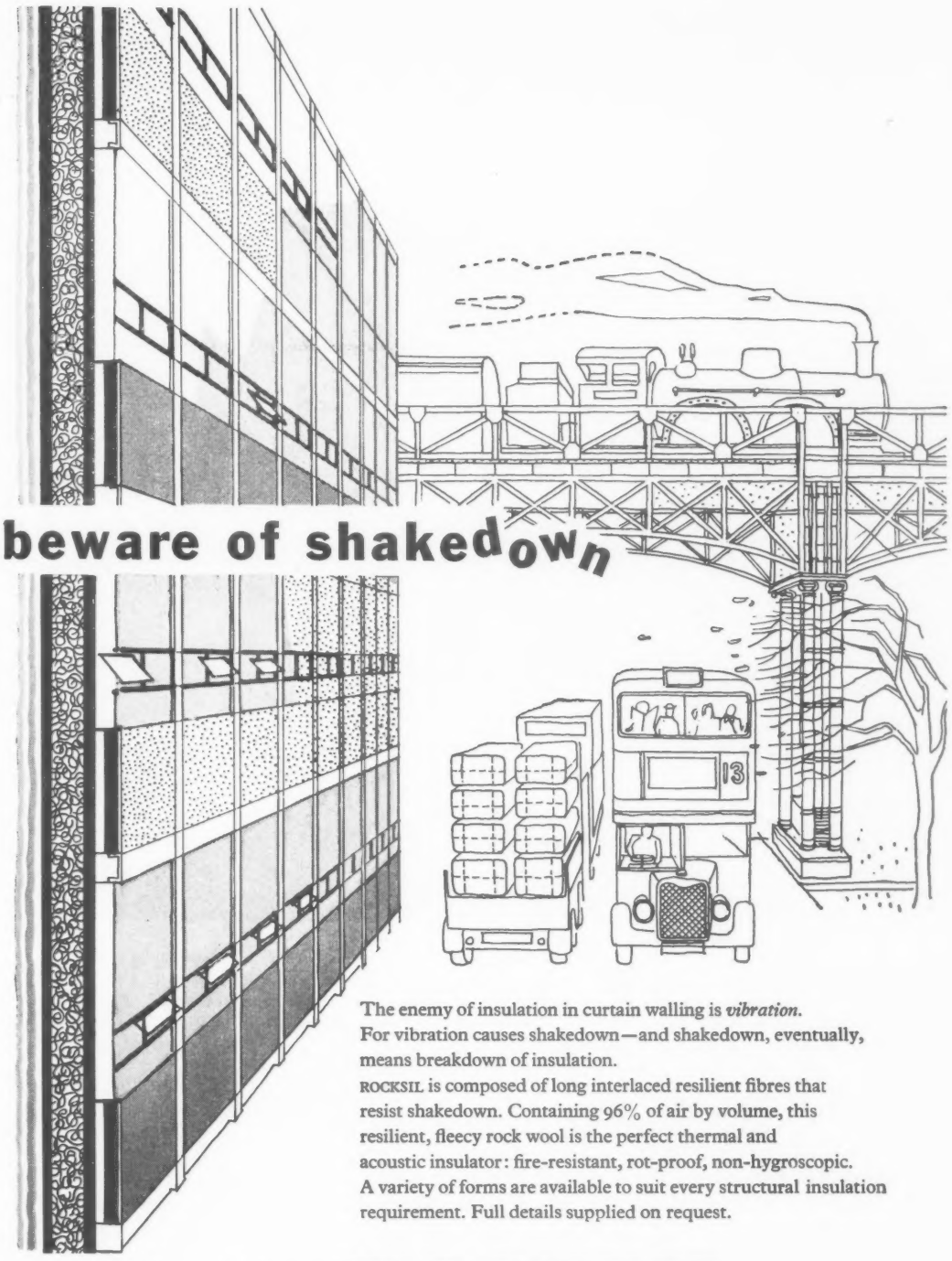
- Sealing concrete structures above and below ground-level, cooling-towers, etc.
- Protecting concrete piles, steelwork, sewer-pipes, and joints, etc.
- Waterproofing old asphalt, lead, zinc, corrugated iron, or felted roofs.

SYNTHAPRUFE

Manufactured by the NCB *National Coal Board*

Synthaprufe is a product of British Coal. Further details, and advice on any technical problem, will gladly be given on application to the National Coal Board, By Products, National Provincial Bank Buildings, Docks, Cardiff.

"Synthaprufe" is a Registered Trade Mark



beware of shakedown

The enemy of insulation in curtain walling is *vibration*.
For vibration causes shakedown—and shakedown, eventually, means breakdown of insulation.
ROCKSIL is composed of long interlaced resilient fibres that resist shakedown. Containing 96% of air by volume, this resilient, fleecy rock wool is the perfect thermal and acoustic insulator: fire-resistant, rot-proof, non-hygroscopic.
A variety of forms are available to suit every structural insulation requirement. Full details supplied on request.

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TA457

"IMPOSSIBLE"

said the pundits

"Roller skate on Hardec", they said. "IMPOSSIBLE: We know it's tough, but not that tough". That was when we were looking for the most conclusive way to show the toughness of the Hardec surface in our recent TV series. *But the pundits were wrong.*

Ravic and Babs found Hardec so good that they asked us to make a permanent platform for them. They had heard of the Hardec Design Service and asked us if we could put heir names in a special design. Well, as you can see, we did. They could, of course, have had any other design they liked—as you can. They say it's the best platform they have ever skated on. And we believe them.

Hardec REGD. **QUICKEST FIXING PLASTIC SURFACE**

(AND THE ONLY ONE IN REGULAR USE AS A ROLLER-SKATING RINK)

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"Wallstruct" was used on this building erected for the Queensway Store Co. Ltd., at Crawley New Town, Sussex.
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Chief Architect: R. G. Thomson, Dip.Arch., A.R.I.B.A.
Architect-in-Charge: D. D. Glennie, B.Arch., A.R.I.B.A.
Contractors: Welwyn Builders Ltd.

BRABY introduce— "WALLSTRUCT"

a Curtain Walling in Aluminium Alloy

Glazing BRABY 'Improved Eseglaze' system of aluminium beading. All thicknesses of glass and most double-glazed panes can be fitted.

Dado panels Double, with glass wool or other insulant. External panel—coloured glass, plastic, aluminium, etc.—may be fitted from outside.

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* **Supplied in natural (mill) finish, or polished, anodised and sealed.**

BRABY "Wallstruct" has been designed to exploit fully the high strength/weight ratio, the excellent weathering and the pleasing appearance of aluminium alloy.

It consists essentially of individually-sized units made up from extruded aluminium alloy sections* assembled into frames of 4″-deep channel section. Expansion and contracting movements are taken care of by expansion mullions, and, fixed to each floor, transom sections.

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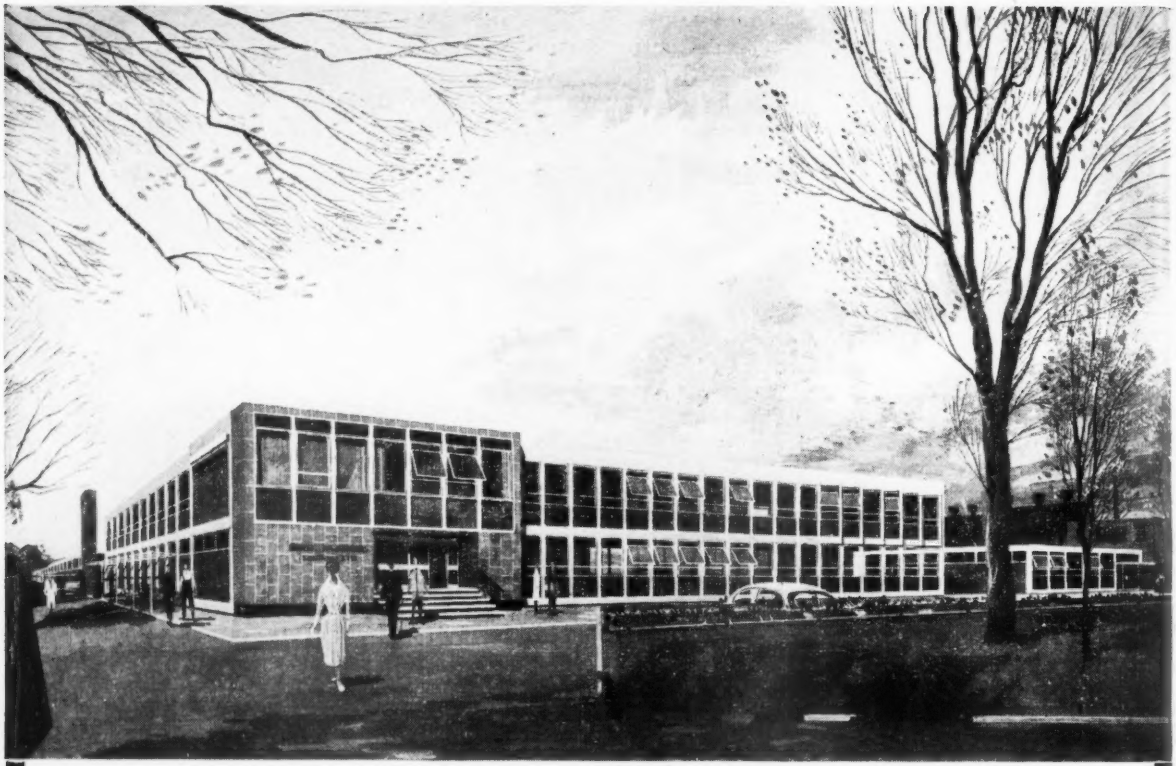

Consulting Architect: Hugh V. Sprince, A.A. Dipl., A.R.I.B.A., A.M.T.P.I.
Quantity Surveyor: W. G. Edwards & A. Avery Hall, F.F.R.I.C.S.

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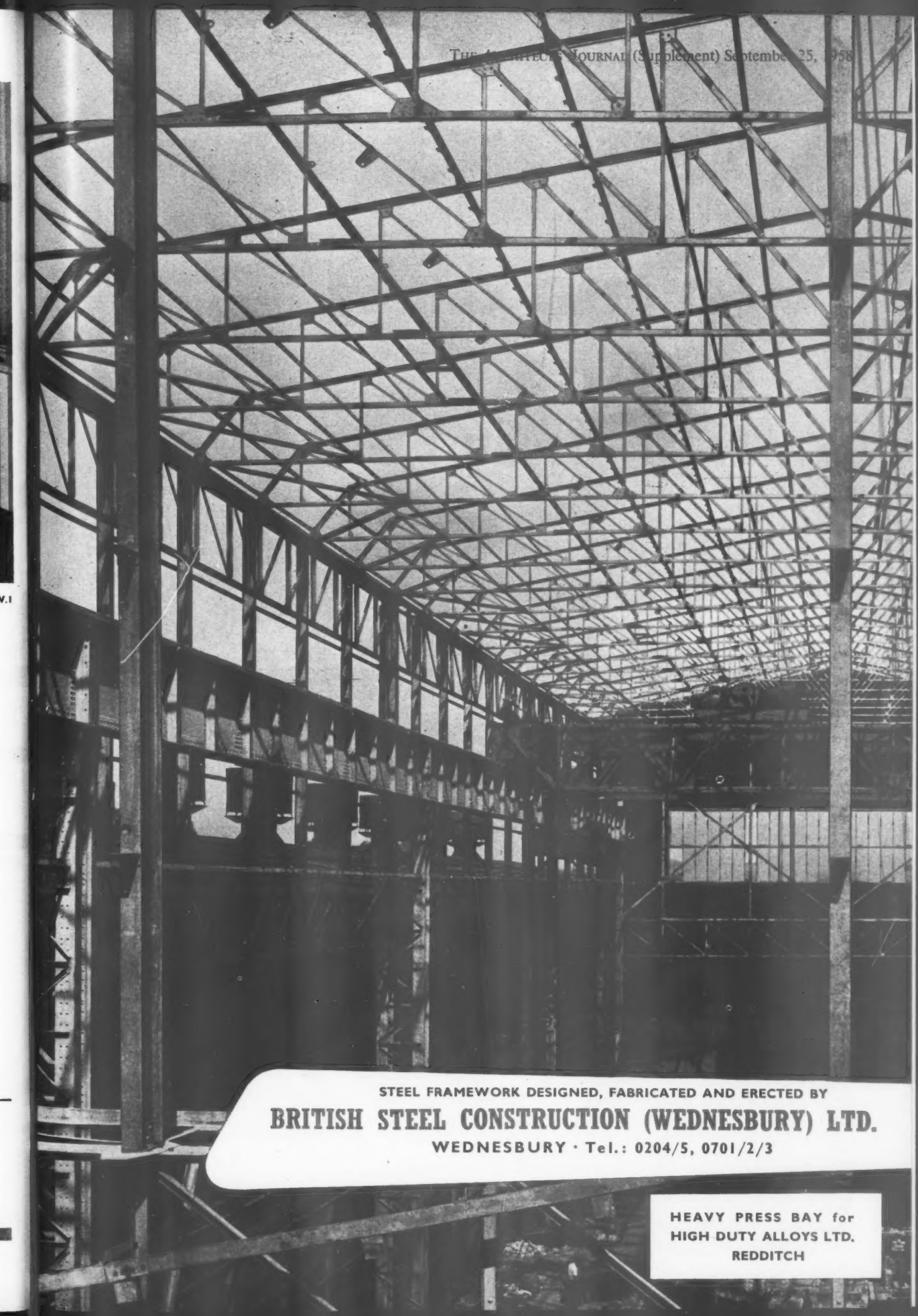

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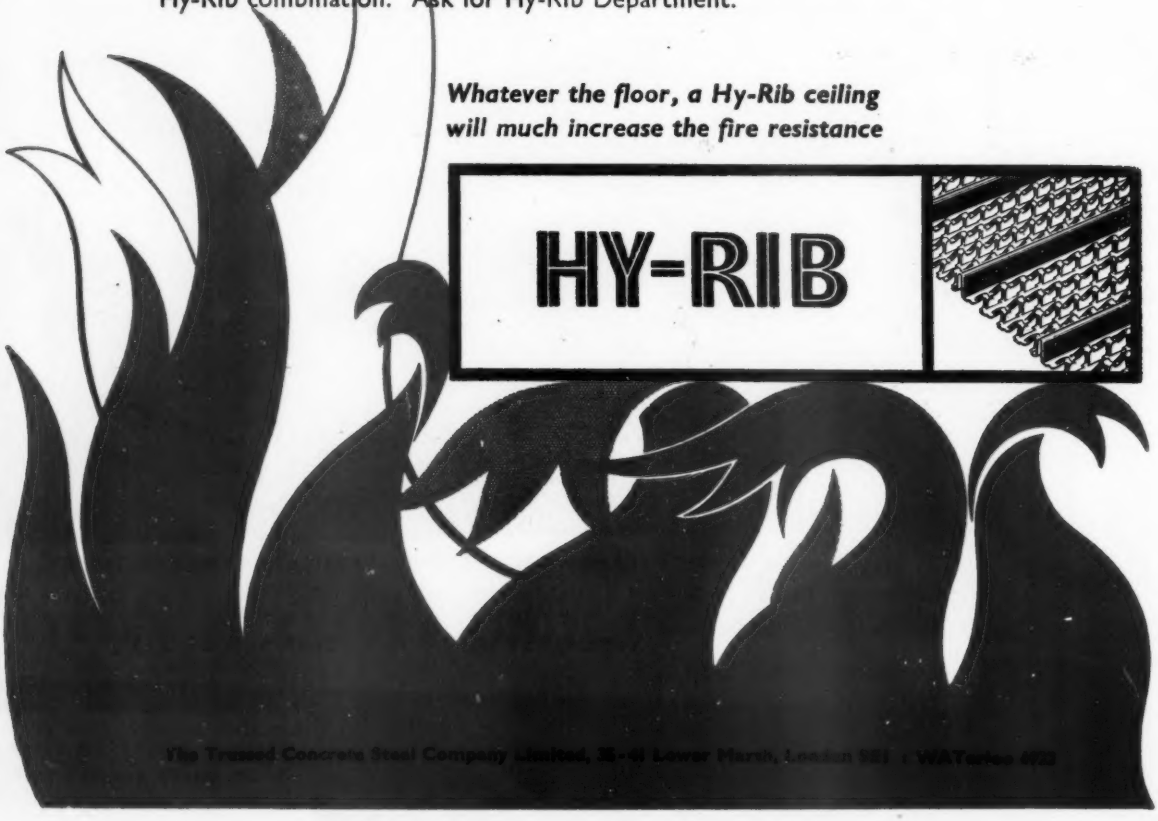
Whatever the floor, a Hy-Rib ceiling will much increase the fire resistance



The Trussed Concrete Steel Company Limited, 35-41 Lower Marsh, London SE1 : WATerloo 4922

TOMO DOUBLE GLAZED WINDOWS and the B.R.S. TESTS

Each of these TOMO WINDOW units, installed for the Sheffield Twist Drill Co. Ltd., consists of a horizontal-pivot-hung light and two fixed lights.

Architects: Ogden and Raine, A.R.I.B.A.

WHEN a standard-production TOMO WINDOW Wall-Unit (8 ft. x 8 ft.) was tested at the Building Research Station, Garston, the mean thermal transmittance of the complete unit was found to be 0.31 B.Th.U./sq. ft./h/°F. *This is equal to the thermal transmittance of a traditional, 11-in. cavity brick wall!* This impressive result was further improved to 0.29 when the TOMO pleated blinds, fitted between the panes, were lowered.

The U-value of the window-area only was found to be 0.38 which, with TOMO pleated blinds down, became 0.35. At 0.38, TOMO double-glazed WINDOWS are substantially (29%) better than the U-value of 0.47 quoted for conventional double windows in the I.H.V.E. Guide to Current Practice, 1955.

In addition to their excellent thermal-efficiency values, TOMO double-glazed WINDOWS have remarkable sound-reduction properties and are specially recommended for offices, schools, flats, etc., in busy streets or near to airports. The amount of reduction in sound level depends on the thickness of glass and the space between panes—thirty-two ounce glass spaced at 1¾ in. gives a reduction of approximately 40 decibels.

These high-quality windows afford all the advantages of finely-controlled ventilation and total indoor window-cleaning. They are suitable for inward or outward opening and can be top-hung, bottom-hung, side-hung or pivot-hung.

FOR UTMOST EFFICIENCY IN THERMAL INSULATION AND SOUND REDUCTION
—SPECIFY
TOMO WINDOWS
—purpose-made in finest timbers to Architect's own design and finish

HAVE YOU HAD YOUR FREE COPY OF THE NEW EDITION OF THIS HELPFUL BROCHURE?

Fully illustrated and packed with information, this 24-page brochure shows many examples of TOMO WINDOWS in use throughout the country. Secure your copy now!

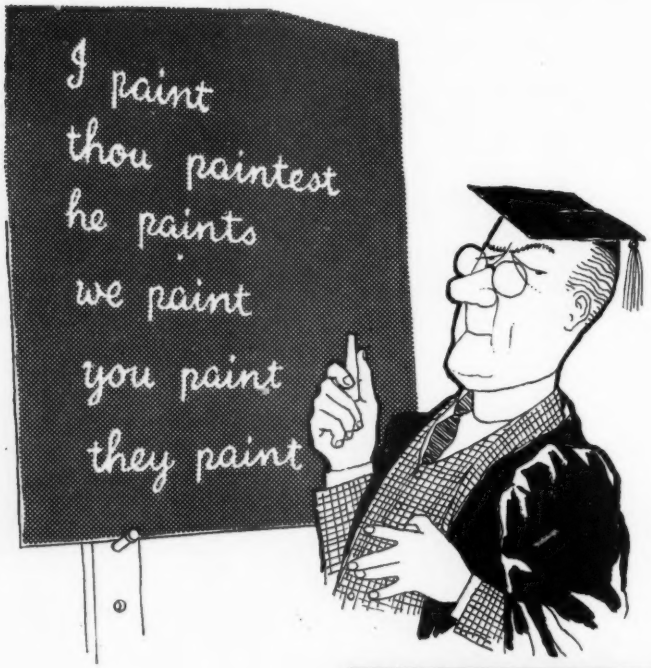
To: TOMO TRADING CO. LTD., COWLEY PEACHEY, UXBRIDGE, MIDDLESEX (Tel: West Drayton 3751)
Please send me a copy of your revised TOMO WINDOWS brochure

Name.....

Address.....

.....

For the attention of..... A.J.9



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DRYNAMELS

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Say **DRYNAMELS** and be word perfect

Full documentation of Decorative and Industrial Paints on request.
DRYNAMELS LIMITED, HALL GREEN, BIRMINGHAM, 28.

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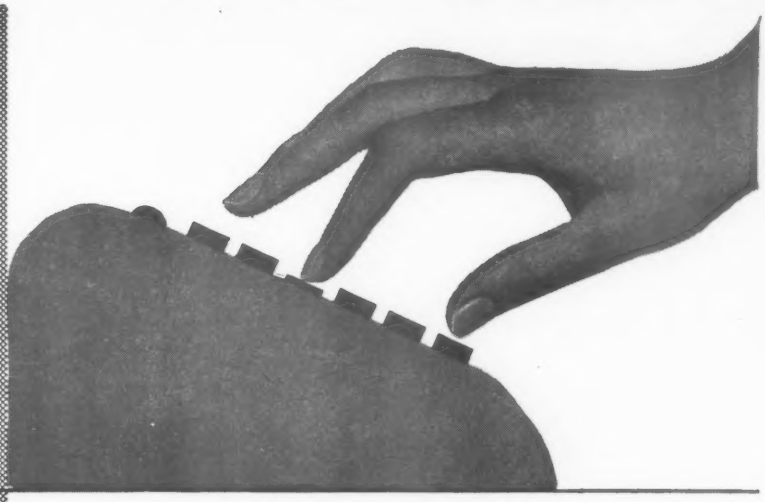

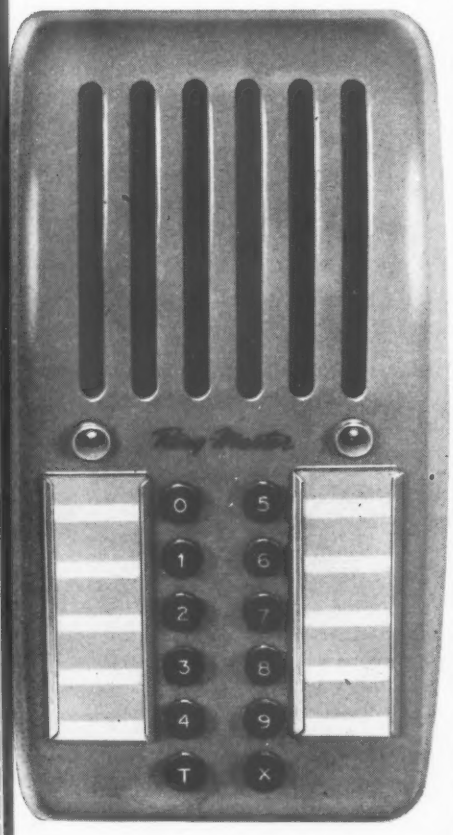

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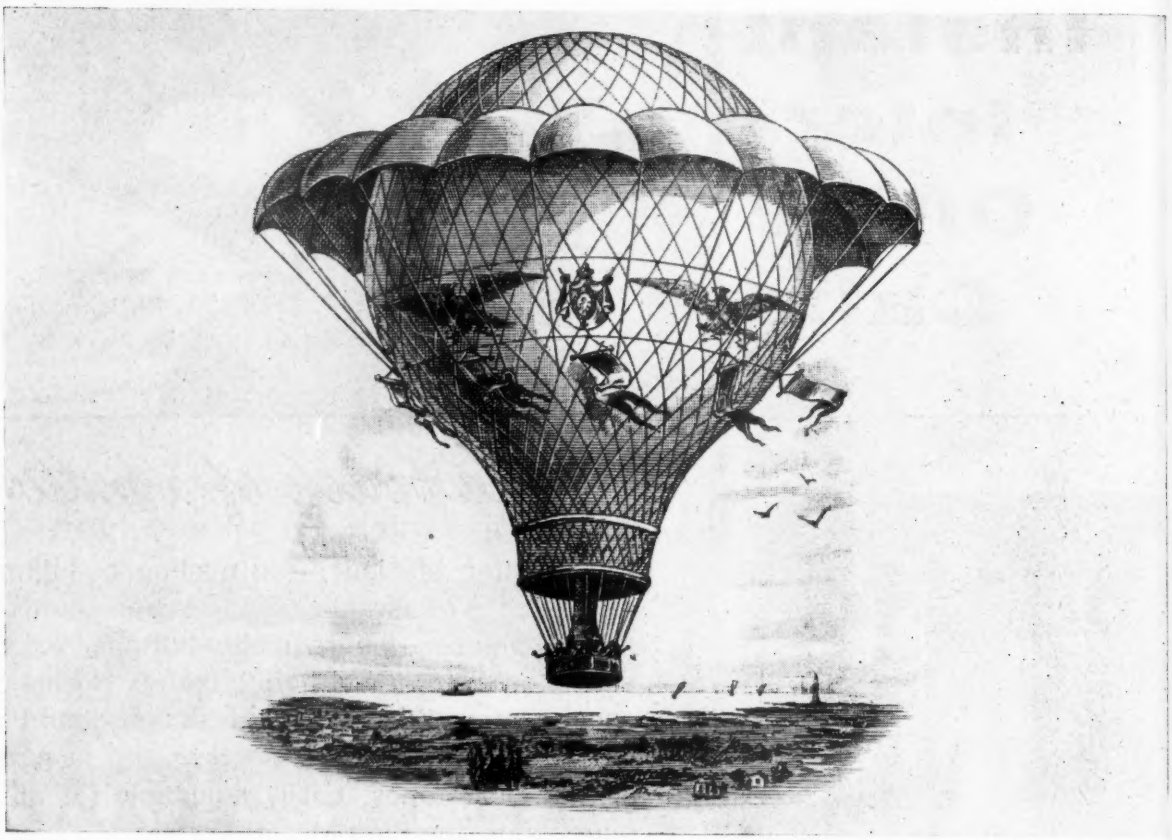

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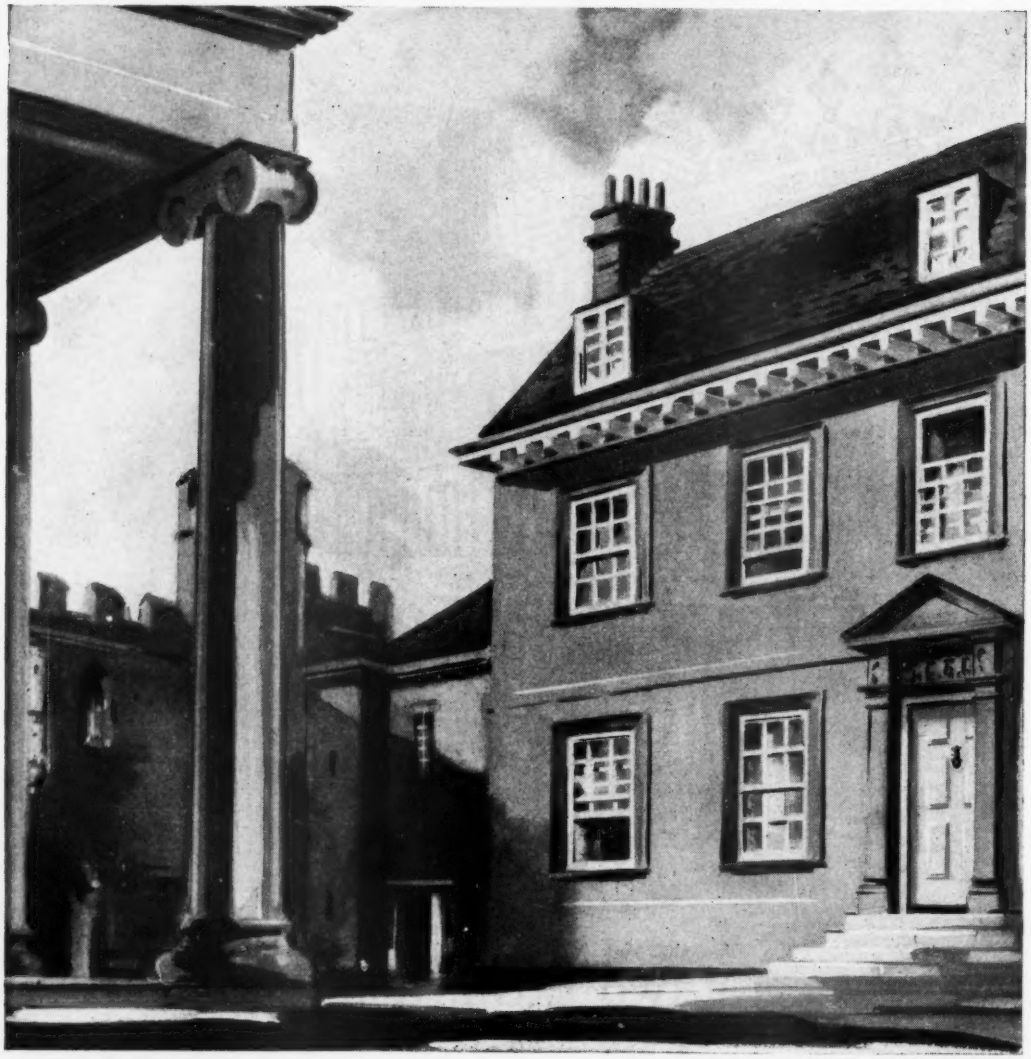

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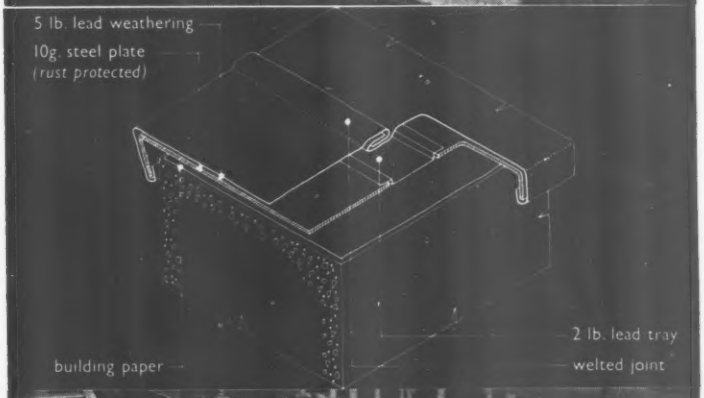

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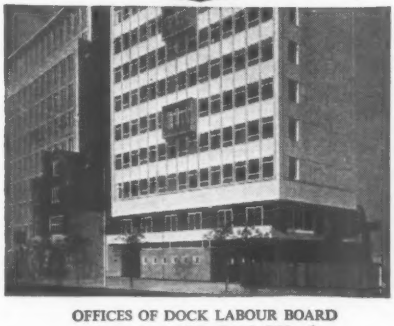

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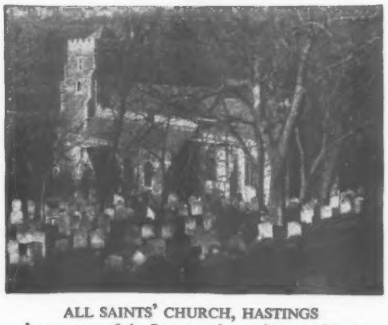

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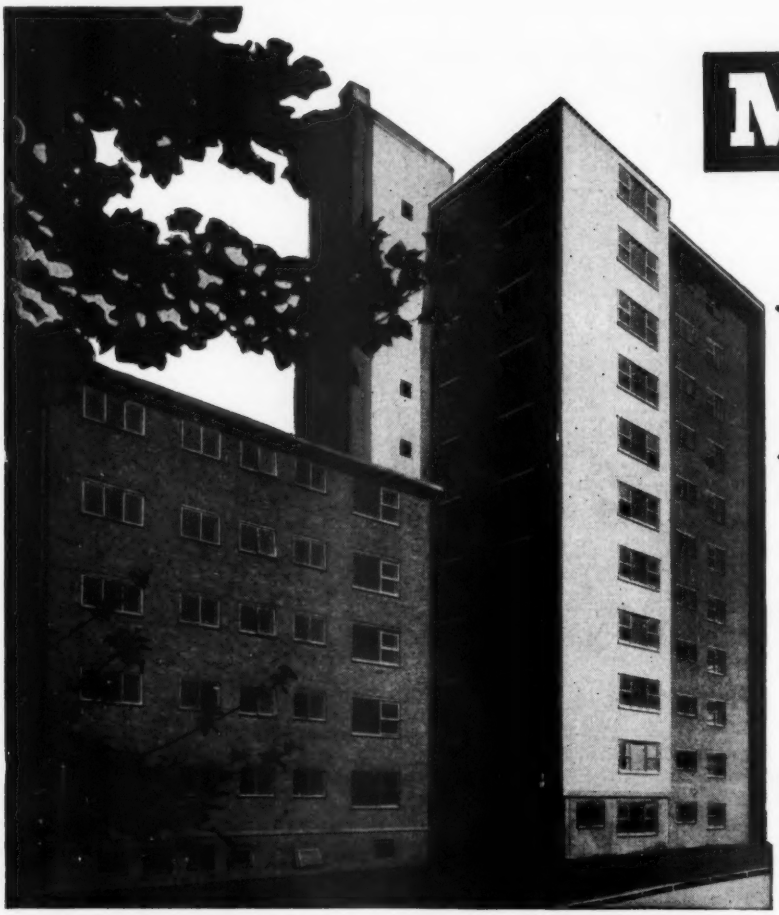

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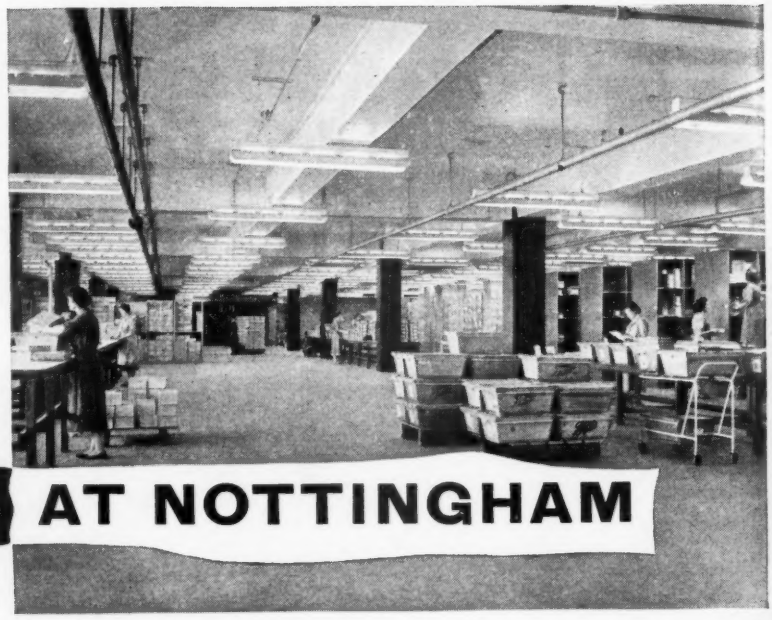

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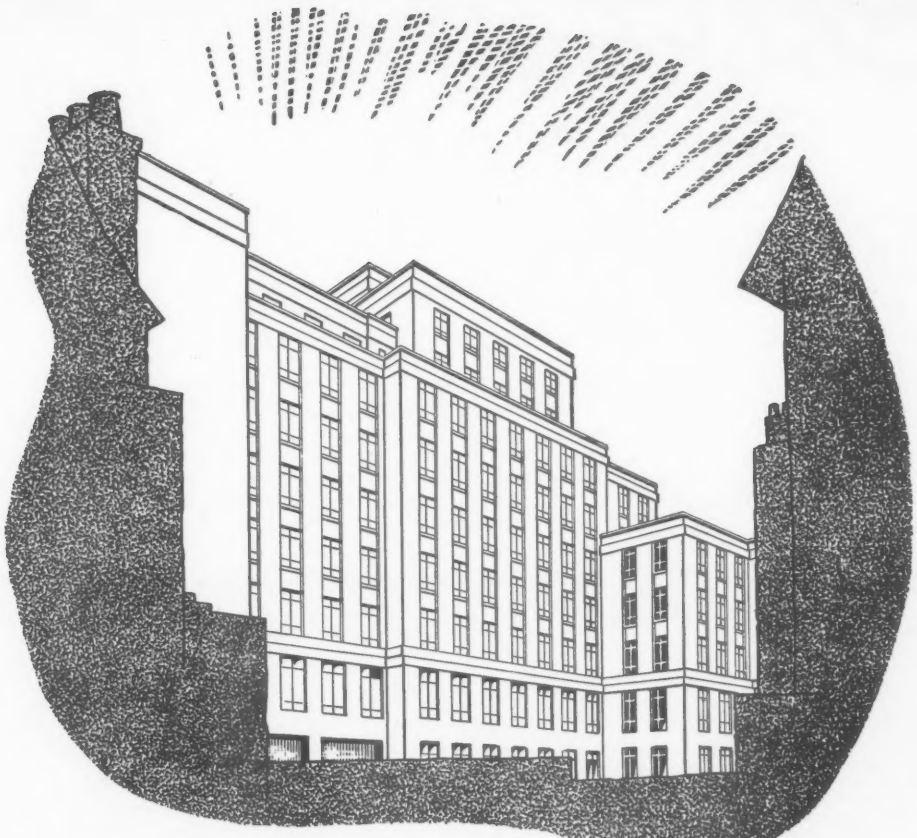

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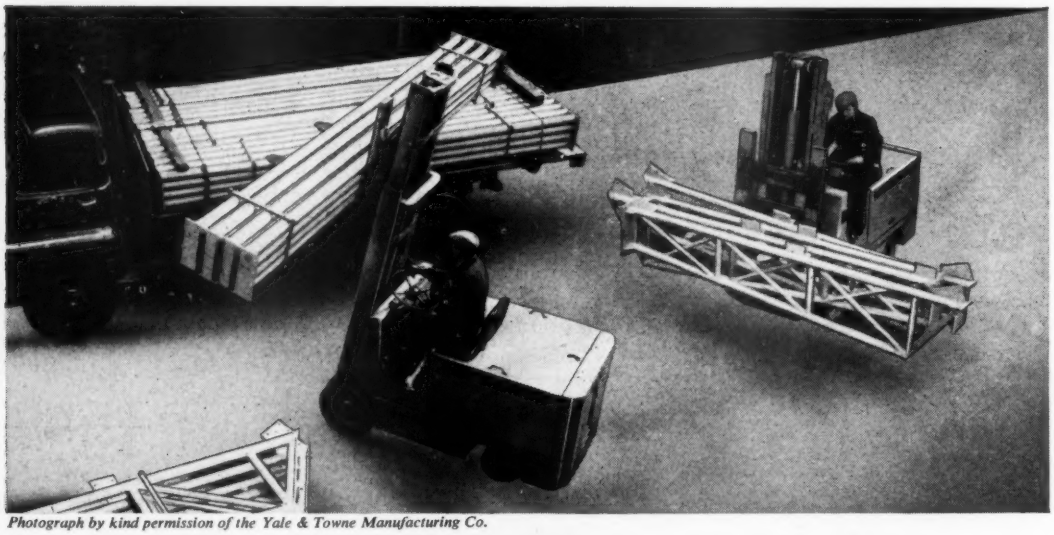

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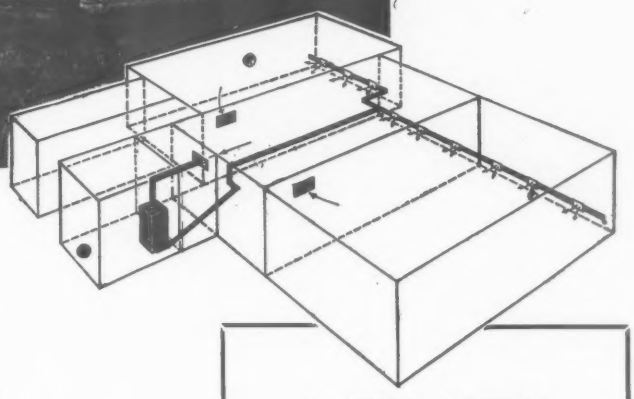

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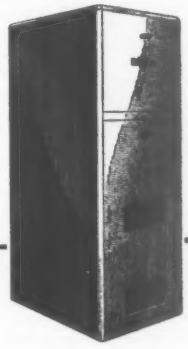

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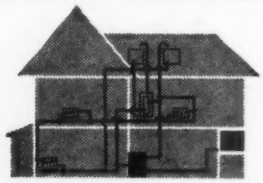

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CONTENTS PAGE

Editors' Introduction 434

The repair of old roof coverings 437
Repair or renewal? 437
Sheet roof coverings 438
Unit coverings 443

Timber structures, pests and fungi 445
Repairing timber structures 445
Eradicating timber fungi and pests 447

Walling, stonework and rendering 455
Walling decay 455
Stonework decay and repair 457
Brickwork 463
Rendering, plasterwork and wall-paintings 463

Special features 467
Repairing metalwork 467
Repairing rainwater furniture 467
Glass in old buildings 468
Maintaining church bells 469
Fire precautions and lightning conductors 470

Conclusion 470

Astragal 471

The LCC's Roehampton Housing Estate 473

HOW MUCH?

We preface this special issue on the Preservation and Repair of Old Buildings with this photograph of one of the flanking pavilions and colonnades of Stoke Park, Northamptonshire. These were built by Sir Francis Crane, probably with the help of Inigo Jones, between 1629 *and* 1635, *from designs which he brought from Italy. In* 1949 *these remains, which are evidently of key importance in the history of English Renaissance architecture, were in the hands of a speculator and would undoubtedly have been lost had not the SPAB taken up their cause and with the help of* Country Life *found a sympathetic purchaser. To the question "How much?" there is in this case some sort of answer. An Historic Buildings Grant of £5,700 was made to the two pavilions and their colonnades in* 1954 *and this was increased to £8,800 in* 1955. *Indications are, however, that this will not be quite enough. . . .*

Donald Insall

The Repair and Preservation of Old Buildings

In devoting, first, a series of articles and now a special issue of the JOURNAL to the repair and preservation of old buildings, the Editors have had two purposes in mind. The first is to call attention to the need for a more realistic public policy with regard to old buildings. We are clearly approaching a kind of technical " parting of the ways." Up to now all craftsmen and, up to a few years ago, all architects, were trained on the basis of traditional techniques. Now it seems likely that these techniques will tend, as the years go by, to occupy a marginal position in building and architectural education. This means that their practice will become increasingly a speciality, requiring a special force of craftsmen and of architects. This turn of events means that we will have to be more critical of our stock of old buildings. We must face squarely the question of " What proportion of them deserve to be maintained?" For only then can we decide such consequent questions as " How large a specialized architect and labour force ought we to bargain for to maintain them?" " What will be the cost?" and " How ought we to apportion it?" In theory the existence of these problems has long been acknowledged: the Ancient Monuments Branch of the MOW, the National Buildings Record, the listing of buildings by the Ministry of Housing and Local Government and, more recently, the Historic Buildings Grants are all evidence of official concern with them, and the vast number of Preservation Societies, headed by the SPAB, testifies to widespread public interest. Yet there is no co-ordinated policy. Our second purpose in treating this subject is to provide a useful reference for architects who may be called on to do this class of work. This is the more necessary as the general run of architectural practice has tended to flow in other directions: publications on preservation work during the last 25 years have been few and they have been dispersed among so many different sources. The purpose of our author, Donald Insall, has been to gather the substance of such published data as exists and to

add to it his own experience as an architect who has specialized in preservation work. Feeling that this was a project which ought not to be "one man deep," he has submitted his manuscript to the Technical Panel of the SPAB, who have kindly read it through and have made a number of useful amendments, which we here gratefully acknowledge.

Of all the categories of architect's work, this is one which lends itself least readily to "quantitative advice": it is hardly ever possible to indicate the amount of any given kind of decay which necessitates such-and-such a treatment, or the relative unit cost of one treatment as against that of another. It is perhaps worth recording here that by reason of this unpredictable quality in preservation work, both the SPAB and the author were originally averse to the publication of specification notes in this issue, on the ground that, in the event, everything must be left to the architect's discretion and that it is unwise to provide a ready-made phraseology which may not fit a given case. The Editors concede this, but hold that specimen clauses are of value in indicating how much information the builder should expect from the architect, and in eliciting many useful points of detail which might otherwise have been forgotten.

While accepting that there must always be a measure of incommensurability in preservation work, the Editors feel that life could be made very much easier for the architect and less costly for the client, if treatments, their cost and their effectiveness were systematically recorded and if critical precis were made publicly available from time to time. Fortunately, we have in this country a single organization, the Ministry of Works, which is itself responsible for so substantial a part of the nation's repair work that it would stand to gain enough from the compilation of data of this kind to more than justify the cost involved. Why should we not be as businesslike in the preservation of our old buildings as we are in the construction of new ones ?

THIS ISSUE : *Finding that we could not provide a useful coverage of the repair and preservation of old buildings within the compass of a special issue, we were obliged to publish part of our subject matter in advance of the special issue, in the form of technical articles. The titles of these articles and their publication dates are as follows: Introductory, the legal background, money, August* 28; *Organizations which can help, September* 4; *Job organization, September* 11; *The diagnosis, September* 18. *The publication of these subjects, which together cover the preliminaries to preservation, enables us to devote this special issue to the actual techniques. These are divided into four main groups: The repair of old roof coverings; Timber structures, pests and fungi; Walling, stonework and rendering; Special features.*

THE REPAIR AND PRESERVATION OF OLD BUILDINGS

The repair of old roof coverings

Repair. or renewal?

The repair of roof coverings is of paramount importance in all building maintenance.

In examining the condition of an old roof, one must first recall its detailed function—the collection of rain and snow, to be shed from the building at predetermined points—and how this is achieved. This may be either by a system of overlapping small units such as tiles or slates, or by means of a continuously jointed surface such as sheet metal. In either case, the effectiveness of the roof is chiefly limited by its behaviour at certain "danger points," the most pronounced of which are the following:

(*a*) The fixings holding the roof covering to the structure.

(*b*) The joints between its materials, such as drips and welts.

(*c*) Points of maximum exposure or mechanical wear, such as metal slopes facing the sun, or at the foot of a rainwater pipe.

(*d*) Inaccessible and unattended points—especially internal valleys and secret gutters.

(*e*) Interruptions such as skylights and chimney stacks.

(*f*) Abutments against other structures, either more or less rigid than the roof itself.

Besides watching these points, useful information can also be achieved by interrogating the building's inhabitants, whose evidence will usually not be lacking, although it may be overstated.

The architect must, however, concentrate not only upon locating the points at which water is actually penetrating, but upon assessing the whole general condition of the roof covering. Present water-tightness is not the only criterion. It may, for example, be found that a slated roof which at first sight is perfectly sound is laminating so badly at some points that it cannot long remain so, or that lead shows fatigue lines which must very soon become actual fractures. Or, on the other hand, poor roof design may be causing local weakness which could now be remedied in such a way as to make the structure perfectly sound and lasting.

The first question which must be asked is whether the existing covering can be patched, or must now be renewed. In the latter case, there will be the problem of the possible substitution of different materials. The main issues in taking these decisions can usefully be summarized as follows:

(*a*) What is the condition and remaining life of the materials? Is it economic to patch them any more, or would renewal now be cheaper in the long run?

(*b*) How serious and costly would further leaks be? Would they merely make a patch on a ceiling, or might they set up dry rot before being noticed? Does the interior contain valuable decorations and furnishings, whose protection should be taken into account?

(*c*) Is the material one which *can* be patched, or can it only be renewed as a whole?

(*d*) Is the roof covering material the same as the original? Does it form an integral part of the building's architectural appearance?

(*e*) Is the present covering potentially an efficient one, suitable to the building which it protects? Should the old material, although it was perhaps the best or cheapest available when it was laid, be replaced now by any other, more suitable and effective?

(*f*) What budget, labour and materials are at present available? Will any anticipated future demolition work release useful replacement materials, such for example as stone slates?

(*g*) How much maintenance would a particular roof covering need, and how much is it likely to get?

(*h*) Above all, which is the more economic in the end —present repair, or deferred expenditure on roofing but with consequently increased maintenance costs? If roofing repairs are deferred, other less urgent work *must* wait its turn?

The repair of existing materials brings mostly technical rather than æsthetic problems. Almost always, it is in fact neither necessary nor desirable to introduce "foreign" materials into a roof; but difficulty may sometimes be found in obtaining matching materials such as individual tiles. If different materials are already present, the change may be simpler to make—for example, ridge tiles and bonnet hips may often inconspicuously be used to replace defective leadwork dressings.

The nature of the roof covering material itself may dictate whether repair is possible or not. For example, cracks in reasonably sound lead may be satisfactorily repaired by "burning," but it is not possible to patch copper in this way.

Inevitably, cases will occur which are on the borderline between repair and replacement. Thus old tiled roofs are found from which the tiles fall like leaves in early autumn. Inspection generally reveals that this is due to the corrosion of ungalvanized wire nails

with which the tiles were pinned. In such a case the only permanent remedy is to strip and re-hang the old tiles, even though the great majority of them are apparently hanging on grimly, and may be years in their final decline. Cost is usually the main factor, and the architect's only course is then to try to influence the client to interview his bank manager. Otherwise, he can only stress that replacing the tiles as they fall is purely a first-aid measure, and that the cost of replacing the roof entire must still loom large on the near horizon.

It is when complete stripping and re-covering are necessary, that major complications are more likely to arise. The simpler cases are those in which the covering material itself is largely sound and re-usable, but must be stripped because of the failure of its fixings; for example, in the case of a tiled roof in which the pegs or battens have perished. There is unfortunately almost always a large proportion of wastage in removing the old covering, and new material must be added when re-covering. Ideally, the new units should closely match the old; but sometimes this is impossible because of cost or short supply. In these cases it is usually wisest to gather the old materials together to the most important section of the roof, and to use the new tiles or slates for slopes concealed from view. If modern tiles have to be introduced, it is better to choose a good sparkling bright type than to attempt an exact match, which will often darken to a depressingly drab colour in the course of time. On a building with high parapets, it is sometimes possible to re-use the old tiles or slates for the upper parts of the roofs, and to confine replacements to unseen positions below. This is well worth the effort, for many an old building has been ruined by the hard appearance of patches of machine-made tiles.

The most careful thought is needed when the old covering is so unsound as to be unusable. It may then be necessary to consider substituting a new, cheaper material for the old; and here the change in the appearance of the building, as well as the introduction of a material of perhaps lower standard, are matters not to be undertaken lightly. The extreme example of this type of substitution may be seen in almost all country districts, in the rusting corrugated iron which now covers so many a once-attractive thatched cottage. Another problem is the possibility of substituting copper for lead, for reasons of cost. On concealed roofs, this may not be a matter of architectural moment; but on roofs exposed to view, the changed appearance is a public concern; and it is thus vital to be conscious of one's responsibility to the building, and certain of the result. This apart from practical questions of durability, which must also be weighed in the balance, and of cost which can best be investigated by obtaining actual alternative estimates.

Generally speaking, the use of substitute materials should only be resorted to when economic factors make the change inevitable, or when the original material has shown itself to be in some way seriously unsuitable for the building which it covered. In many old buildings, the roof contributes so much to the interest and attraction of the whole that the use of incongruous materials can mean utter spoliation.

Sheet roof coverings

The durability of all metal coverings is dependent upon: (*a*) their degree of exposure, particularly to acid-charged droppings and to sunlight, and (*b*) their means of support and fixing, with special regard to provision for thermal and structural movements. The most frequently used metals are lead and copper.

Lead

The great virtue of lead as a roof covering is its ease of shaping and adaptation to irregularities of shape, and its very great durability when properly supported and fixed. Its one disadvantage is a liability to "creep" when improperly used, so that if the material is denied its natural freedom, thermal movements may accumulate without returning to their original position.

Recasting sheet lead: In historical times, cast sheet lead was widely used; and this is still the longest-lived roofing material. Old leadwork, whether cast or milled, may be melted down and recast, either on a casting-table erected at the site, or at the centralized workshops of one of the several firms specializing in this type of work.

Milled lead is a perfectly good material, easier to dress than the cast sheet, but slightly less stiff. It is, therefore, at a disadvantage in exposed positions such as cornices and places where rigidity is sought. A debatable point is whether milling actually reduces the life of lead by rearranging its crystalline structure; this is often claimed, but scientific proof has never been given. Since in recasting lead, the old material is all re-used without complexities of salvage and financial credits, cast lead is, however, in fact no more expensive in renewing old work, especially in relation to its undoubtedly longer life. The old lead removed from the building should first have all soldered patches cut out—other impurities can then be skimmed from the surface of the molten metal in the "pot." Stories that ancient leadwork contains valuable silver are mostly apocryphal, and there does not seem to be any special reason for setting aside old lead for return to its own particular building. If interesting old inscriptions are found, these may be cut out and saved for display. Otherwise the old material is all melted down, and a proportion of new pig lead added as may be needed. The finished lead can be varied from 6 lbs. to 9 lbs. in weight, and cast lettering and ornamental devices can readily be formed by pressing patterns into the sand.

Re-laying roof leadwork

Sheet lead must always be firmly and continuously supported, and the boarding carefully overhauled and prepared. An underlay of building paper facilitates natural thermal movements, and may help to even out minor irregularities of the boarding. Lead should always be protected in this way from contact with oak, so as to prevent attack by tannic acid.

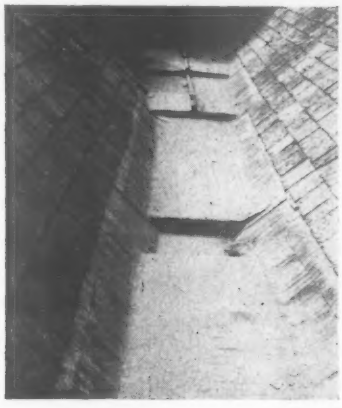
Whatever the original arrangement of the roof, the new sheet sizes and lengths must be carefully restricted, to localize movements and provide plentiful expansion joints. A maximum area of 24 sq. ft. must

normally be strictly insisted upon, with individual sheets not more than 10 ft. in length. Under proper supervision and in very sheltered situations, particularly for internal leadwork protected from sunshine, these sizes may be slightly exceeded. But no single cause has so much reduced the life of ancient leadwork as its layout in sheets of excessive size. If through this fault in the past old lead has suffered premature decay, it is essential to remedy the design and to limit the sheets to a proper size. This is not always easily done, since the sheet sizes govern the position of drips, whose number may in turn be limited by the available fall, for instance behind a parapet. In tapered gutters, too, an increased number of drips, the depth of each of which has also sometimes to be increased for safety, can result in embarrassingly wide gutters climbing far up the roof slopes. But much can be done by re-planning the layout of drips and rolls to new falls, designed upwards from the outfall, and by introducing additional upper drips as economically as possible. Sometimes, excessively large sheets adjoin unnecessarily small ones, when their sizes may be averaged out; or a very large slope can be re-laid to cross falls in the shorter direction, with rolls laid diagonally or crosswise. If a slope falls in more than one direction, the roll should be formed with its open side on the more sheltered face; and if a roll cuts diagonally across a vertical drip, this must always be set with the open side downwards.

In relatively flat surfaces such as gutters, trouble from inadequate drips is common; these should indeed preferably be no less than 2½ in. deep. If, however, as frequently occurs in old buildings, this depth is unobtainable, the drip may be reduced to 1½ in., if some means of capillary check is provided in the vertical face. One way of doing this is to chamfer off the lower edge of the boarding before it is fixed, forming a groove into which the head of the lower sheet can be dressed; the foot of the cover sheet is afterwards dressed vertically past and down on to the flat.

In specifying joints between the sheets of re-laid lead, a choice must be made between lapped junctions over a wooden roll, and tightly-dressed open rolls or standing welts. Where heavy traffic is anticipated, or when future replacement of individual sheets is anticipated, the wooden roll has the advantage. In this case, intersections and the ends of rolls are "bossed." Generally otherwise the open roll is best, and on any degree of slope, its tight and continuous grip is a great help in restraining any possible slipping of sheets. This method of fixing was general until the 19th century, and thanks to the firm grip of the curved, open rolls, leadwork of the upper part of Robert Adam's dome at Kedleston Hall has recently been found to be almost free from movement after 200 years.

The head of each sheet on sloping surfaces is usually fixed by two staggered rows of copper nails; but on steep slopes, additional support can sometimes be obtained by turning the top of each sheet over the boarding, and securing it by nailing to the back. Whatever was there before, proper soakers and cover flashings are the only satisfactory way of protecting the junctions between roofs and walls or chimneys, where any kind of fillet is bound to crack away.



Internal outlet to roof gutter at Whitelackington Manor, Somerset. Arrangements like this (caused here by a Georgian extension to an Elizabethan building) constantly give trouble. Also to be seen is the cutting effect of acid charged droppings from lichen-covered slates.

The recasting of sheet lead. Above, a cascade of molten lead is poured on the casting table. Below, lead on the casting table which has cooled and is being cut up into suitably sized pieces. Bottom, lead burning. (Lower photographs by courtesy of MOW).

It is useful to remember that sheet lead dressed into a hollow box such as a sump is strengthened by dressing, and that it is weakened by working when beaten over a projecting arris. Proper fixing clips, lead "dots" and cover flashings must never be skimped, and a typical specification for the renewal of roof leadwork is given below.

A difficult problem, for which no really satisfactory remedy has yet been produced, is to prevent leadwork damage by the acid-charged washings from lichen growing on slates. A lead gutter immediately under stone slates is often found to be deeply scored by this acid, in narrow "rivulets," entirely distinct from the shallow depressions left by mechanical wear or constant dripping water. The damage is believed to be caused not so much by heavy rain as by the more heavily charged dewdrops, whose action is not diluted by washing. Since stone roofs under copper telephone

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Outline specification for re-covering roof in recast lead in accordance with architect's detailed site direction

1. STRIPPING AND RE-CASTING: Carefully strip old defective lead from roofs where directed, load and transport from site and credit certified weights at rates to be agreed.

Cut out and remove all solder and impurities. Carefully cut out any inscriptions, records of previous re-castings, etc., and set aside for re-use as directed.

Re-cast all remaining to the following weights, making up as necessary with virgin English lead:

Cornice	8 lb.
Roofing generally	7 lb.
Dressings to wooden sills	6 lb.

Cast new inscription and date into one sheet, as directed by the architect.

New milled lead to be used for soakers, is to be best English milled, of 4 lb. weight, uniform in thickness and texture, and free from defects.

Transport new sheet lead to site, unload and store as directed by the general contractor.

2. RE-LAYING LEADWORK: Except where otherwise agreed by the architect, the work throughout is to be carried out only by registered plumbers. All new lead to be well and neatly dressed without injury, in sheets of specified sizes, securely fixed with copper nails and lead or copper tacks, joints where necessary being welted or "burned" and not soldered, and proper provision being made for expansion and contraction. Detailed site instruction on the work will throughout be given by the architect.

3. SPECIAL PRECAUTIONS: Where excessive hammering, etc., is liable to cause damage to internal plasterwork or finishes, special precautions are to be taken to avoid vibration, including the use of screws instead of nails wherever directed.

4. SHEET SIZES: The previous excessive sheet sizes are not to be reproduced. New sheet sizes are not to exceed 24 sq. ft. in area, nor 10 ft. in length, except where specially directed by the architect.

5. BOARDING: Boarding of all flats, gutter, etc., is to be carefully adapted by the general contractor, with revised and additional drips in positions to be directed by the architect. All projecting nails to be driven well home and edges and irregularities planed off to provide a continuous, smooth supporting surface. After the architect has approved the repaired substructure, an underlay of stout waterproof building paper, with smooth surface on both sides, shall then be laid over the whole substructure before the lead is laid.

6. FIXING: New sheets are to be fixed at the head with two staggered rows of copper nails with ¾-in. flat heads at 3-in. centres and 3 in. apart. Drips at the joint between the top of each sheet and the foot of the next are to be provided, each of depth at least 2½ in. whenever the old boarding layout allows. Where existing boarding does not permit drips of this depth and cannot be adapted to provide it without raising gutter heads to an impracticable extent, or tapering gutters to uneconomic width, drips may be retained where directed at a minimum of 1½ in. deep. The top of the lower sheet must, however, in this case be dressed into an anti-capillary groove half-way up the vertical face of the drip, the foot of the upper sheet being dressed past and down on to the flat.

On inclined roofs exceeding 15 deg. in pitch, drips may be replaced by overlaps, to be at least 6 in. deep, measured vertically.

The sides of all sheets are to be fixed with lead or copper tingles 2½ in. wide, securely nailed down and turned into hollow rolls. Alternatively, where directed, fixings may be made by dressing around wooden rolls, with bossed ends and intersections. The foot of each sheet more than 2 ft. 6 in. wide is to be similarly supported by lead or copper clips.

Lead "dots" are to be formed to support all vertical faces as directed, and whether or not these were originally so provided, and wiped over countersunk brass screws and washers at centres not exceeding 2 ft. 6 in. in any direction.

7. VERTICAL ABUTMENTS: Against all vertical abutments, form 6-in. upstands and protect with cover-flashing inserted 1 in. into walling, new grooves being cut for the purpose where necessary. Cover-flashings are to be secured with lead wedges at 18-in. to 24-in. centres, pointed in with cement mortar, and dressed down at least 4 in. over upstands. Sheets are not to exceed 8 ft. to be lapped at least 4 in. at junctions, and supported at intervals of not more than 2 ft. 6 in. by means of 2½-in. lead or copper clips securely fixed to walling and turned down behind flashings, then dressed back 1 in. over outer face.

Secret gutters against abutments are in future to be avoided. Where specially permitted, they are to be formed of 6-lb. lead, copper-nailed to roof boarding under the last slate, dressed over a tilting fillet and across the gutter, then turned up and protected as described above.

8. VALLEYS: Valley boarding, adapted and repaired as directed, is to be recovered with 7-lb. lead, dressed to slope of boarding, turned over tilting fillets at each side, and carried up under re-fixed slates to a distance of at least 3 in. measured vertically. Upper end of each sheet to be close copper-nailed and lower end lapped at least 6 in., measured vertically.

9. RIDGES AND HIPS: To be covered with 7 lb. lead in sheets not exceeding 8 ft. in length, with 6-in. lap at joints, dressed over rolls and 6-in. to 7-in. down slates on each side. All dressings to be firmly held at 2 ft. 6 in. intervals by double lead clips 2½ in. wide, fixed under rolls and carried down under wings, then dressed back 1 in. along upper face.

10. GUTTERS: Tapered gutters are to be reformed by the general contractor in accordance with the architect's detailed site instructions, with drips at intervals as specified above, and from width at least 9 in. at lowest point. Before refixing of slating, re-dress gutters with 7 lb. lead carried 6 in. up slope and over continuous tilting-fillet. Form upstands and cover-flashings at abutments as specified above.

Downpipe boxes to be re-formed where directed, and of dimensions at least 9 in. × 9 in. × 4 in. deep. Cut away masonry of parapets and provide 7 lb. lead overflow spouts to each box as directed, discharging through parapet and clear of wall externally.

Back-gutters behind chimneys to be re-dressed with 7 lb. lead dressed at least 4 in. around each angle of chimney

11. DORMERS: Boarding to be made good by general contractor all as directed, and any particularly uneven old boards, faced with approved outdoor quality hardboard, securely nailed down.

Cheeks to be recovered with 6 lb. lead dressed over top board and nailed thereto on reverse and also supported by wiped lead "dots" as specified above. The front edge to be dressed around the corner post, securely copper-nailed and welted back over nail heads. Tops of dormers to be re-covered with 6 lb. lead as for flats, with lead or copper fixing tabs at all exposed edges.

Dormer and chimney aprons to be dressed at least 4 in. around angles, and to have 9 in. inclined apron supported by lead clips at not more than 2 ft. 6 in. intervals. Soakers against dormers and chimneys to be 1 in. longer than slates and turned up under cover flashings and dormer cheek leadwork.

12. DRESSINGS TO CORNICES AND LEDGES: Whether or not these were originally so provided, all cornices and water-holding or permeable ledges stonework are to be carefully dressed with 8 lb. lead with welted expansion-joints at 7-ft to 8-ft. intervals and dressed at least ¾ in. into joints of walling. All ledge and cornice dressings are to be fixed by lead dots at distances not exceeding 2 ft. 6 in., utilising original mortices where possible. Where possible damage to stonework would be avoided thereby, old "dots" may with the permission of the architect be cut off flush, and fixings obtained by large-headed, coarse-threaded, brass screws and washers driven into the retained lead plug, the upper part of the new "dots" being wiped around them.

13. REPAIRS: Thoroughly inspect and check over all remaining existing leadwork to roofs throughout and repair as directed in detail by the architect.

Cut out all soldered or inadequate patchings, iron nails and other temporary fixings; and repair by burning-in new pieces all of weight to match existing.

Re-dress and re-fix all loose and displaced leadwork as directed, making up with new lead or copper clips, and copper fixing nails where these are deficient or inadequate. Where severe acid cutting is apparent on sloping faces (*e.g.*, under drips from slating at heads of dormers) these are to be reinforced by temporary 4 lb. milled lead overcloaks where specially directed.

14. DUCKBOARDS: Overhaul and renew all duckboards as directed in creosoted deal, so as to permit free flow of water from melting snow. Repair and replace all defective and deficient guards to downpipes and other constricted points as directed where blockages could otherwise be caused by leaves and rubbish.

15. COMPLETION: All roof plumbing works are to be approved in detail by the architect before the operatives leave the site. Leave all leadwork in a sound and weather-tight condition, and remove all tools, plant and equipment and unused materials. Carefully clean out all gutters with wooden shovels; wash down and leave all tidy on completion.

wires may often be observed to be lichen-free, it has been suggested that one expedient may be to set a copper strip at the ridge, or in the slope itself. Evidence of the practical effectiveness of this method would be most valuable. The only alternative seems to be either to set an extra renewable overcloak at the point of maximum wear, in which case provision must be made to resist capillary attraction, or to reduce the width of outer lead sheets against the foot of roof slopes, regarding them as expendable. In this case, the use of wooden rolls will enable individual sheets to be renewed without damage. It is a pity that no more satisfactory solution has yet been found. Small dew-gutters have been rejected as being awkward and unsatisfactory, and perhaps the only remedy may be the introduction of an eaves course of some kind of absorbent tiles. Other ideas would be welcomed.

Repairs to old leadwork should always be made by lead burning and never with solder, which has a different coefficient of expansion and will break away. Temporary stopping of lead cracks with the various mastics and bituminous compounds is all a very doubtful business, and really cannot be relied upon. In practice it usually only conceals the trouble, while inviting further damage as soon as the leak starts again.

Copper

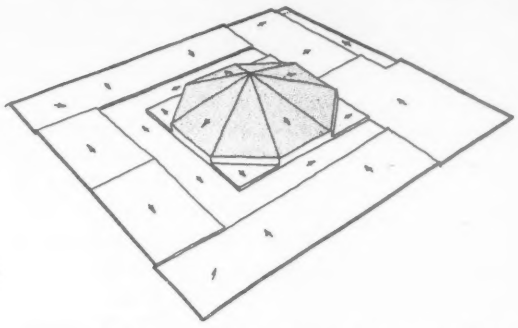
Copper has been used for roofing buildings for many hundreds of years. The green " patina " which the material develops is itself an attractive and important feature of many architectural exteriors; and copper is much lighter than lead. It is also cheaper, although enjoying a slightly less venerable old age than its sister material.

The greatest danger to copper on a roof is from excess working, either when it was originally dressed, or through " drumming " due to inadequate support. This causes fatigue and eventually cracking, and the Copper Development Association recommend that sheets should not be repaired with soldered patches.

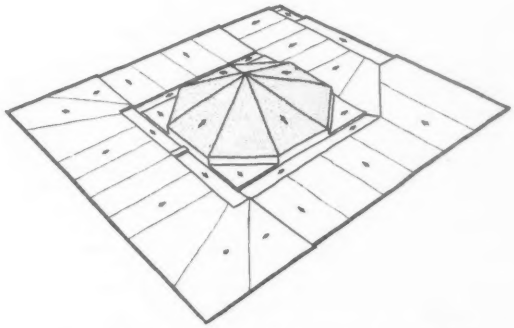
Where a copper roof has failed in any degree, therefore, it is usually more economic to strip and re-lay it throughout. The boarding can also then be overhauled and repaired, with particular regard for the smooth and continuous support which the metal requires. The substructure should be closely examined by the architect before the new covering is laid. Felting is desirable to prevent chafing, but should be non-bituminous: it is laid with butt joints and fixed by copper nails.

Copper for re-roofing should be thoroughly annealed and of 22 or 23 gauge. Samples may be tested by weighing and by a " double-bend " test described in BS 1569. Although old copper can in fact be re-annealed, this is seldom worth while. The new metal is fixed in sheets not more than 6 to 8 feet long, jointed head-to-foot by double welted seams. The width of sheets should not exceed 2 ft.: if sheets of greater size are used, there is a risk not only of drumming and fatigue, but of thermal movements lifting whole sheets of copper from the roof.

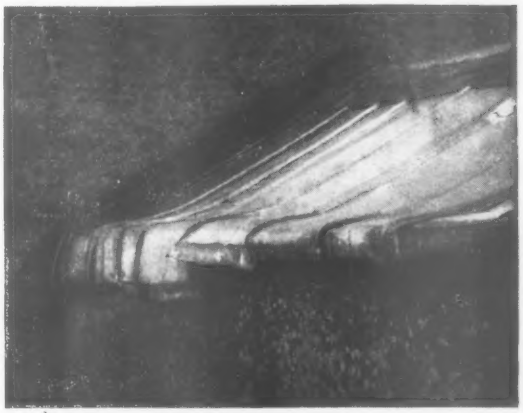
For the side joints between sheets, there is again the choice between standing seams and welting over wooden rolls. Flat-topped rolls are better than the



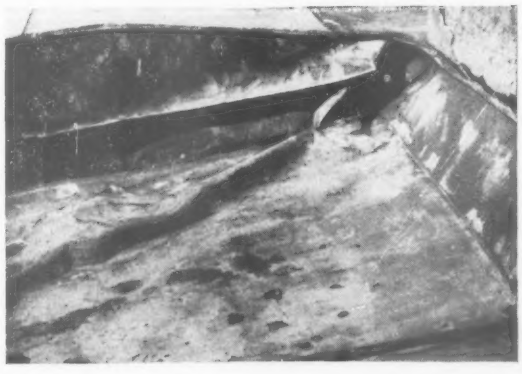
A flat roof designed to allow proper sheet sizes (Clytha, Monmouthshire). Top, diagram showing the original layout of the leadwork. Note size of sheets and absence of drips in internal gutter, making no allowance for expansion. Below, diagram showing the layout as redesigned.



Below, sagging leadwork. The result of age and inadequate fixings.



Below, buckled copper roofing (Wotton House, Bucks,) caused by excessive sheet sizes.



pointed type, in forming which the sheets may easily be dressed up and away from the substructure.

A recent development is the system of "economy" copper roofing in which sheets of extra size are held in place by sliding clips, permitting ready expansion and contraction. Where for any reason the traditional layout is impossible, the method may enable a defective copper roof with excessive sheet sizes to be relaid, without entailing extensive carpentry alterations to the boarding system or substructure.

Copper must not be jointed or patched with solder, which has a different expansion rate and will come away. On the flat, a fall of at least 2 in. in 10 ft. is recommended, with drips at least 2 in. deep in every ten feet: the rolls are usually staggered at the drips to facilitate working. A Scandinavian practice of painting the joints with raw linseed oil before welting has recently won the commendation of the Central Council for the Care of Churches. The re-laid copper roof should be very closely examined on completion, with special regard to the absence of working-cracks, and to firmness and continuity of support. Lastly, as with any metal roofing, it is particularly important to prevent damage during adjoining works, as can so easily happen from a dropped chisel or an in-trodden nail: really adequate protection of the finished job is quite essential.

A typical specification for re-covering roofs in copper is printed below.

Other substitute materials

Aluminium is a young material, and has not yet had

Outline specification for re-covering roof in sheet copper in accordance with architect's detailed site directions

1. STRIPPING OLD COPPER: Carefully strip old defective copper from roofs, etc., as directed, load and transport from site, and credit certified weights at rates to be agreed.

2. NEW MATERIALS: All new copper used shall conform to the requirements of BS 1569 : 1949, and shall be of 24, 23 or 22 standard wire gauge, except as otherwise directed, and of dead soft temper.

Throughout the entire new copper roofing works, no iron nails shall be used in contact with the copper as before. All copper shall be fixed with copper nails or brass screws.

3. RE-LAYING COPPERWORK: The work throughout is to be carried out by experienced plumbers or recognized copper-roofing specialists. The whole of the work in connection with the new copper roofing is generally to be carried out on the site, and in accordance with detailed instructions to be given by the architect.

All new copper sheet is to be laid truly flat, flattening being carried out on the bench. Before laying, the material is to be prepared by cutting, bending and seaming to fit accurately into the bay of the roof for which it is intended: thus avoiding unnecessary forming, dressing and cold working. Due allowance is to be made in all dimensions for expansion and contraction.

4. SPECIAL PRECAUTIONS: Where excessive hammering, etc., is liable to cause damage to internal plasterwork or finishes, special precautions are to be taken to avoid vibration, including the use of screws instead of nails wherever directed.

5. SHEET SIZES: The previous excessive sheet sizes are not to be reproduced.

Except where specifically directed otherwise, new copper sheets are not to exceed 2 ft. in width. Areas of individual sheets in 22, 23 and 24 s.w.g. copper are not to exceed 14 sq. ft. and in 26 s.w.g., 12 sq. ft. each.

6. BOARDING: The boarding of all flats, gutters, etc., is to be carefully adapted accordingly by the general contractor with new drips wherever necessary, in positions to be directed by the architect. All projecting nails are to be driven well home, and edges and irregularities planed off to provide a continuous, smooth supporting surface.

7. FELT: After detailed approval of the repaired sub-structure an underlay of felt is to be laid over the whole of the boarding to receive the new copper. The felt is to be type 4A (ii) brown impregnated flax, known as inodorous felt No. 1, 50 lb. per roll, conforming to BS 747 : 1952. Alternatively, Fibirine Felt may be used.

The felt is to be laid butt jointed, and secured with copper nails.

8. SEQUENCE OF OPERATIONS: After the roof surface has been prepared, it is to be brushed clean and laid with sufficient felt for a day's work. The prepared new copper is then to be laid in the following sequence:

(*a*) cesspools;
(*b*) gutters;
(*c*) drop aprons;
(*d*) main roof sheeting;
(*e*) cover flashings.

9. FIXING: All free edges of the new copper are to be properly secured by means of copper cleats as directed by the architect. These cleats are to be not less than 2 in. in width, and secured to the roof boarding, or passed through slits or joints in the roof boarding and secured on the underside. Cleats 2 in. wide are to be fixed at 15-in. centres in all joints from eaves to ridge, at 12-in. centres on verge edges, and two per bay at drips, eaves and ridges generally. Transverse joints are to be fixed with one 3-in. wide cleat in the centre of each double lock cross welt, and two 2-in. wide cleats in each single lock cross welt. Each cleat is to be fixed close to its right-angled turn by a minimum of two copper nails or brass screws; the tail end of the cleat is then to be turned back to cover the heads of the nails or screws so as to prevent all abrasion of the under surfaces of the copper when any movement takes place.

Ridge to eaves joints are to be formed with standing seams or batten rolls as directed. Standing seams are to be formed to a nominal height of 1 in., and are to be spaced generally at 21¼-in. centres. Batten rolls are to be formed to the following minimum sizes: Height 1½ in., width at base 1⅞ in., width at top 1¼ in. The finish of batten rolls at the eaves may either be splayed or vertical, as agreed on site.

On roofs not exceeding 5 deg. in pitch, transverse joints are to be formed with drips not less than 2-in. in height. On roofs between 5 deg. and 60 deg. in pitch, double lock cross welts are to be used for transverse joints, and are to be staggered in alternate bays. Transverse joints to roofs exceeding 60 deg. in pitch may be single lock welts.

10. VERTICAL ABUTMENTS: Against all vertical abutments form 6-in. upstands and protect with cover flashings, joined to upstand by means of 1-in. single lock welt where practicable. Alternatively, the cover flashings may be beaded and held to the wall by means of a copper strap, fixed behind upstand and turned down behind the cover flashing and welted round its lower edge.

Secret gutters against abutments are in future to be avoided. Where specially permitted they are to be formed of 26 s.w.g. copper, copper-nailed to roof boarding under the last slate, dressed over a tilting fillet and across the gutter, then turned up and protected as described above.

11. VALLEYS: Valley boarding is to be adapted and repaired as directed, and suitable tilting fillets provided to enable the sheeting in the gutter to be joined by means of a single lock welt to a continuous fixing strip, nailed to the tilting fillet so as to allow for free movement of the copper in the gutter.

Lengths of copper in valley gutters are to be joined by double lock cross welts where pitch is 60 deg. or less. For steeper pitches, single lock welts may be used.

12. RIDGES AND HIPS: Ridges and hips to all roofs formed with standing seam down joints are to be finished with standing seams welted in, or with ridge rolls, as directed.

On roofs formed with batten roll down joints, the ridges and hips are similarly to be finished with batten rolls, 2½ in. to 3 in. in height and approximately 2-in. wide at the base.

13. EAVES: The eaves are to be finished by means of a separate and continuous fixing or lining strip cut from half hard copper strip, secured to the fascia by copper nails or brass screws.

A drop apron made from dead soft temper copper is to be secured to the bottom edge of the lining plate, and at eaves level is to be turned outwards at 90 deg. to the fascia. 2-in. wide cleats, two per bay, having previously been fixed to the roof decking, are to be folded over this 90 deg. flange. The roofing sheets are then to be turned over and under this projection, and finally dressed down to form a single lock welt on the fascia.

14. GUTTERS: Tapered gutters are to be reformed as necessary by the general contractor with drips at intervals of from 7 to 10 ft. and from a width of at least 9 in. at the lowest point. Detailed site instruction on the whole of this work will be given by the architect.

In long gutters from 20 ft. to 50 ft. where excessive expansion takes place, special expansion joints are to be formed in the new copper to accommodate such movement, as shown in the graph in CDA publication No. 42, *Copper Weatherings and Flashings*.

Re-line gutters with new copper sheet, with upstands and flashings as described above.

Reform downpipe boxes where necessary, of dimensions at least 9 in. × 9 in. × 4 in. deep. Cut away masonry of parapets as directed and construct overflow spout to each box, of 26 s.w.g. copper, to discharge through parapet and clear of wall externally.

Back-gutters behind chimneys are to be dressed at least 4 in. around each angle of chimney.

15. COMPLETION: All relaid copperwork is to be approved in detail by the architect before the roofers leave the site, and left throughout in a sound and weather-tight condition. Remove all tools, plant and equipment and unused materials; carefully clean out all gutters with wooden shovels, wash down and leave all tidy on completion.

the opportunity to show its paces for such long periods as copper and lead. It dresses well and when proved by time, may well earn a place alongside the other metals suitable for re-roofing old buildings. The chief drawback at present is the practical difficulty of any simple kind of jobbing repair except the replacement of complete individual sheets.

Other useful materials where only a limited life of a generation or so is called for include the various rubberised and reinforced bituminous felts. The latter can be readily dressed when heated, and holds its shape well once it is in position. But in the repair of old buildings whose life is commonly measured in centuries, such materials cannot, of course, hold comparison with metals such as lead and copper.

The various types of asphalt are nowadays used on old as well as on new roofs; but doubts have been raised in many minds by the impossibility of being able to guarantee the roof for any really adequate period, in relation to the life of an old building. Continuous materials of this nature must be supported absolutely firmly; and such details as the junction between a wooden roof and a vertical wall are always danger points. Where a more permanent job is impossible however, asphalt makes a very sound job for its own life span, and may usefully be employed to protect an ageing roof for 20 or 30 years.

Unit coverings

Thatch: Many more mediæval roofs than would now appear so were originally covered either with thatch or oak shingles. Nowadays the use of thatch is mostly confined to rural situations, owing mainly to the cost factor, and to the risk of damage by fire. Thanks largely to the encouragement of the Rural Industries Bureau, the craft is nevertheless very much alive and has many young apprentices. A thatched roof indeed offers the best insulated covering available; but it must be carefully maintained, and renewed at relatively frequent intervals. The simple, unelaborate shapes of old thatched roofs, formed of rough rafters and unwrought spars, are a perfectly adequate and suitable substructure; and there is no need to regularize and sophisticate them. Overhanging eaves and verges are generic to the material; but internal valleys, parapet gables and back gutters are not, and should be removed whenever possible. Eaves gutters are best avoided altogether.

"Longstraw" thatch is the least durable of the family and with a life of only 10 to 30 years, it also requires the steepest pitch (about 50 deg.). The material is cheap, but machine thrashing, which damages the straw, and rising labour costs have made straw thatch an increasingly uneconomical material. Reed thatch is, however, a horse of a different colour: it is tightly "sprung" into position so as to present only the butts of the reeds at the surface, and if re-ridged at intervals, may last easily 70 or 80 years. Combed wheat reed is a little less durable, with a life of 35 to 60 years. There is no more depressing sight than worn-out thatch; and periodical repair and attention are essential. Damage by birds and vermin can be minimized by wiring over the roof with a stout galvanized mesh. Thatch may also be fireproofed by treating it with a solution of sulphate of ammonia, borax, boracic acid and alum*; but the treatment is simpler for new than existing thatch, and needs periodic renewal. Experiments are being made with a fireproof blanket underlay, fixed over the rafters to protect the interior; and if successful, this method may easily help to reduce the chief hazard of the material.

Tiles: Clay tiles were imported from the Low Countries during and after the 13th century, and their use became compulsory in London in 1212. In historic buildings they are usually hand-made, and held in place by means of oak pegs hung over riven oak battens. Except when iron fixing nails were used and have been eaten away by tannic acid, the battens are usually the first casualty needing replacement.

In rebattening a roof, the old tiles should be carefully set aside, and the battens stripped and replaced by new ones, usually of heavy gauge deal. It is false economy to skimp batten sizes; and to preclude corrosion, they must be securely fixed to the oak timbers by copper nails, or if these will not penetrate the ancient and hardened timber, by heavily galvanized nails.

Tiles may be re-hung either from oak pegs, as they were originally, or by means of stout copper or galvanized-iron nails.

Where the pitch is adequate, roofing felt under the battening is not really necessary. It may, however, be found a great convenience in keeping the structure watertight during the course of operations. Otherwise the additional ventilation admitted by the unfelted tile roof is all in fact a credit on the health account. Pantiles are indigenous to some parts of the country, but elsewhere are too assertive for use as a substitute material.

Slates: Stone slates are common in some areas, and vary enormously in quality and characteristics. Some are liable to damage by frost, especially in the upper half, which is kept wettened by contact with the slate above. For all stone slates, a very heavy roof construction is needed. The lowest courses of a roof, where there is the most water to be combated, were first laid with the heaviest and largest slates, the remainder being laid in succeeding courses, decreasing gradually in weight and pitch until the smallest offcuts could be utilized at the ridge. When cheap rail transport became available in the 19th century, the smooth, black Welsh tiles, drab in appearance but amenable to pitches of as little as 22 deg., easy to lay and predictable in performance, to a great extent supplanted local stone, and were often used for replacements. It is however always possible, where expense permits, to obtain a high-quality stone slate of a closer match. Where an area of slating is to be cut out for repairs, this may be achieved by working diagonally upwards from the eaves so as to damage the fewest possible fixings. The support of individual replaced slates by lead tabs turned up at the bottom is an unsound practice, since the tabs gradually open and release the slates, and are especially liable to damage when the

* Recipe recommended by Rural Industries Bureau: 28 lb. sulphate of ammonia, 14 lb. carbonate ammonia lump and 7 lb. borax lump, dissolved in 50 gallons water. Coverage 500 sq. ft.

roof is being brushed clear of snow. Copper tabs are stronger; but the best device of all is to slot the slates at their fixing holes, where they will later be protected by the course above, and to hook in stout copper tabs, tucked through the slots and laid flat on the underside. The slate may then be slid up into position, with the tabs in place, to be turned down over the battens from inside. This is only practicable when there is reasonable access to the roof-space. The common but bad practice of drilling and screwing tiles into place with brass screws and washers, covered with mastic, is a fundamental error and can never make a good job.

Shingles: Oak shingles are now rarely found, and have been almost entirely ousted by cedar, which is an excellent material for the purpose. The life of shingles is limited to some 40 or 50 years, after which considerable repairs begin to be necessary. Swarming insects behind shingles also sometimes attract damage by woodpeckers. On the rare occasions when shingles are to be renewed in oak, the nail-holes must be burned with a hot iron, as protection to the nails against tannic acid attack.

Duckboards: Although scarcely a roofing material, these are an important provision under this heading. Proper means of access over roofs should always be arranged, so as to avoid any damage to delicate slates and tiles. Duckboards in gutters are useful in supporting melting snow, while allowing the free passage of water beneath. They should be carefully designed to avoid interference with the flow of water, and must be of creosoted deal or cedar, and not of timbers harmful to metal like oak. Care should also be taken in the placing of nails and screws to avoid harm to the metal. An adequate supply of wooden shovels or cleaning boards must lastly be kept at hand in any ancient building, to encourage snow clearance without unnecessary damage to the roofs.

Outline specification for repair of slated roof in accordance with architect's detailed site directions

STRIPPING: Strip all lead dressings and leadwork from gutters, dormers, hips, valleys, ridges, etc., of slopes as indicated on the plans, by sections as directed on site, and cart away and credit.

Any leadwork in good condition may be salvaged for re-use if approved by the architect. Carefully remove existing stone slates to roof slopes as indicated, and set aside as many as possible for re-use.

Strip old battens and cart away, and remove boarding where existing, for re-use as directed.

Shore as necessary, and remove all disused, seriously damaged and useless timbers. Cut out or remove all timbers found heavily infested with beetle, and thoroughly treat remainder with " ..... " or other approved insecticide, all as directed.

Cart away all rubbish with minimum disturbance and mess, and protect interior from damage whilst unroofed.

Replace all deficient and inadequate rafters, purlins and other roof members with new well seasoned deal of similar scantlings, all as directed by the architect.

It is not intended to renew or straighten old and crooked structure, but rather to set the roof in sound and healthy repair. In general, timbers are to be inspected and repaired individually and as far as possible in position, with a minimum of replacements and renewals. All " live " structural movements must be resolved, design defects such as insufficient drips or falls properly remedied, and beetle infestation cut out or thoroughly poisoned. Exact symmetry and straightness are, however, not sought after, and irregularities which are not unsound or unsafe are to be retained. Detailed instructions on all points will be given on the site by the architect.

FELTING AND RE-BATTENING: After approval of repairs to each section of roof carpentry, lay " ....." ..... quality or other equal and approved roofing felt over rafters, lapped sheet over sheet, and batten with ..... deal battens securely fixed with heavily galvanized nails at .... in. centres.

LEADWORK: All leadwork to gutters, hips, valleys and dormers, and all dressings, soakers, etc., throughout are to be renewed in accordance with the attached Specification for leadwork, and as directed on site.

SLATING: On all external slopes visible from the ground, the existing slates are as far as possible to be re-used, made up as necessary with new " ..... " slates or other equal and approved, of nearest possible match to the old, as directed. Carefully relay ..... face with new or salvaged slates as directed, in regularly diminishing courses from eaves to ridge, to present an unbroken face of similar slates towards this side.

Elsewhere the slates are to be kept as far as possible of a single type within each roof slope, changes being confined whenever possible to the lines of hips, valleys or verges.

On unseen slopes where indicated on the drawings, ... quality " ..... " slates are to be used equal to a sample to be approved by the architect.

FIXING: Slates to be of random width, laid to regularly diminishing courses, as may permit the maximum re-use of existing slates. No slate to be cut to a width of less than half its length. Only wide slates to be used at the hips and verges.

Each slate to be securely fixed by two stout copper nails, equal to sample to be submitted to and approved by the architect. Slates to be accurately cut to rake of roof on dormer cheeks and at valleys, hips and verges. Nailing to be clear of woodwork. Lay double course at eaves and verges and point up verges in waterproofed cement mortar, struck off smoothly.

Against raking parapets at ..... gable where there is insufficient upstand for lead soakers, slating is to be carefully flaunched with fillets of waterproofed cement, weathered away from stonework. Elsewhere against abutments, insert 4 lb. lead soakers 1 in. longer than slates, turned up under proper stepped or raking cover flashings as specified.

COMPLETION: On completion and approval of the roofing repairs, remove all rubbish from roof and attics.

Carefully vacuum clean attic spaces and leave all clean and tidy.

Notes on re-thatching

Thatching being a specialist craft, no specification is usually issued; but the following notes are of guidance. (See also Bibliography).

NORFOLK REED: All old thatch must be completely stripped; to attempt encasing old reed roofs is never satisfactory.

New reed thatch should generally be 12 in. thick, reduced to 10 in. at the verges. For every " square " of 100 ft. super, about 100-120 bundles of best Norfolk reed (or in poorer work, "mixed " reed) will be needed.

The reed is laid in courses, " sprung " into position and held down by hazel rods some 5 to 8 ft. long, at 6 ft. to 7 ft. centres. These are stitched to the battens with stout tarred cord, or secured by pointed iron hooks 8 in. to 12 in. long, driven into each rafter.

In completing the ridge, a reed " roll," 4 in. to 8 in. in diameter is first laid, and then covered with 6 in. of sedge, held with rods and herringbone cross spitting, and patterned to design.

In roofs open to view from below, a woven mat of reeds is sometimes used in place of battens.

COMBED WHEAT REED: Wheat straw instead of being threshed can be passed through a reed combing machine, when being unbroken it can be used for thatching like reed.

Old work may be cased, when a 12-in. new coat is sufficient; otherwise if it is completely stripped, 12 in. to 18 in. thickness is required, calling for approximately 20 bundles or " nitches " (28 lb.) of the combed wheat reed, 25 spars and 25 four-foot " binders " per square. The finished roof is often completed by trimming with clippers.

THRESHED LONG STRAW: All eaves and verges should be stripped, together with any superfluous and decayed old thatch, down to a sound foundation of the original coat. The wheat straw should be of good quality and is prepared in " yealms " or layers 14 in. to 18 in. wide by 4 in. thick, well wettened and laid to a thickness of 10 in. to 12 in. The verges and eaves may be increased to 12 in. or 15 in. The straw is held in place by " brotches " of split hazel or willow 2 ft. 0 in. to 2 ft. 6 in. long, pointed at each end and twisted in the middle to form a staple. Exposed rods are finally fixed over the straw to hold down the eaves and verges.

Timber structures, pests and fungi

Repairing timber structures, roofs and woodwork

The successful repair of ageing timber structures, perhaps more than any other type of old buildings work, demands of the modern architect a real appreciation of the structural and design principles employed by his professional ancestors.

The timber framed structure, indeed, often has as much about it of engineering as of architecture. The first thing to do is by analysing the construction in detail, to reach a real understanding of the stresses and loading pattern involved. Sometimes the part which each structural member fulfils is clear enough. Often too, for example, in elaborate mediæval roofs, one will find all manner of complications to unravel, before the cobwebs can be brushed from one's hair.

Timber framing will usually be either of Tudor date, with post and lintol framed storey by storey, each floor overhanging the last, or of the later fully framed, diagonal-braced type in which the main posts run the full height of the building. The reasons for overhanging storey construction were partly practical, the lower storeys being thus protected by the upper, and the maximum accommodation crowded into the walled-town sites, and partly structural, as the weight of the walls in fact "pre-stresses" the floor beams as well as reducing their span. Where the ground-floor of this type of building has been enlarged, the structure may be greatly weakened if internal posts are removed. Similarly, upper floors may be weakened by the removal of projecting gables which balance and tension them.

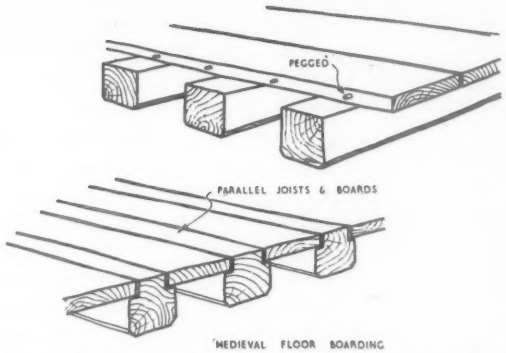
Roof construction at first consisted of coupled pairs of rafters, laid "flat" and pegged at the apex: later, integrated systems of transverse trusses and longitudinal ridge-boards and purlins were introduced.

Timber trusses were often prefabricated, then taken apart and re-assembled on the site; and the identifying numerals of each number may often be found cut into the timber at the joints.

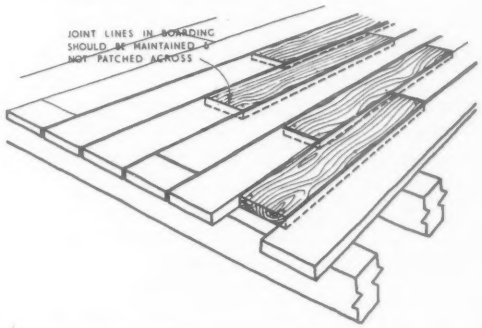
Mediæval timberwork was always heavy and usually very lavish: our forebears apparently had no appreciation of the principle of the thin, deep beam. In consequence there is often an enormous factor of safety, and even fairly widespread depredations of rot and beetle can be accommodated without real danger. The timber used was usually oak which, although often full of shakes and holes, becomes iron hard with age and will suffer little harm from the elements, even out of doors. Chestnut may also be encountered; the theory that it is impervious to beetle attack is, alas, a fallacy. Elm was frequently used for flooring.

During the 17th century imports of foreign deal began, but by this time the great period of timber building was on the wane, and it is rare to find a framed old building constructed with softwood.

It is important to remember that movement plays a large part in the life of any timber structure, and is a natural part of its history. Oak, in particular, moves fiercely for many years after felling. It is thus more

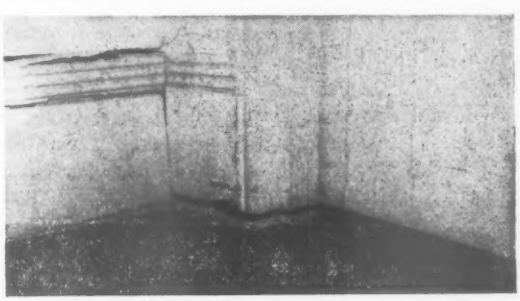


Above, drawing showing two common types of mediæval floor boarding. Below, when repairing floors it is important to preserve the lengthwise joists between boards.



Below, inconspicuous reinforcement of carved beam with m.s. plate bolted from underside.

Below, the dropping of floors is frequently caused by dry rot in wall plates and may be detected by cracks at skirtings.



often than not a mistake to attempt to straighten up a framed building which has come to rest in an eccentric posture, provided only that its individual parts are sound, and the structure not so distorted as to be unsafe. Similarly, one must beware of doing anything which may violently alter the conditions to which timbers have become accustomed over several centuries. Thus the practice of stripping and exposing plastered timbers, "for effect," is questionable on structural as well as æsthetic grounds.

Having got to know his building therefore, from the viewpoint of what makes it stand up, the architect must be very careful in deciding which of its many apparent faults are harmless eccentricities and which are active, dangerous defects, requiring a remedy.

As a general principle it is best to renew carpentry with carpentry, provided no assertive "faking" is thereby entailed. Furthermore it is usually best also to use the same species of timber as the original, always provided that really well-seasoned stuff is available. Quite often, and especially in the country, secondhand oak can be found, which if sound, is ideal for repairs.

Carpentry should not be more sophisticated than its history and situation warrants—for example, unshaped larch poles may be perfectly adequate for a thatched roof.

There are times, however, when the extensive shoring and dismantling, and perhaps the disturbance of moulded plaster finishes, which would be necessary to reach and replace defective timbers, may justify the use of metal plates and splints instead. It has been said indeed that some ancient buildings have now structurally a metal roof, merely faced with the relics of ancient timberwork. The architect must therefore consider very carefully whether the historical interest of the work requiring repair is sufficient to pardon this structural dishonesty. A possible compromise while decorative detail is seriously damaged is to gather all original surviving work to a single part of the building—for example, to the bay nearest the chancel in an old church roof.

Where metalwork will be exposed to view, wrought-iron is less foreign-looking than steel. The tannic acid in oak will attack small iron fixings unless they are protected, for example by bitumen, but will not seriously weaken stout metal bolts.

The weakest links in any timber structure are the joints, which should always be carefully examined. The oak pegs pinning mediæval tenons are frequently found to have perished, and must then be drilled out and renewed—the new pegs should be left projecting, and not trimmed off flush. Failure of the tenon itself through decay or fracture is fortunately less common. Where it is possible without excessive cost or disturbance to remove the affected beam for repair, it may be possible to contrive the insertion of a false tenon, well and tightly housed into it. Otherwise the defective junction may be strengthened by means of metal angles or plates, securely bolted to it and placed to "bridge" the point of maximum weakness across to solid members.

Actual physical failure of a timber member due to overloading is comparatively rare, unless it has been weakened by some external influence. The thoughtless removal or maiming of a strut or brace, or even of a whole load-bearing partition, during the course of some ill-contrived past alteration, may sometimes have caused sagging or even collapse and no architect needs to be reminded of the depredations of amateur electricians. Empty mortices give a useful clue to missing members; but their presence does not always indicate a lost link, for secondhand timbers were frequently used by the old builders. If over-stressing is definitely found to be due to the removal of intermediate supports, they should undoubtedly be reinstated: but since more often than not, a post or partition was removed simply because it was in the way, a similar fate may sometimes be confidently predicted for the replacements. As it may be impolitic for the architect to insist on his client's selling the Bechstein, ways may have to be sought for giving the structure new courage. If the over-stressed member is in a floor construction, it may be possible to stiffen it by bearers from its better-blessed neighbours. Alternatively the effective span can sometimes be divided by inserting additional beams in the opposite direction—for example by cutting the member and inserting a steel joist, carrying the cut ends by means of a plated lower flange. Complete replacement of a beam by steel is usually a last resort, as complicated bearing problems will almost always be involved. An interesting example given by the SPAB is the typical case where tie beams of a mediæval house have been cut away to give increased headroom: here it is sometimes possible to overcome the inclined thrust of the rafters by trussing the ridge in the other direction, lengthwise from gable to gable.

Replacement by timber is usually less difficult, assuming that a sufficiently strong member can be accommodated, but alternatives may sometimes have to be found to achieving this with a single beam, owing to the impossibility of tenoning it into existing mortices in fixed members at both ends. For example, it may be found possible to replace one beam with two, inserted alongside each other, each tenoned into one end and subsequently bolted together.

Much can often be achieved by "plating" a defective beam with steel where it is most needed. The plates may be applied on the same principle as on a rolled-steel joist, either at top and bottom or even only on the tension face. If much heavy steel is added to an already sagging floor, however, its weight may cause further deflection unless the existing structure is first jacked up to an equivalent extent. Occasionally it may be possible to stiffen a beam from above, suspending it by hangers from some other part of the structure. In this case it is vital first to analyse what new stresses will be set up in the building as a whole, and to ensure that the suspending member itself is a rigid anchor. For example, it is useless to attempt to support a sagging beam by means of a tie-rod suspended from another timber which is itself subject to movement.

In all timber repairs it is very important to remember

the special propensity of timber to adjust its dimensions under unequal loading. Thus a beam whose bearing has no "slack" will jam itself tightly between the walls when expanded during damp weather and may actually compress itself between them. If the end, or joint of a timber member is repeatedly blocked from natural expansion by dust or grit and rubble, it will compress when damp, and then shrink further upon subsequent drying. In time, these cumulative shortenings may become quite appreciable, often reducing the bearing area of a beam with disastrous effect. For this reason, the wedging of timber members "for rigidity" between walls or other fixed structures is quite useless, and may well be actually harmful. Timbers can be blocked up with hardwood wedges to give a uniform bearing, but the wedges in compressing uniformly easily fall out, and should be nailed or otherwise fixed in position.

The most common cause of weakness in structural timbering is, as always, damp and its resultant evils, fungal and beetle attack. The end of a timber particularly is its Achilles' heel and should be well protected from weather penetration. For this reason, too, even in dealing with a sound timber structure, every opportunity must be taken to provide adequate ventilation, and to introduce adequate damp-proof courses between timbers such as wall-plates and damp walling. Timber ground floors were often set directly on damp earth. In cellars where the floors above have suffered from damp and lack of ventilation it is often possible to reduce the span of damaged and sagging beams by supporting them intermediately on new brick piers incorporating proper d.p.c's. New timbers should never be set alongside, or in close contact with damp walling.

Defective timbers under parapet gutters are a source of disaster and the bearings of trusses are frequently found in a precarious state of decay. The classical remedy is to shore up the structure and to scarf on a new length of timber, carefully jointed to the old. Both tie beam and principal rafter may be treated in this way so that the triangulation of the truss is restored *in situ*. The usual procedure is to cut away the decayed end of the beam until structurally sound timber is reached, allowing a diagonal cut to be made, with a length of approximately three times the depth of the beam. Feather edges at top and bottom should be avoided by cutting stopped ends to the main diagonal. The new timber end is then cut to match and bolted on and the joint may be further tightened by driving wedges from each side into a socket cut equally into the old and new timber half-way along the diagonal cut. Structurally this type of joint is strongest if the bearing end of the timber is sloped to "carry" the remainder; but the scarf may safely be reversed in favour of the saving of ancient mouldings upon the under side of the old beam. The job may be further strengthened where necessary by plating the joint with steel, bolted closely right through the beams.

Alternatively, the load of a truss may sometimes be carried to the wall by new concrete corbels, set well into the masonry so as to avoid overturning or by means of metal hangers. If this type of repair is adopted, great care must be taken to maintain the triangulation of the truss.

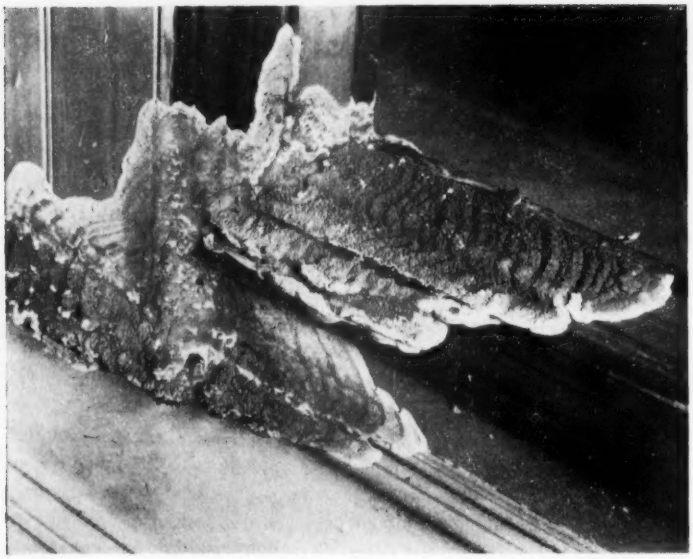
Sometimes timbers in concealed, damp situations such as below parapet gutters are best completely removed and replaced with concrete; but in this case it is essential to avoid subsequent damage to leadwork by irregularities or direct contact with the concrete, by means of careful screeding and heavy building-paper underlays.

Joinery and floors

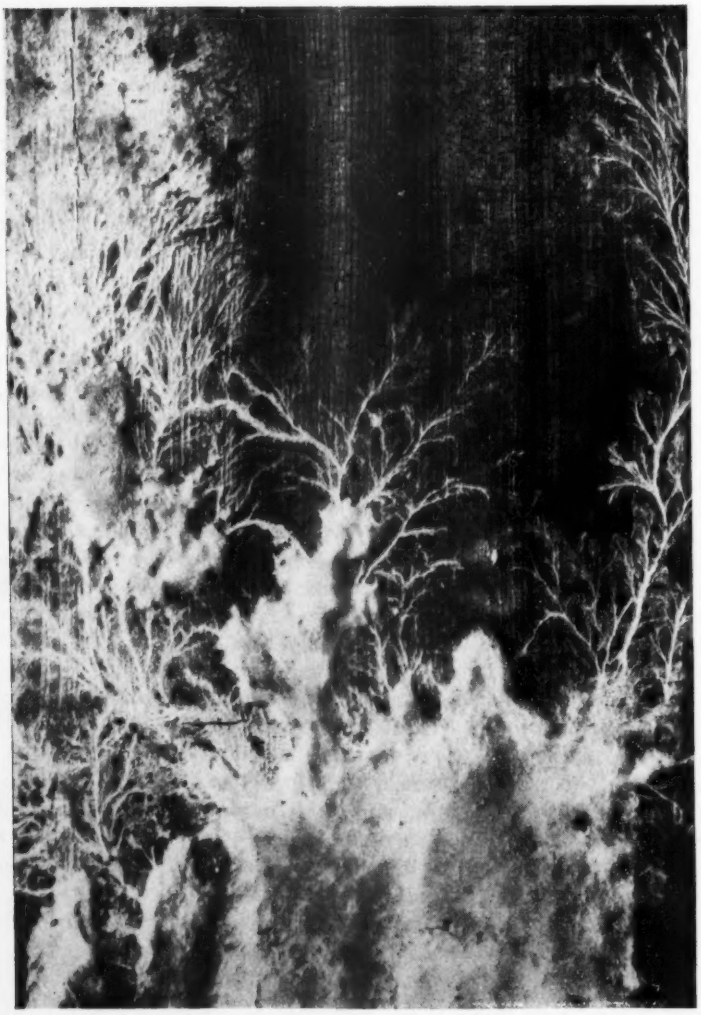
The repair of joinery is not usually a difficult matter. It is generally sufficient to cut out rotten sections of woodwork, and to piece in new wood, securely jointed home. Where decayed wood is difficult to remove—for example when glazing bars containing valuable glass are beginning to fail—it can often be strengthened by plates of brass or other non-ferrous metal, housed into the surface and secured by countersunk brass screws. In repairing doors and other joinery, it must be remembered that wood requires room to move, and that joint lines give it just this facility. The foot of a vertically boarded door should thus be pieced board by board, maintaining the joint lines between them.

Timber floors in old buildings are usually of wide elm boards, or occasionally of oak. Floors are one of the most rapidly worn finishes in a building, and may have been frequently renewed. Very often, damaged boarding will be found to be cased with new deal, the old beetle-infested woodwork being left as a source of hidden trouble. Occasionally a good original elm or oak floor with only local patches of damage may have been cased in the same way, and can now be opened up and properly repaired. In repairing timber floors, each board should be treated individually and cut away and pieced, the joints between the boards being maintained. Even if two adjoining boards are pieced, the patches should still be individual to their boards, and movement and shrinkage thus confined to the regular pattern of original joint lines. Loose and squeaky boards are often the product of careless electricians, or may give a clue to structural failure. A whole floor which has dropped slightly, leaving a wide gap between the boarding and the surrounding skirtings, is always suspect as a possible case of dry-rot, with attendant shrinkage and collapse of hidden wallplates.

It is important not to misjudge a floor in a superficially tatty and neglected condition: if it is structurally sound even the most irregular and unprepossessing boarding may be capable of polishing beautifully. As with many other "finds" in an old building, a feature which many would not have looked at twice may yet so easily again become an object of value and pride.



Above, dry rot. Below, one form of wet rot. (*Photographs supplied by FPRL.*)



Eradicating timber fungi and pests

All timber pests are fundamentally Nature's forest scavengers, whose function it is to break down and convert dead trees into soil, and allow new trees unimpeded growth. Once a tree is felled, whether by age or by the axe, the timber is, from a natural standpoint, "dead" and ready for destruction. The fact that wood has been shaped and re-used as a building material is of no interest to a fungus or a beetle, whose ambitions culminate in costly damage to old woodwork.

The fungi are parasitical, and can only live by feeding directly on organic matter, such as wood and leaves. They breathe in oxygen and give out carbon dioxide, and are thus vulnerable by respiratory toxics. Some may spread to dry wood and others cannot, but all require an initial host with a moisture content of some 20 per cent. for germination. Although in a new house, the moisture content of timber may for a while be as high as 18 per cent., this is soon reduced in normal circumstances to some 12-14 per cent., so that in fact, a sound, dry building has nothing to fear.

Identifying Merulius Lachrymans

The most serious and devastating fungus from the point of view of the building owner and also, unfortunately, the species most frequently found in old buildings, is *merulius lachrymans,* or "weeping merulius." Paradoxically, the fungus is usually known as "dry rot," the name being something of a misnomer, except that the infection can spread to dry wood, and leaves it arid, dead and brittle.

The life-cycle starts with a spore, of which there are many millions in the atmosphere. They are remarkably resistant to physical extremes of heat and humidity, and very long-lived. A spore landing on wood with a moisture content of about 20-25 per cent., in a temperature of 45 deg. to 80 deg. Fahrenheit, and preferably in a still, stuffy atmosphere, can germinate, and then throws out hollow strands known as "hyphae." Hair-like and fine at first, these seek their way by thrusting and branching gently into the wood. Timber consists of approximately two-thirds cellulose and one-third lignin; and it is on the cellulose that the growing hyphae feed, their enzymes converting it into sugar, digesting it and reaching on to new wood, leaving behind a dry and desiccated framework of lonely lignin. The hyphae unite into a rapidly-spreading cotton-wool like structure known as "mycelium," which is at first white, and develops yellow and purple spots on exposure to light. In later stages of the attack, strands called "rhizomorphs" develop from the mycelium, and it is these which convey moisture from the decomposing wood to sound timber many feet beyond, weeping tears on it until it too is subjugated and ripe for attack.

When the attack is sufficiently well established, the fungus will produce a "sporophore" or flower—a fruiting body which produces millions of spores or

seeds. The sporophore is at first a whitish grey, like an unwholesome fleshy growth, and gradually becomes more leathery and clammy. The spores are a bright rusty red, and unbelievably numerous—a sporophore may give out from two to five million spores per square foot, for several days; and these are carried everywhere as a fine red dust in the air, to germinate in damp timber elsewhere and start the process afresh.

Dry rot exhibits an uncanny knowledge of the presence of timber, and can thrust through brickwork and over walls for great distances to reach and consume fresh food. An attack in a damp cellar may often spread in wall linings to seek the timbers of a roof, or from one building through brick party walls into the next. The whole process is entirely voracious and obscene.

The symptoms of dry rot are quite unmistakable, and may be suspected from any of the following symptoms:

(*a*) a musty, frowsy smell,
(*b*) the appearance of fleshy, spreading mycelium or in severe cases, of actual fruiting bodies,
(*c*) cracking and bulging of joinery (skirtings, panellings, linings, etc.) caused by shrinkage of hidden surfaces attacked by the fungus.
(*d*) loss of nature in the woodwork, which gives a dead, hollow sound when tapped and offers no resistance to probing,
(*e*) the characteristic, hungry destruction of timber, with deep cracks, especially *across* the grain, giving a "cubed" appearance.

Once *merulius lachrymans* has been discovered and identified, the only remedy is an utterly ruthless, detailed campaign of extermination, coupled with careful remedy of the unhealthy conditions which started the attack. The fungus has no heart and no Achilles' heel, and unless completely destroyed to the last limit, it will gather its forces and start again more virulently than ever. Fortunately it may readily be poisoned, once its entire extent has been discovered.

The architect charged with the responsibility of eradicating an attack has two alternatives open to him. He may either employ a local builder to carry out the whole of the work of opening up and eradication, or he may call in one of the numerous specialist firms to deal with the attack. If a builder is entrusted with the whole of the work, the architect must ensure by thorough briefing and supervision that only careful and conscientious workmen are employed, and that they know exactly what to look for and what is to be done. The advantage of employing a specialist firm for treatment is that the work of trained and experienced workmen is more certain to result in a thorough and successful job, reinforced in most cases by a guarantee. This is particularly valuable when, for example, a property which is known to have suffered from dry rot is shortly to be sold.

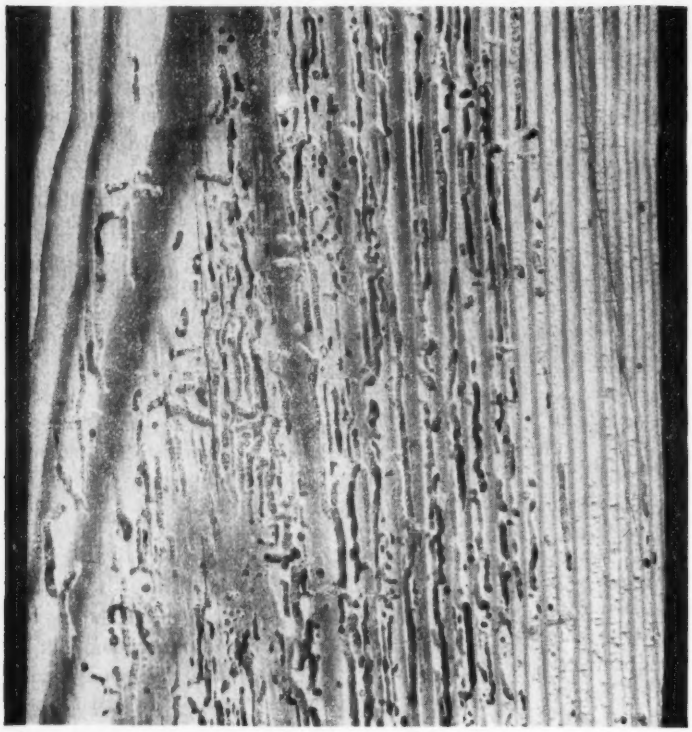
The resultant peace of mind, however, is purchased at a price, since any firm issuing a guarantee must inevitably err on the side of over-thoroughness, and will therefore of necessity be more expensive. It is of course impossible to lay down hard and fast rules as to when specialists should be called in: so much depends upon the convenience of the individual case. The cost of disturbance, for example, may be greater than that of repair, so that complete eradication is essential at any cost. Or if a specialist firm is just around the corner, there may be little cost difference to be considered. If the architect is confident from his own knowledge and experience that he is master of the situation, and that the builders are available and can be relied upon to co-operate fully with him, success is assured. If, however, the attack is a particularly virulent and complicated one, or if there is no general contractor who can be given the job in complete confidence, it may be worth the extra cost to call in the specialist. Most of these firms make an initial charge for visiting and reporting on a building; and this is usually deducted from their account for any work subsequently carried out.

Eradicating dry rot

The first step in eradicating dry rot is to find the heart of the outbreak, and to trace its extent with the greatest care and thoroughness. Each searching branch of the fungus must be systematically traced from its source to growing tip, and the finishes opened up for a foot or two beyond. Floorboards, plaster, joinery and finishes must be removed without compunction if there is the slightest suspicion that the fungus has penetrated beneath or behind them. Extreme care is necessary in examining the backs of timbers in contact with walling, and all vestiges of fixing and built-in timbers, along the back of which the hyphae can easily reach.

When the extent of the trouble is known, treatment can begin. If fruiting bodies are present, these should first be liberally treated with fungicide to prevent the spread of airborne spores. All infected timbers are next cut away: it is usual to require the removal of all infected wood to an arbitrary distance of at least 18 in. beyond the last visible attack. Where, however, important structural timbers are infected, but have not yet been actually weakened by the fungus, it is possible under vigilant supervision to poison them very thoroughly and retain them. All fungus-infected timber removed should meanwhile immediately be burned, together with all sweepings, dust, dirt, shavings and sawdust from the infected area. No attempt should be made to save any scrap, even "for firewood"—for this is a cancer, the last vestige of which must be destroyed.

All brickwork into which mycelium has spread, and any masonry or walling adjoining an outbreak, must next be similarly poisoned. Hyphae may be destroyed by heat, but the effect of waving a blowlamp over brickwork is very inconclusive. If a structural wall is too thick to absorb fungicide into its heart, it must be drilled with holes at intervals, into which the liquid can be sprayed under pressure, so as to permeate the entire material. In this respect, thorough heating with a blowlamp or with flame-throwers is useful in drying out moisture and making the brickwork receptive to the liquid: but care must be taken to avoid damage



Comparative details of wood attacked, above by furniture beetle, below by death-watch beetle. (Photographs supplied by FPRL.)

by fire, especially by charring the end-grain of cut timbers. Walls should whenever possible be treated from both sides. Volatile and flammable solutions cannot, of course, be used in conjunction with a blow-lamp; and usually only water-solvent solutions should be used.

Meanwhile the cause of the outbreak must be traced and rectified. The presence of any of the fungi is always evidence of an unhealthy condition, inviting further damage and decay. Leaking gutters, inadequate soakers and flashings, defective downpipes, earth piled above damp-proof courses, and all sources of dampness must be removed. Ill-ventilated and stagnant spaces must be opened up to a constant current of air, by the introduction of new ventilators and openings since the fungus abhors fresh air; and even a vigorous growth may be arrested (but not killed) by exposure. If wall-panelling has suffered, it may be possible to introduce air-bricks so as to provide a continuously ventilated cavity behind it. If a spring or other source of moisture is traced, it may be possible to pipe the water safely away: water should never be blocked, but always encouraged to flow away by the easiest possible route. Ventilation must be continuous, and not dependant upon intermittent opening of windows or closable ventilators of any kind.

New timbers inserted as replacements should be thoroughly treated on every face against infection, and no unnecessary wood fixings or bonding timbers re-introduced into walling. A careful inspection must lastly be made to ensure that adjoining parts of the neighbouring buildings are free from infection.

The finishes can then be reinstated, and except for periodical future inspections in difficult cases, the attack can be confidently regarded as cured.

Eradicating other timber fungi

The only other fungal decays attacking timber in buildings are relatively unimportant, since they have not the power of spreading to sound wood. They do however indicate the presence of unhealthy conditions, in which more serious trouble could well develop. These minor fungi are usually known somewhat loosely by the general name of "wet rot."

"*Coniophora Cerebella*" or the "cellar fungus" is the commonest. It cannot live on timber with a moisture content of less than 25 per cent., and is thus usually found in situations too damp for true dry-rot. The fungus can be identified by its fine dark brown or blackish strands, and the green and leathery, lumpy fruiting body. A paper-thin shell of sound wood is sometimes left on the surface of the timber, which shows deep cracks *along* the grain but rarely across it as in true dry-rot.

Other "wet rot" fungi found in old buildings include *Poria Vaillantii*, the "pore fungus," with spreading strands rather like string (see photograph on page 448).

Eradication of all these less serious fungal varieties is usually a simple matter of cutting out and burning all the infected timber. It is however wise to treat the area with fungicide as a precaution against any subsequently outbreak of dry rot, which may otherwise easily occur during drying-out.

Timber pests

Beetle destruction in timber is rarely as dangerous as fungal attack, the reason being that an infected section is only weakened by the total cross-sectional area of the tunnels it contains—the timber around them remaining unimpaired in strength. It is important to remember this in dealing with beetle attack in old buildings. In Mediæval structures particularly, the members are often of such massive sections that even the loss of 50 per cent. of their cross-sectional area may not result in any significant weakening relative to the strength required of them.

Beetle attack which is expended need receive little attention, except for any necessary strengthening of the damaged timbers. Active attack should not however be left unattended. Current infestation is easily identifiable by the clean, bright appearance of recent exit holes, and by the little piles and patches of fresh boredust which fall from them. To assist in distinguishing the pest, a resumé of the life-cycles of each is given :

Identifying timber pests

The chief insect destroyers of timber in buildings are the death-watch beetle and furniture beetle. Both are of similar family with a broadly similar life-cycle of egg —larva—chrysalis—adult beetle, and the two are often found together. It is at the larva stage that the boring and feeding of the grubs causes all the damage, for adult beetles do not eat, and their life is short.

The different species are identifiable mainly by the sizes of the flight holes, by the appearance of the excreta, and sometimes by the type of wood attacked. In early summer, the beetles themselves may also be found.

The Death-watch Beetle, Xestobium rufovillosum, has a life-cycle of three to 10 years, depending upon environment, from a damp, warm timber to old, hardened hardwood. The eggs are laid in clutches of about 70, in any cracks and crevices in suitable timber. Hardwood is preferred, particularly its outer, softer layers of sapwood next to the bark, and timber pre-digested by decay or fungus is a special attraction. The attack is usually concentrated in the damp and more edible timber such as wall-plates, the feet of rafters and bearing ends of beams and trusses, and in all timbers buried in or set against damp walling. Timber softened by fungal attack is particularly tempting to beetles of all kinds. The eggs of the death-watch beetle hatch out in about 2-8 weeks and the larvæ, which are curved white grubs with brown heads, select a suitable spot and then burrow into the timber. After a varying period of years, during which extensive galleries are eaten into the timber, the dust being emitted in bun-shaped pellets, the larva enters a pupal stage lasting 3-6 weeks, and emerges as a full grown beetle. In the case of the death-watch beetle, this remains in its pupal chamber until the following spring, then emerges in April, May or June to seek a mate. During these months the characteristic tapping sound can be heard as beetles of both sexes rap their heads quickly—about eight taps per second—in short bursts upon the timber as a mating-call.

The full-grown beetle is about $\frac{1}{4}$ in. to $\frac{1}{3}$ in. long, brown in colour, with little patches of yellowish hair; and emerges through a flight hole some $\frac{1}{8}$ in. in diameter. The beetle often falls to the floor—once, one fell on my drawing-board—but can fly in search of a mate. An attack may die out if timber becomes sufficiently hard and unpalatable through age and proper maintenance. Softwood is rarely attacked.

The *Furniture Beetle* (Anobium punctatum) may be found in both hardwood and softwood, again chiefly in the sappy layers under the bark, especially some 8-10 years after felling, and often in furniture. It is therefore a more serious pest in the lighter constructed post-mediæval buildings where the proportion of sapwood is often high. Although the flight holes frequently appear in polished surfaces, the eggs are laid in cracks and joints and unvarnished recesses, in smaller clutches of 15-20. These hatch out in 3-4 weeks, and the larvæ bore into the wood, first along the grain and later in all directions, forming cylindrical or oval pellets of bore-dust. They are whitish grubs with red-brown jaws, and shed their skin at intervals. After a shorter period of 12 to 36 months, the last 2-3 weeks of which are spent in a pupal stage near the surface, the larva becomes a full-grown beetle. Without waiting for the next season, this immediately finds its way to the surface and emerges to mate, a little later than the death-watch beetle, in June, July or August.

The flight-holes of the furniture beetle are smaller than those of the death-watch beetle and about $\frac{1}{16}$ in. in diameter. The beetle is about $\frac{1}{4}$ in. long, reddish to blackish-brown in colour, with short yellow hairs, and lines of marks along the wing cases. Both hardwood and softwood are attacked, but only when seasoned: wet or damaged timber is again attractive, but has by no means a monopoly of attention.

The *House Longhorn Beetle*. Another insect pest, so far confined in this country to areas of Surrey and found chiefly in timbers less than 50 years old, is the House Longhorn Beetle (Hylotrupes bajulus). This is a much larger creature, up to one inch in length, with a life-cycle of 4-11 years. The eggs are laid in large numbers—perhaps 100 to 300 per beetle—but singly and in pairs, and hatch out in 10-14 days. The larvæ bore voraciously to and fro along the grain, often under a thin intact surface, and their activity is said sometimes to be plainly audible at night. The galleries are shallow and broad, up to $\frac{1}{2}$ in. wide, and packed with fine dust which makes chemical penetration less certain. After a pupal stage of some three weeks, the beetle emerges in June or August.

The full-grown Longhorn Beetle may be $\frac{1}{2}$ in. or 1 in. long, and the upper part is heavily covered with gray hairs "parted" in the middle. There are also four patches of grey hairs on each wing cover. The beetle emerges through few and scattered flight holes about $\frac{1}{4}$ in. to $\frac{1}{2}$ in. long, representing a relatively disproportionate amount of unseen damage. Only fresh, sound softwood is affected.

The *Powder-Pest* or *Lyctus Beetle* attacks only unseasoned hardwoods, and thus is rarely found in old buildings, being a greater enemy of the timber yard.

Bats are an enemy of beetles, and an excellent scavenger of roof-spaces. They should never be destroyed without reason, since they certainly do more good than harm to a building.

Eradicating timber pests

The eradication of timber pests in buildings is simplified by the fact that the different species all respond to the same treatment, the advantage to the architect of being able to distinguish the beetle being that it will enable him to make a more accurate assessment of the actual damage suffered by the structure.

As with the fungal treatment, there are specialist firms who deal exclusively with beetle eradication, carrying out excellent guaranteed work, but inclined to be expensive. The choice again then must be dictated by circumstance and preference, but generally in simple cases, a good local builder under proper supervision is quite capable of producing a completely satisfactory job.

The work of eradicating pests in an old building usually falls into three main phases.

As with fungal attack, the architect must first look for the unhealthy conditions which have encouraged the pests to feel at home, and cure them at source. Damp and lack of ventilation are again the enemies; and once these are dealt with, the beetles will feel less inclined to linger.

All dust, dirt and rubbish should next be removed, preferably with a powerful vacuum cleaner. This is necessary, not only to remove conditions favourable to the beetle, but also to facilitate the treatment which will follow.

Next, the extent of the attack must be traced and its severity assessed. The latter is often a most critical part of the work in old buildings, particularly in dealing with valuable carved or moulded work. The architect must differentiate between timbers which have been so badly eaten that their strength has been impaired to the point where replacement is necessary, and those which, although attacked, still contain sufficient sound timber to play their original rôles in safety. Beetle-riddled "frass"—that is, timber which is so severely honeycombed that it is virtually useless —will usually be found to coincide with the sapwood areas of structural timber. Thus a beam which at first sight appears absolutely riddled and useless may be found to have a solid heart quite adequate for its work, the limit of the beetle damage being the clearly demarked surface of the heartwood. Extensive opening-up is not usually necessary for the purposes of an inspection as the beetle's flight-holes are of necessity always on outside surfaces.

Having decided upon the scope of the work, the actual treatment and repair can be started. Where damaged timbers of a roof or other structure are to be treated *in situ*, the first step is to seal off the area as far as possible to exclude dust and dirt from spreading elsewhere and to introduce as much as possible light and air for proper access and treatment. When a roof can be re-battened at the same time as the timbers are treated, a more thorough job can, of course, be ensured.

The most extensive and often the most expensive part of the work in severe cases is the initial cutting away of badly infested wood and beetle-riddled "frass." The latter may often be removed simply by scraping or wire brushing: rather blunt tools should be used, to avoid damage to sound timber. All infested wood and fragments must then be cleared away and burnt—it is useless to leave them lying between attractive ceiling joists—and all accessible spaces again thoroughly cleaned with vacuum-cleaners. When the timbers are clean and accessible they may be treated with insecticide.

For the *in-situ* treatment of timbers in existing buildings, the most useful methods of application are brushing, spraying, and injection. Brushing should be regarded as a method of spreading the chemical lavishly over the surface and into the cracks. There is no "brushing-out" as with paint. Spraying should be carried out with a coarse spray at fairly low pressure, rather than as a high-pressure atomized mist, which is wasteful and inefficient. Where the bearings of timbers are inaccessible, it may be necessary to drill ¼-in. holes and to saturate the buried wood by injection of these. Since flight-holes must connect with the sub-surface "galleries" of borings, injection into these is also a valuable means of reaching hidden timber with insecticide where it is most needed. Gas treatments, at one time recommended by the authorities, involved the sealing of an interior and saturation with methane gas or gammaxene smoke sublimate, but have been proved relatively ineffective.

Whatever method of treatment is adopted, very much depends on the skill and intelligence of the operatives, the degree of supervision and working conditions. A good operative must be honest and thorough, and must have a proper knowledge of the enemy, and of his ammunition—slapdash and clock-watching personnel are useless in this class of work. The architect must be vigilant and co-operative, and must personally know exactly what is being done in the most inaccessible places. Cramped, stuffy spaces in a vapour concentration, with inadequate access, are extremely uncomfortable and unlikely to be as thoroughly treated as they deserve: plenty of light, air and access are essential to proper treatment. Where flammable liquids are being used, fire extinguishers should always be provided.

Any new timber introduced into the "danger areas" in repair or replacement work should also be treated with insecticide. This is best carried out before it is fixed. Timbers may be vacuum impregnated in sealed cylinders, or treated by the "hot-and-cold" process, when they are heated in a tank of liquid, or by cold "steeping" (from three minutes to 72 hours) or "dipping" (from 10 seconds to three minutes). With hardwoods such as oak, maximum penetration can be achieved by steeping; but with softer timbers a greater penetration of the insecticide is assured by these methods than usually results from simple brushing or spraying.

It must be admitted that however thorough the treatment of a structure may be, it is physically impossible to guarantee that every single egg, grub and beetle in

the timber has been utterly eradicated. But if the roof has been made inhospitable by thorough ventilation, the drying of sound timber and the removal of damaged wood and frass, and if all accessible timber has been saturated with a suitably toxic and permanent insecticide sprayed over it and injected into the flight holes, cracks and joints, the chance of any further serious weakening of the timbers by beetle should be extremely remote for many years to come.

Fungal poisons and insecticides

The architect who has to deal with combating fungal and beetle attacks in old buildings cannot complain of a lack of choice when it comes to selecting a poison or insecticide for any particular case. Indeed, the very multiplicity of these products may almost prompt him to pick one with a pin and hope for the best. However, it is of the first importance that the particular poison selected should be based on ingredients of known and proved efficacy, and any firm unwilling to provide this information should be treated with suspicion.

The qualities chiefly required of an *in-situ* timber preservative are:
Ease of application.
Deep penetration.
High toxicity to insects and fungi at low concentrations.
Permanence.
Absence of smell and colour.
Harmlessness to operatives, paint and furnishings.
Non-corrosion of metals.
Preferably non-flammability.
Reasonable cost.
No single preservative combines all these virtues, but the best have most of them.
There are basically three types of wood preservatives:
(*a*) those based on tar oils,
(*b*) those based on water-borne salts, and
(*c*) the organic type.
The organic solvent type are those most used for the *in-situ* treatment of existing timbers. They are based on either a rapidly evaporating vehicle such as white spirit, naphtha or one of the petroleum distillates, or alternatively, a penetrating non-volatile base, which is usually a petroleum fraction such as diesel oil or gas oil.

The fungicides incorporated are usually either
(*a*) pentachlorphenol, or
(*b*) copper or zinc napthenate, or
(*c*) chlorinated napthalenes.
Pentachlorpenol is a crystalline solid, used as a 5 per cent. solution: to prevent surface crystallization, some non-volatile as well as a volatile solvent is generally used. It is highly toxic to plants, and also a little to humans. It is, however, non-corrosive, chemically stable and odourless; and the timber treated can subsequently be painted. Water-solubility and volatility being very low, it is very permanent.
The metallic naphthalenes have a powerful fungicidal and insecticidal effect, are again chemically stable and of low water solubility and volatility, so that they too are of high permanence. Care is sometimes necessary in the treatment of painted timbers, or in repainting treated woodwork, especially with the lighter colours. Copper naphthenate is light green, and the more powerful of the two. Zinc naphthenate may be used where a colourless fluid is required, but is somewhat less potent. Both are non-toxic to plant life, and are therefore suitable for timber in greenhouses and similar situations. Admixed with pentachlorphenol, their effect is even more potent than either chemical alone. Chlorinated naphthalenes may be either liquids or waxy solids, both of which are toxic to humans by virtue of their chlorine content.
Either together with the fungicide, or as a separate fluid, powerful insecticides may also be included in a timber preservative. The most common and effective are Benzene Hexachloride, DDT, and Dieldrin. Generally, more than one line of attack is used, the insect being subjected to contact and stomach poisons, and the timber made repellent to the female for the laying of eggs.
The solvent base may be either volatile or non-volatile. The volatile types are mostly petroleum or coal-tar distillates, which are clean and non-staining but highly flammable. These carry their "passenger" chemicals into the wood; and then quickly evaporate outwards again. The other types are the less volatile petroleum fractions such as gas oil and diesel oil, which are cheaper and at least as effective, since their penetration is continuous after application and does not depend upon immersion time. They are, however, only generally suitable for non-painted timbers where discoloration and a slight oiliness and odour are not objectionable, and must not be used near plaster, along which they creep and stain. Aqueous solutions may cause damage by swelling timber, and are undesirable in buildings. It is always wise to test samples for their staining effect before any fluid is used.
Fumigant insecticidal processes are generally suitable only for objects which can be comprehensively treated in a fumigation chamber. Smoke treatments, by which a suspension of contact insecticides may be disseminated, are useful in inaccessible places, but are effective only if carried out at the right time of year, when the adult beetles are emerging. There is no residual effect, and frequent repetition of the treatment may be necessary.
Recently, poison has been produced in two new and ingenious forms, designed to protect uninjured timbers. One manufacturer now produces solid sticks of water-soluble fungicide which can be built into a wall, and are designed to impregnate any rising damp with its own defence against the fungal attack of timbers. Special surface paints are also now made which are designed to release a gradual surface "bloom" of contact insecticides over a long period, thus obviating the need for frequent spraying, for example in the tropics: the "bloom" is of course self-renewed whenever it is cleaned or rubbed away. These are doubtless the advance guard of other interesting new methods of prevention, but vigilant maintenance must always remain the soundest defence again every harm to which buildings are heir.

Outline specification for fungal eradication in accordance with architect's detailed site direction

Preliminaries

Preliminary Clauses as for General Contract.

General

FUNGICIDE: The fungicide to be used throughout is to be " ....." obtained from Messrs. ..... of ....., and used strictly in accordance with the makers' instructions. A fugitive dye is to be incorporated if required by the architect, to enable the extent and penetration of the fungicide to be traced.

SHORING The contractor is to provide and maintain all necessary shoring, propping and other temporary supports as necessary, to ensure the stability of the whole of the structure during the works.

FIRE PRECAUTION: Special care is to be taken to provide and maintain adequate fire extinguishers, as directed by the architect in consultation with the Fire Officer.

TEMPORARY SCREENS: The sections of the building in which fungal attack is known or suspected are as far as possible to be isolated from the remainder by means of temporary screens, tarpaulins, etc., maintained throughout the course of the works. Operatives working upon fungal eradication may enter or pass through sound sections of the building only when absolutely necessary for access and as sanctioned by the architect.

DISPOSAL OF INFECTED MATERIALS: All infected timbers and materials are to be removed as directed in detail on the site by the architect, carted immediately from the infected area to an agreed site outside the building, and there burned without delay.

SALVAGED MATERIALS: Any re-usable materials such as floor boards, linings, panelling, etc., removed for purposes of tracing fungal growth, but which themselves appear sound and unaffected by attack, are to be stored outside the building for the architects detailed inspection and disposal instructions.

Order of works

REMOVAL OF INFECTED MATERIALS: The architect will direct each stage of the work in detail on the site and no stripping, eradication or remedial work is to be done without such detailed instruction. Eradication work will commence at the heart of the fungal outbreak; and the first stage to be directed will comprise the tracing of each line of fungal spread from its source to its farthermost limit.
Remove and cut out, cart away and burn all infected timbers, joinery, flooring, etc., as directed in detail by the architect on the site. Similarly take up floorboards, remove wall plaster and finishes as directed, tracing all visible signs of fungal spread until the limits of each strand are reached. Continue stripping of all finishes to points at a distance beyond these limits to be directed in detail by the architect.

CLEANING: If fruiting bodies are present, these are in no circumstances to be disturbed until their inspection by the architect, and will then be liberally sprayed with fungicide before any cleaning is undertaken. When the full extent of the fungal attack has been traced and all affected timbers removed as directed, thoroughly clean down all surfaces, remove all loose material and clear out all dust and debris prior to treatment, cart away and immediately burn.

TREATMENT: A brazier's blowlamp is to be played upon walling wherever directed in the area of fungal attack, until the surfaces become too hot for the hand to be held on them in comfort. Immediately afterwards and while the surfaces are still warm, spray or brush on liberal applications of fungicide, all as directed by the architect.
Where further directed, drill ¼ in. diameter sloping bore-holes in large timbers, and in all thick walls adjacent to area of infection, to facilitate penetration of fungal poison to their interiors. Very thoroughly irrigate these drillings with fungicide, fed by means of large funnels, and continue as directed until lack of absorption indicates that penetration is as complete as possible.
Liberally spray or brush all timber and other surfaces in area of attack with applications of " ..... " fungicide, paying special attention to the backs of timbers, and to ends of beams, etc., where exposed end-grain is favourable to deep penetration by the poison. The architect will give detailed site direction on the whole of this work.

NEW WORK: Make good removed timbers with new construction as directed. All new timber used is to be impregnated with " ..... " preservative by the ..... process before fixing. Wherever possible, hidden members will be replaced by inorganic materials, *e.g.* timber lintols by concrete and timber fixing blocks by breeze.

REMEDY CAUSE: Trace and remedy the cause of the outbreak, all as directed by the architect; building in new damp-proof courses, additional ventilators, etc., to ensure the proper prevention of any further trouble. Detailed direction of this work will again be given on the site by the architect, without whose instruction and approval no work is to be done.

REINSTATEMENT: Clauses as for General Contract.

Outline specification for pest eradication in accordance with architect's detailed site direction

Preliminaries

(Preliminary Clauses as for General Contract)

General

INSECTICIDE: The insecticide to be used throughout is to be " ..... " obtained from Messrs. ..... of ..... and used strictly in accordance with the makers' recommendations.
A fugitive dye is to be incorporated if required by the architect, to enable the extent and penetration of the insecticide to be traced.

SHORING: The contractor is to provide and maintain all necessary shoring, propping and other temporary supports as necessary to ensure the stability of the whole of the structure during the works.

FIRE PRECAUTIONS: Special care is to be taken to provide and maintain adequate fire extinguishers, as directed by the architect in consultation with the Fire Officer.

DISPOSAL OF INFECTED MATERIALS: All infested timbers, frass, etc., are to be carted immediately from the infected area to an agreed site outside the building, there to be burned without delay.

SALVAGED MATERIALS: Any re-usable materials such as floorboards, linings, panelling etc., removed, but which appear either free from attack or else to contain sufficient sound material to permit their re-use after repair and treatment, are to be stored outside the building, pending the architect's detailed inspection and disposal instructions.

Order of Works

REMOVAL OF INFECTED MATERIALS: The architect will direct each stage of the work in detail on the site and no stripping, eradication or remedial work is to be done without such detailed instruction.

REMOVAL OF INFESTED WOOD: Remove plaster and finishes as directed and clean out all surface rubbish from the area to be treated.
Trim off all "frass," (*i.e.*, surface wood so heavily riddled that it has lost its usefulness) from the timbers by means of wire brushes or blunt scrapers, until structurally sound timber is reached, all as directed on site by the architect.
Open up existing structure as necessary to permit free access for treatment to hidden faces of all timbers; and remove or cut out all heavily infected timbers as directed.
Thoroughly clean out all accessible spaces with vacuum cleaners; and leave the whole as clean as possible for detailed inspection prior to treatment with insecticide.

TREATMENT: All infested timbers, and sound sections immediately adjacent, are to be thoroughly treated with the specified insecticide as directed in detail by the architect. This is to be applied liberally, wherever possible by brushing, the liquid being run into the flight holes, and elsewhere with an approved coarse spray. Particular attention is to be paid to shakes, joints and other crevices in the timbers, and generous treatment given to ends of beams etc., where end-grain is favourable to deep penetration by the insecticide. Wherever directed drill ¼-in. holes downwards into inaccessible timbers and inject insecticide into them until lack of absorption indicates that saturation is complete.

NEW WORK: Repair or replace timbers with new, securely scarfed and jointed into the existing. All new timber after cutting and before being fixed is to be thoroughly impregnated with ".....preservative by the..... process, as a protection against further pest attack. Detailed direction of this work will again be given on site by the architect, without whose instruction and approval no work is to be done.

REINSTATEMENT: Clauses as for General Contract.

Walling, stonework and rendering

Walling decay

Decay in walling may have taken one of two chief courses: either the whole wall, its facing, core and jointing may have deteriorated, or else the individual units such as bricks or stones may themselves have suffered damage. The remedies are distinct, and the problems of "walling" should be considered separately from those of the individual stones.

Old walling may have been constructed in one of two ways. Either the stones were laid in courses the full thickness of the wall, or else the two faces were constructed separately, with a rubble core between. The first method is constructionally sound; but the second is not—hence the early collapse of many a heavy Norman tower.

In faced walling, however attractive at the surface, the weight of internal floors is often concentrated upon the inner face. If the infilling shrinks or settles, a further load is also placed upon the two outer leaves of the wall. The loosened rubble of the interior progressively drops into any interior spaces behind the two faces, further separating them so that eventually a loose wedge of free rubble is driven steadily down the inside of the wall, bulging and separating its outer faces.

Solid, coursed walling is free from this trouble and is more likely to have been damaged either by structural movement, or by persistent saturation. The most vulnerable situation in any wall lies in the topmost few courses, where the most water can penetrate and there is no superimposed load to hold the structure together. Rainwater can damage walling in two chief ways—by washing out the mortar from the joints, and by expanding into ice and forcing the stones apart. Another trouble-point occurs where, from a lack of supporting partitions, or from the placing of window and door openings too close together, or from structural settlement, the joints of masonry have opened to admit weather penetration.

Flint walling presents special problems, since the unit is so small and smooth, and offers so little key for proper bonding. When the faces are finished with knapped flints, the facings are particularly liable to part from their rubble backing. Since flint-knapping is a dying art, this type of walling is increasingly of historical importance. The flints themselves are practically indestructible, but their hard and non-porous nature precludes any real "grip" by mortar and may provide hard-lined water channels into the walling, offering free inroads for frost and erosion.

Apart from damp, a frequent cause of damage is the movement of dissimilar materials built into walling, as when timber bonding members and lintols or wall-plates have shrunk, and no longer give proper support to the stonework above. The rusting of iron ties and cramps has probably resulted in more damage to walling than any single other cause.

Lastly, a great deal of damage is caused by the roots of vegetation on walls. Some creepers are harmless,

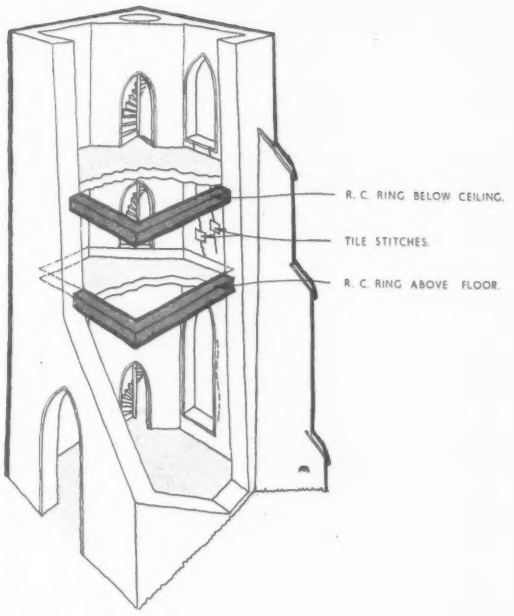


Diagram showing strengthening of stone tower by inserting r.c. ringbeams and by tile stitching of vertical "ringing cracks."

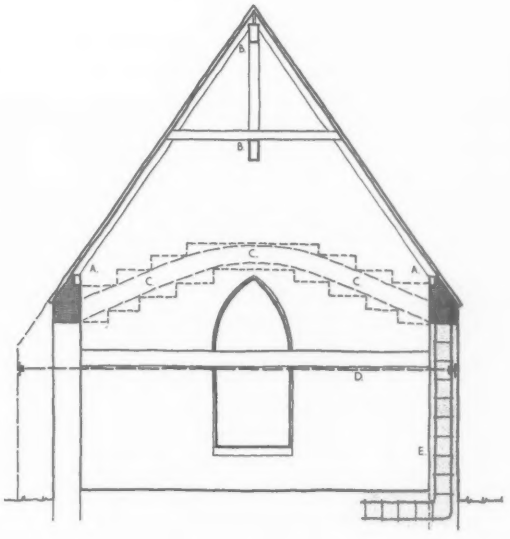


Diagram illustrating five different methods of checking live roof thrust. These are: (i). By the use of r.c. eaves beams (AA) spanning between end walls. (ii). By the construction of a trussed ridge (BB) spanning between end walls. (iii). (For use where the masonry in the gable wall is itself defective). By the insertion of ties in the gable wall (CCC). This would be used in conjunction with eaves beams. (iv). By a tie dropped to immediately below first floor (D). (v). By the insertion of internal buttresses (E). (Diagram based on material provided by SPAB.)

while some are not. Virginia creeper attaches itself to a wall by means of suckers, and except when it spreads into gutters, hopper-heads and the like, does relatively little harm. Ivy, on the other hand, sends deep roots searching into the joints of masonry, loosening the mortar and weakening the structure. Lichens and mosses, where the air is sufficiently pure to permit their growth, are also harmless; but the presence of moss will usually indicate an extremely damp patch, such as might be caused by a leaking gutter. Tree branches, shrubs and undergowth of all kinds should be kept well cut back from buildings, which they damage not only by harbouring moisture but sometimes by physical beating and scratching as well.

Repairing damaged walls

In setting about the repair of any wall, the first step is to remove all plants, creepers and vegetation whose roots are causing internal damage. This should be carefully done; and ivy, in particular, must be cut at the roots and poisoned at least six months and preferably a year before the repair, when the dead creeper will have lost its grip and can be gently lifted away. It may be necessary to dismantle the topmost stonework courses so as to be able to grub out all the roots which otherwise might grow again.

The next stage in cases of serious failure, and where the heart of a wall has perished, is either to dismantle and rebuild all defective sections, or to strengthen the wall *in situ* by careful internal grouting. The decision must depend upon how serious is the condition, and how important the identity of the walling as being itself of special character or interest.

In grouting a decayed wall it must first be carefully shored and supported, where necessary by means of close-boarding. After any damaged upper courses have been removed, the interior is next washed out by copious hosing with clean water, to remove loose dust and rubble from within. Grouting is usually carried out in stages of two to three feet at a time, from the bottom upwards. Lines of vent holes are driven into the heart of the wall, and a strong cement grout is then poured in to fill and consolidate the interior spaces. As the grout begins to appear at each line of vent holes, these are stopped up in turn until the whole of the spaces have been filled.

The mix for grouting may be either a strong portland-cement mortar, or a weaker lime mortar, depending upon the materials and structure of the wall. Care must in all cases be taken to avoid disfiguring the face by overflow-marks at the vent-holes.

If the core of a wall has burst it so seriously that it cannot be grouted, whilst either the external stonework or interior finishes such as wall paintings are to be preserved, it is sometimes feasible to save one face, and to rebuild the other. The structure must in this case be carefully shored, and the face to be rescued may need continuous support from close boarding. In rebuilding, the two faces can be reassociated by through-stones properly bonded into both sides: these may sometimes be achieved conveniently at old putlog holes. In cases of minor movement, it may be possible to give support by short metal ties between the two faces, carrying generous tie plates: but this is at best an expedient rather than a remedy.

The final resort for walling whose heart has failed is the local rebuilding of offending areas. Where this is done, a record photograph should first be taken of rubble walls, or a numbered elevational drawing made of ashlar work. Most of the materials may be suitable for re-use; and salvaged brick or stone from the interior of the wall may be useful for new facings.

Less serious is the case where it is the face of the walling, and not its inner core, whose joints have failed. These should always be raked out to a depth of at least one and a half inches: superficial repointing is soon fetched out by frost, and the last state may then be worse than the first. To ensure proper adhesion, the architect must then insist that the brickwork or stonework is extremely thoroughly wettened. Repointing mixes should wherever possible match the original mortar in density, and should on no account ever be harder than the material being pointed. The amateur mason must be restrained from spreading the pointing over the face of stonework like butter; and it should be stressed that it is the individual units—the stones and bricks of the wall—and not the pointing lines which must take the eye. "Ribbon" repointing is incredibly widespread and equally hideous; and the mortar must be kept back to show the arrises of the courses above and below. On no account must joints ever be widened "to take the pointing" as some inexperienced builders will suggest.

If surface joints are too deep for normal repointing, they may sometimes be repaired by surface grouting: this more frequently occurs with very random rubble stonework in exposed positions. In this case the wall is again thoroughly hosed and wettened, and any insecure stones temporarily blocked into place with wooden wedges. The joints are then stopped with tow, leaving small holes through which the grout may be poured. The tow is in due course removed, and the repaired walling repointed in the normal way.

In walling of flint and similar hard materials, the joints are the only part of the wall which may "breathe" and a soft mortar is essential. Where individual flints have fallen from the faces, these may be replaced; or sometimes, over-large areas of surface mortar may be "galletted" with small pieces of flint, to good effect.

Shafts and mullions in dressed stonework should ideally have the same number of joints as the stonework in which they are set. In practice, and especially in 13th Century work, this is rarely the case. The shafts of Purbeck marble which cluster around Early-English piers, and window mullions of all periods cut from long stones and set alongside many-jointed rubble walling, are often found damaged as a result. Where it is possible to contrive new mortar-joints of extra depth to accommodate the extra settlement, this should always be done. The spalling arrises of the longer, harder material can otherwise only be repaired by replacement or piecing. Similarly, the cast-iron shafts and balusters which are sometimes found to

have been introduced into stonework will inevitably be "foreign" to the construction, causing extra damage unless provision is made for their differential movement. In external work, the expansion and scaling of ironwork features due to rust is almost unpreventable, unless the fixings have been very carefully sheathed with lead. The only possible remedy is periodically to clean off the rust and scale, rustproofing the metal where accessible, and to point up the surrounding expansion spaces with waterproof mastic. Galvanizing is not permanent, and iron in contact with stonework should whenever possible be replaced by non-ferrous metal.

Some iron ties are impossible to remove, owing to the extent of structural disturbance which would be entailed: these can only be cleaned very carefully, rustproofed, and as far as possible protected from moisture penetration—for example by bitumen paint and additional damp-proof courses. Mortices can also sometimes be cut in surrounding stonework to permit their future expansion. But where it is practicable to remove iron ties, they should always be replaced by harmless materials such as the non-ferrous metals—bronze, copper or delta metal—or slate, according to the needs of each particular case.

If it is desired to remove vegetable growths, the Building Research Station recommend that this may be done by spraying with a 2½ per cent. solution of zinc or magnesium chloride. But unless actual harm is being caused, chemical treatments are really best avoided.

Stonework decay and repair

Stone types

In understanding the weathering of stonework in old buildings, it is essential to distinguish between the different stone types and their structure. In outline only, these may be recalled as follows:

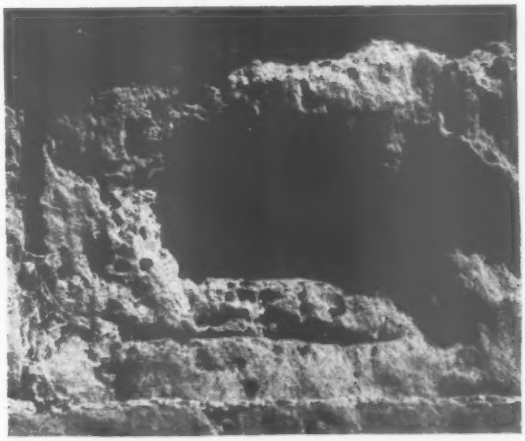
Granite. Formed by the crystallization of cooling molten minerals: granite is therefore unlayered, and consists of an irregular close packing of grains or crystals of quartz, felspar and mica. Hardness relates largely to the condition of the felspar grains, but is of the highest order. Granite is virtually insoluble under normal conditions, as well as being practically impervious to moisture.

*Sandstones.** Consist of individual calcareous or silicous sand grains, united by cementitious materials, which may be either carbonates (soluble) or silica and iron oxides (acid- and water-resistant). Since sandstone is "laid down," the structure is stratified, with a natural "bed"; and sometimes there is a considerable clay content. Of variable permeability.

Limestones. Principally carbonates of lime, laid down in prehistoric sea-beds. Limestones have a pronounced natural bed and often contain numberless fossils and shells. They are slightly soluble, especially by water carrying carbon dioxide or sulphur dioxide in solution. The magnesian or dolomitic limestones are compounds of carbonate of lime with carbonate of

* The name "freestone" usually refers to a sandstone, but is merely a non-specific term for an easily wrought stone in which the sedimentation layers are not pronounced, such as may be used for dressings.

Sterilising brickwork affected by dry rot. Holes have been drilled into the joints, and the brickwork is heated and then saturated with fungicide.



Above damage to soft sandstone by mason bees. Below, wind erosion of stonework caused by eddies in a re-entrant angle.

magnesia: they are particularly vulnerable by sulphur. The differing constituents and properties of the various natural stone types govern their weathering and decay in buildings, and give the key to their behaviour in any particular situation.

Identifying the cause of stonework decay

The chief agents of erosion and decay in stonework are:

(*a*) external physical abrasion;
(*b*) internal disruption by frost;
(*c*) internal disruption by crystallizing salts;
(*d*) direct solution by rainwater and airborne chemicals;
(*e*) faulty materials and craftsmanship.

External physical abrasion

Stonework, like any other material, is liable to wear by friction of any kind. Steps and pavings in old buildings are not always of the most suitable stone, and may have received more wear than they were designed to receive. Damage by point loads and knocks is also frequent, especially in positions facing motor traffic. Wind erosion is sometimes marked, especially in corners where little eddies and "whirlwinds" are found. Trees planted near buildings may take them unawares, lashing and scratching any soft stonework within their growing reach. Schoolboys' penknives are another hazard. Although the cause may no longer be apparent, the effects of physical damage are usually easy to identify.

An interesting but rarely found cause of damage to stonework is the mason bee. This insect enlarges holes in the softest sandstones found in certain parts of the country (notably in Lincolnshire) and nests in them. The damage done may be quite extensive; but the mason bee most commonly attacks only the very softest of stones (see photograph on page 457).

Internal disruption by frost

When water expands into ice, it increases in volume by one-tenth. If the pores of the stone contain sufficient room for this expansion, no harm will result. But if, whether from an extraordinary damp and unventilated situation, or from the use of stones of inherently excessive suction, the pore spaces are themselves already full of water, then freezing can only disrupt and burst the stone.

Damage by frost is usually therefore found in positions where stone may be completely saturated, whilst being at the same time exposed to extreme cold. Small chips and fragments of stone at the foot of walls during frosty weather, and the little clean scars on the stonework itself in exposed positions, will usually give the clue to mischief from this cause.

Internal disruption by crystallizing salts

The other cause of internal expansion and bursting of stones is the crystallization of salts. These may have been introduced with actual building materials, such as unclean sand, or absorbed from the ground and atmospheric soot deposits. The natural moisture rhythm of the stone carries them with evaporating moisture, to be deposited just beneath the surface, where they crystallize and expand, bursting successive layers from the face of the stone. Close examination will sometimes even show the crystals themselves, on the line of fracture.

The worst offenders against stone are the sulphur compounds. Sulphur is almost always found in soot deposits, but the resultant damage tends to show different forms in town and country. In heavily polluted areas, soot generally tends to collect wherever stonework is not washed by rain. The sulphur content combines with atmospheric moisture, firmly attaching the deposits to the unwashed stone, and building up into thick encrustations of heavy, form-destroying dirt. Stonework protected from normal washing is particularly vulnerable when allowed to become saturated with water from other causes, such as leaking gutters and flashings. This happens for example when the lead dressings on a stone cornice have perished, and the moulded console brackets beneath are frequently saturated, without ever being properly washed.

In the less polluted country areas, there is less visible soot deposit; but sulphur gases are still present in the atmosphere, to be carried into the stonework by rainwater.

In limestone, these sulphur deposits react with the natural carbonate content to form sulphates, crystallizing and producing the characteristic blistering and scaling of the surface. A hard and shiny "skin" of calcium sulphate is sometimes found on limestone in unwashed positions: at one time, this was thought to protect the stone, but it is now realized that by first cracking at the arrises and then gradually separating away, this "case-hardening" is as harmful a product of sulphur as any other.

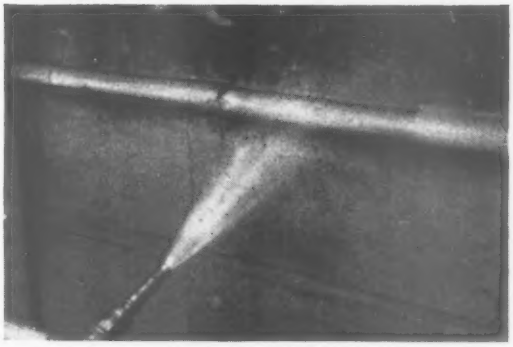
A particularly violent type of damage by sulphur compounds may be seen in some old buildings of magnesian limestone, such as York Minster. Where the stonework is not regularly washed clean, it may be eaten into cavernous holes by magnesium sulphate derived by the sulphur from the stone.

The harder sandstones and granites show less serious damage from atmospheric pollution. They do not build up the limestone pattern of cleanly washed and gently eroded highlights, backed by deep and soot-encrusted shadows. Instead, they tend to gather a thin and extremely hard black film on both exposed and sheltered surfaces, which although chemically less harmful, is an architectural detraction, and may be much more tenacious and difficult to remove.

Direct solution by rainwater and airborne chemicals

Finally with certain stones, erosion may be caused not only by the internal bursting forces of ice and crystals, but by an actual dissolving of the cementing element which binds the stone grains themselves. Even pure rainwater, allied with the natural moisture rhythms, can gradually dissolve the bonding agent of some stones. Sometimes this in turn is carried back to the surface of the stone, where it is deposited by evaporation to form a hardened "crust," closely following the shape of the stone, from which it will eventually crack and separate: the whole process then starts again.

Above, scabbing of stone caused by action of railway smoke on the carbonates in the stone. (Photograph supplied by Midland Silicones Ltd.). Above right, soot incrustations in Portland Stone washed away in streaks. Right, washing stonework by water spray.



Below, repointing a flint wall. The upper half of wall has been brushed down to remove the trowel marks. Below right, correct pointing in lime mortar with joints slightly recessed behind face of stones. (Photograph supplied by MOW). Bottom right, a bad case of "strip pointing." Note that the joint wires bear little or no relation to the real joints in the stonework.

More frequently, this " dissolving " of a stone is aggravated by chemicals absorbed by the rainwater from the atmosphere. Limestone especially is soluble by water carrying carbon dioxide or sulphur dioxide. Carbon dioxide is a natural constituent of the air, being given to it by the breathing of all animal and plant life. Sulphur compounds in coal are either sent into the air as smoke and soot, or else combust to make sulphur dioxides. In this respect, slow-combustion stoves are indeed almost more damaging than open fires, for even where there is no smoke, there may well be sulphur dioxide.

Faulty materials and workmanship

Apart from chemical causes, stonework may suffer from defects either in the stone itself or in the position and method of its use.

A common cause of unequal weathering in stones from certain quarries such as Ham Hill, is the presence of visible " soft beds," which erode more quickly than the rest. On a small scale, the alternation of hard and softer layers merely produces a slight surface roughening, which may be of no consequence. Any deeper beds of soft stone will, however, bring serious faults and failures.

Another stone defect is the presence of minute fissures, originally caused by earth movements and later resealed by deposits of calcite. In elaborately carved stonework, such " vents," as they are called, can cause serious weakness, as has occurred in the Anston stonework of the Houses of Parliament.

From a craftsmanship point of view, the commonest error found in masonry work is incorrect bedding. All sedimentary rocks, laid down on the ocean bed, have a laminated structure, with a more or less pronounced pattern of layers. They are strong in compression, but weak in shear along the lines of lamination. The stones may have been laid in the building correctly, or with a vertical bed, either at right angles to or parallel with the face. In general, vertical bedding is durable only in moulded work such as stringcourses, which might otherwise lose projecting members, and for arch voussoirs and the like. Face bedding is usually encountered as a device for utilizing stone from thin beds in deep stonework courses. Other masonry faults are of course legion; but a particularly interesting cause of occasional failure is the juxtaposition of sandstone with limestone in such a way that water drippings from the latter have apparently attacked the sandstone. Nonetheless, it must be admitted that limestone and sandstone were not infrequently laid down in geological juxtaposition, without apparent ill effect! It seems likely that the true cause of the phenomenon is again either the crystallizing of soluble salts, or the dissolving of the cementing material in the sandstone, by impurities in moisture " drawn " by the more porous material into itself. In this case, the effect is yet one more example of the unequal yoke.

Other physical phenomena which must have an effect on the life of stonework are the varying temperature movements of its mineral constituents, and the differences in thermal and moisture movements between exposed and protected stone. It may readily have been forgotten that some stones have quite marked expansion when wettened. This is normally taken up by the joints; but in exceptional circumstances as with large monolithic columns, the movement may be quite significant.

Remedying stone decay

Repairs to decayed stonework fall into two stages: firstly, the removal of harmful elements such as soot and deleterious salts, usually by careful washing; and secondly, the repair, piecing or renewal of missing and damaged stones themselves.

Washing stonework

There can be no doubt that the streaks and smears of sooty deposits on stonework often make nonsense of architectural form. We have not in our climate the deep, cast shadows of sunnier countries; and a building must rely for its effect upon gentler variations of light and shade. Even when the sun is shining, the black patches of urban soot deposits mask and obscure the true architectural effect. Neither from the point of view of structural health, nor that of appearance, is there any justification for sooty stonework.

For the guardian of historic buildings, the problem is complicated by sometimes unthinking public sentiment. Should St. Paul's Cathedral be washed? The thick and patchy cloak of chemical deposits which it now wears can be doing nothing but harm to the stonework. Wren must surely have conceived his masterpiece in white Portland stone, with reflected light in its shadows, and all its forms heightened by subtle graduations of light and shade. Today there is only a matt and sooty black, streaked with white by the rain. Only the magnificent sculptural design of the Cathedral enables it to stand up to such maltreatment and yet come recognisably through. Yet such is the tenacity of sentiment, and so associated in the minds of many people are St. Paul's and London grime, that any suggestion of cleaning would undoubtedly provoke a huge correspondence in *The Times*.

At Westminster Abbey, there can now surely be no question that the present cleaning of the interior stonework was right and necessary. The shining darker shafts of Purbeck marble, punctuating and outlining the design, had become almost indistinguishable from the remaining stonework, the whole interior merging into one formless dull black surface. After cleaning, the architectural idea grows clear and sharp; and soon the Abbey will appear as it was meant to be seen. It is a sobering thought that if atmospheric pollution continues at its present rate, it will only be a few generations before the Abbey has again vanished in new layers of grime. Surely meanwhile, there is a case for air conditioning of any really important architectural interior such as this, in a foggy, industrial atmosphere such as ours?

The first step in washing stonework is to protect the building from accidental damage by water. Especially where a building has thin stone walls and contains valuable decorations and furnishings, great care must be taken to prevent open moisture paths by which water can penetrate inside. A great deal of trouble

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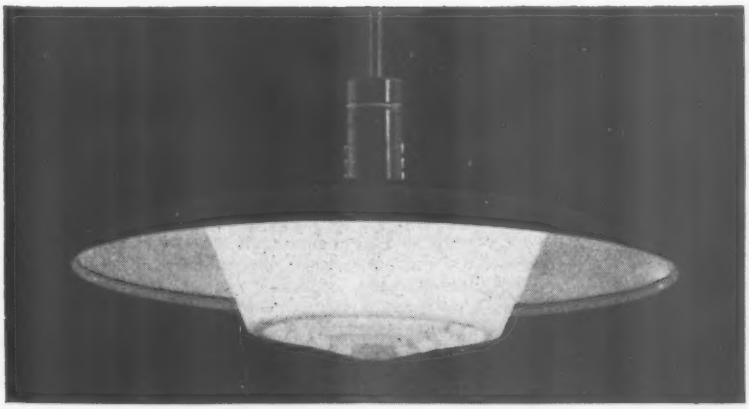

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was caused during the early days of washing some of the Georgian Crescents in Bath, when it was found that the facing stones of the curved facades were not cut with proper radiating joints, but only butt-jointed with their corners touching on the face, and joints widening into cavities behind. Any open cracks and moisture paths should be grouted *before* intensive washing, and features such as window-openings carefully protected by tarpaulins and screens. Excessive water must also be deflected away from the foot of a building, where it might otherwise cause damage to foundations and cellars. In towns, additional shelter may have to be provided to protect passers-by.

Work will start at the top of the building, the scaffolding being removed by stages as the work descends. When cleaning is carried out from a suspended cradle, a set of nozzles may be slung below it, so that the wall is always prepared in advance of the descending masons. For the uppermost levels of the building, a pump may sometimes be needed to raise a sufficient head of water.

Whenever delicate details such as figure carvings in poor condition become accessible for repair, careful record photographs should next be taken before anything is touched. Subsequent treatment should be given extremely gently, under the personal direction of the architect, loose fragments of stone being removed only so far as this is vitally necessary to prevent increasing damage by rain and frost.

The most difficult and inefficient way to clean stonework is to advance upon it and to scrub, without preparation of any kind. So much of the labour, and of the risk of accidental damage, can be avoided by proper washing. The adhering grime must first be thoroughly loosened with a prolonged and direct fine water spray, after which brushing with bristle brushes will be the only further treatment needed. Thick encrustations of soot can be lifted away with a wooden scraper—metal tools are best avoided. Wire brushes are generally only suitable for cleaning metal-work, but may sometimes be used on really hard stones such as granites, in large, flat areas where there is no possibility of mischief.

Throughout the work, only pure, clean water should be used. Much unnecessary harm has been done to stone by washing it with caustic soda, soda-ash and similar preparations. While these may quickly bleach the surface into an advertisement-like whiteness, they are actually very harmful to stone, and by leaving behind damaging salts, will rapidly bring about accelerated decay. Modern detergents mostly contain sodium sulphate, and are thus also chemically harmful, even apart from the searching breakdown of surface tension that their use implies.

It has been said that diluted hydrofluoric acid may in expert hands be used for cleaning some sandstone, leaving no salts behind. It is also claimed that local stains can occasionally be removed by solvents, such as ammonia for copper stains. But extreme care must be taken to remove the residue by careful washing, and there is nothing to guarantee that salts are being washed out, and not in. These processes should surely therefore be regarded as a very last and very doubtful resort. Safer remedies include the removal of oil stains by spirits such as carbon tetrachloride, white spirit or benzine. Another is a limewash " poultice " applied to the surface, to draw the foreign element out of the stone and into itself, to be brushed away. Paint can be carefully removed with organic strippers, but the caustic type must never be allowed near stonework. It really is safer to exclude from the site all soaps, chemicals and preparations but water.

Where cleaning by water is for any reason impossible, a gentle abrasive such as pumice powder is sometimes used (as in the interior of Westminster Abbey); or alternatively, steam-cleaning may be adopted The steam jet is a convenient means of reaching stonework in awkward positions or at great heights, and the warmth of the arriving steam does no harm to the stonework, while it may bring cheer to the mason. But the higher cost of maintaining the boiler and equipment normally makes steam cleaning more expensive than the simpler process of washing it with water.

Whatever the method, the workmen should appreciate that the purpose of cleaning is always the health of stone, rather than any false newness of appearance. Only when this is clearly understood will there be no temptation, when everything is nearly clean, to do violence to the one tenacious dirty patch. In this connection as in so many others, a sympathetic and workmanly co-operation between architect and craftsman on the scaffolding is worth a hundred letters.

Stone " preservatives "

Apart from the various solutions designed to repel surface water by filling the pores or increasing surface-tension, modern experiments have produced materials designed to reinforce the actual physical binding medium of the decayed stone itself.

The first trials were made with sodium silicates; but these decompose under atmospheric conditions to form harmful sodium sulphate, and their use has largely been discontinued. Experiments were later carried out with silico-fluorides, the theory being that on contact with limestone these would deposit silica, rebinding the broken face of the stone. In practice, however, it has been found that this deposition can only take place when the natural calcite content of the stonework has in turn been attacked and weakened.* Ethyl silicate is a useful and harmless building material. An adhesive sometimes used for sticking loose pieces of stone in position is made by dissolving celluloid in an acetate solution.

When decorative stonework such as statuary is concerned, in which the chief aim is to save every vestige of a friable and flaking surface by constant attention, such devices as adhesives and bonding agents may be justified. But few " preservatives " have been found really suitable for general use. There are dangers both in substances which can chemically attack any constituent, and equally in those which tamper with the physical surface structure of a natural material such

* A detailed description of the chemistry of the process is given in *Building Materials* of June, 1957, by a pioneer architect in this field, Col. Bertram C. G. Shore.

as building stone. Either is as liable to cause active harm as to prevent it.

In the normal case, and for the ordinary maintenance of large areas of stonework, it cannot be too strongly stressed that the only treatment which can be readily recommended as being safe and almost always worth while is regular, careful washing with clean water.

Repairing stonework damage

For all troubles due to the internal expanding forces of frost and crystallizing salts, the first remedy is the improved control of moisture movement.

Where stones have been destroyed by frost, it is essential to remedy the conditions which invited the damage. This can usually be done by means of additional cover-flashings and protection. Where damage has been caused by salts, their source must be traced. Often, earth will be found to have been piled above a damp-proof course. Another frequent source of trouble is the raising of roadways and pavements, especially where these are set in a bed of polluted clinker. If a pavement has been raised, it may be necessary to renew the facing stonework of the plinth in granite or another non-porous stone, to act as a vertical damp-proof barrier. It is often recommended that new stone inserted into old walling should be protected from any possible contamination, by backing it with bituminous paints; but there would seem to be many situations in which this artificial barrier can only accelerate damage to the older stone. If salts appear on the inside of thin features such as stone mullions, for example in seaside situations, the only remedy may be to experiment in waterproofing them by means of materials such as silicones.

The only way to remove harmful salts is by patiently and repeatedly washing them to the surface and brushing them off. Coats of limewash may help to "draw" them from the wettened masonry, to be brushed away and discarded. Many repeated soakings may be necessary; but eventually it should be possible to bring the stonework to a reasonably clean and healthy state.

Once its cause is cured, to remedy the actual effect of stonework decay is usually straightforward, and will consist in piecing or renewing the worst-damaged stones. Paving and similar stones can sometimes be "turned" to present their unworn lower face. In situations where a previously unanticipated extent of traffic must now be expected, it may be necessary to substitute a harder stone.

The choice between repair and renewal is always a delicate one, and must be taken one stone at a time. If weather is being admitted to carved detail such as window tracery, for example by a missing section of hood-mould or string-course, the decision is clear. But every effort must always be made to maintain the identity of the building, and to prolong the life of original materials as far as reasonably possible.

Stone of an exact match, from the same quarry and bed as the original, can rarely be obtained. At Gloucester, an old quarry has recently been re-opened for the special supply of the Cathedral. It is extremely difficult to obtain up-to-date information about the smaller quarries except by direct enquiry, since they mostly lack the publicity and advice facilities of the larger combines. This is a pity, and a greater degree of co-ordination for these smaller firms would be of great service to those with the responsibility of maintaining old buildings. The British Stone Federation* have recently published a directory of quarries at present operating, which is extremely useful.

Wherever the original stone is no longer available, a replacement should be sought in which the geological type and structure, physical properties and appearance are as nearly as possible matched. The best guide to the behaviour of a given stone in building is undoubtedly local observation and experience. The Building Research Station are further always glad to carry out practical laboratory tests, and to advise on the suitability of selected samples for given situations.

When a stone is removed, the problem arises as to whether it is to be dressed to its original face, in anticipation of further renewals on this "correct" line, or whether the eroded face is now to be accepted as permanent. It is important to avoid a "patchy" effect, for example in a wall of finely-dressed and uniform stones from a single quarry; and the situation may call for a good deal of common-sense and compromise. New facing stone must always be of adequate depth, so as to become a genuine part of the wall, and not a thin applied casing. Wherever possible, the original joint pattern should be continued, and replacements confined either to piecing or replacing individual stones.

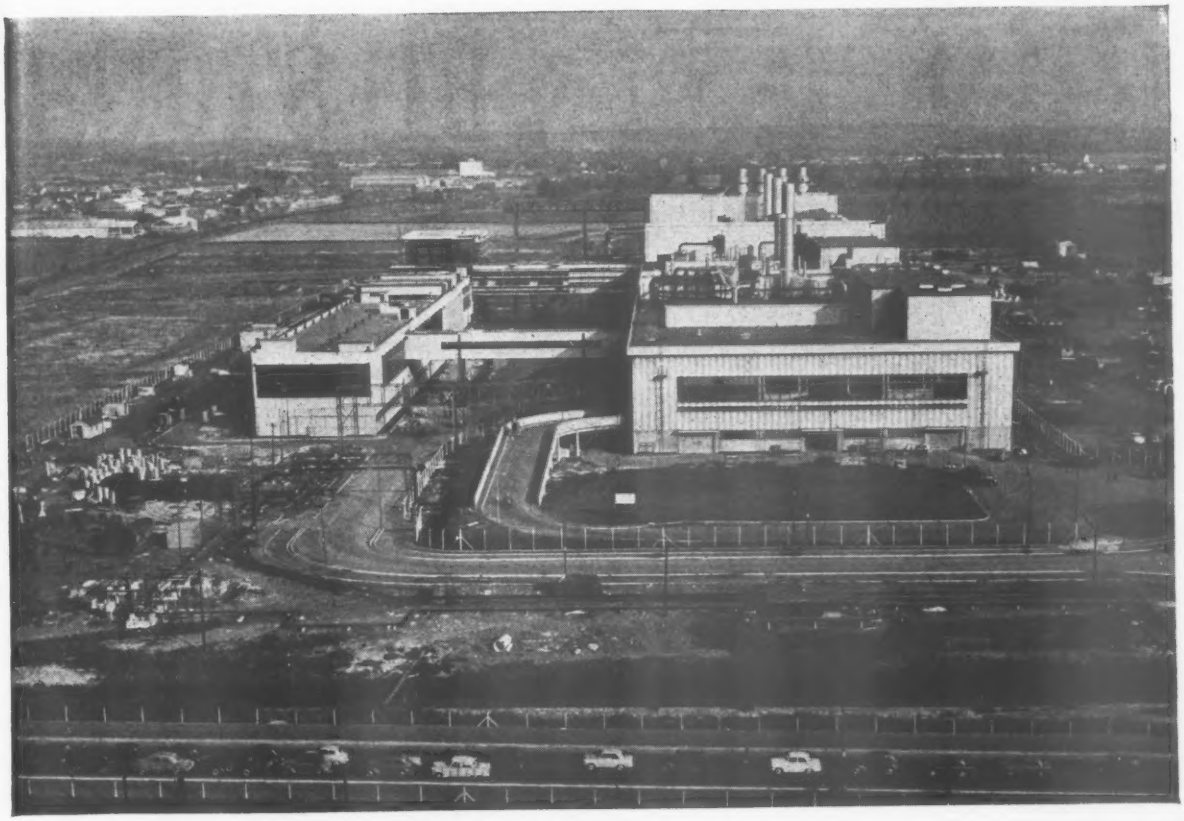
Mortar for replacements should equally as nearly as possible match that of the original wall, and always softer than the stones, so as to "chaperone" and protect them. A soft lime mix of the order of one part lime to six parts sand is typical; and a light gauging just before use with one part of Portland cement to some six parts of the remainder is useful in ensuring a quick initial set. But the mix for every job must be decided individually after careful practical site experiment.

The suggestion may sometimes be received, when much of a wall surface has become scabbed and flaking, that the entire wall should now be cut back and redressed. Certainly there are a few cases in which this can be done without architectural violence. But generally the idea is a dangerous one, because walling is rarely so flat and featureless as to avoid difficulties at moulded openings, stringcourses and the like, and possibly the loss of original craftsmanship. It was by vigorously opposing this aspect of 19th century "restorations" that the SPAB earned its nickname of the "Anti-scrape." Although the climate of opinion has changed since then, and with it the need for any exaggerated purism in such matters, it was by such ill-considered refacings and renewals that too much of mediæval England perished under the Victorian chisel.

"Plastic repair"

In recent years, a degree of success has been achieved by the plastic or "dentistry" method of repairing

* 70, Victoria Street, London, S.W.1.



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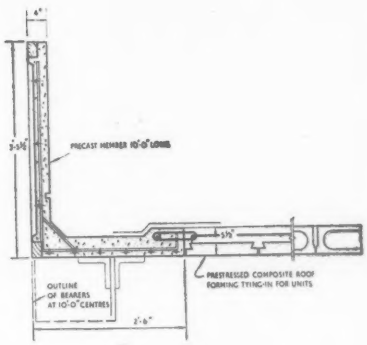

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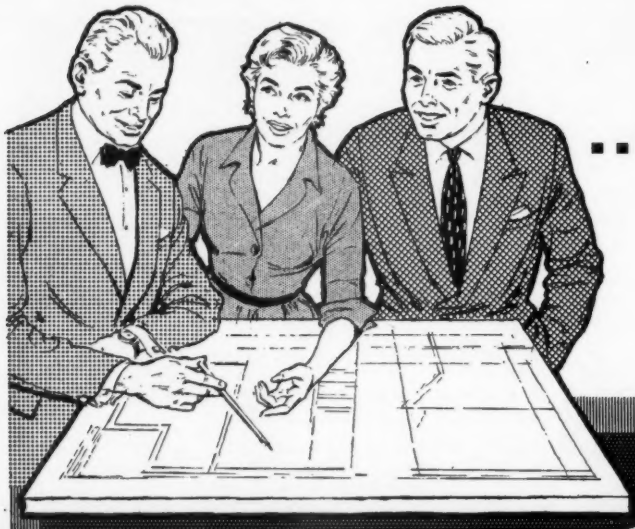

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stonework. As its name implies, this entails cutting out the damaged parts of a stone and replacing them by a plastic material, reinforced and carefully keyed into it.

The damaged stone is first cut well back to a sound base, and drilled or cut to afford a good key, at sufficiently wide centres to avoid weakening the stone. Reinforcement, usually of copper wire, is next inserted and either hooked securely into the parent stone, or in exceptional circumstances run in with lead. The backing is lastly thoroughly brushed and slurried with white cement, and the new section built up, a layer at a time, and finished with a wooden float.

The filling material consists of coarse sand or crushed stone-dust, bound either with Portland cement (sometimes white Portland cement) or with a zinc or magnesium oxychloride cement or organic binder. Silicon ester has also been used as a binder. Some firms specializing in this type of work send out their materials ready-mixed at a central depot, and in sealed waterproof containers; but this "batching" system is really only appropriate where the whole of the stonework is from a uniform quarry and bed. The exact degree of moisture of the mix is of great importance in securing proper adhesion without subsequent cracking and crazing. Any mix incorporating Portland cement *must* be used while fresh, and within 45 minutes at the most, to avoid premature setting.

Another less expensive method of keying and reinforcing plastic repair is with tile insertions; and sometimes in unsophisticated stonework, tiles themselves may be visibly inserted as a kind of "galleting," quite attractive in appearance.

The filling, particularly if it contains Portland cement, must be allowed to dry very slowly and protected from excessive sun and heat by wet sacks and tarpaulins. When almost dry, the unpleasant "laitance" which even with a wooden float may appear on the surface, should be removed by brushing with a stiff, near-dry brush. Or the insertion can be oversized, and dressed back like stone with a chisel; but extreme care is then needed to avoid disturbing the bond between the insertion and its host.

Plastic repair should *always* be confined to the repair of individual stones, the original joint lines being carefully maintained and repointed in the normal way. As with rendering, it is best to carry the material to a straight or rectangular line like that of a stone joint. Infillings should never be less than ¼ in. in thickness, and delicate feather-edges and smoothings-into-line are always to be avoided.

The special benefit of the method, apart from its economy, is the ability to repair small parts of single and otherwise undamaged stones, whose renewal would cause disturbance to the structure of the walling. No plastic material has, however, quite the same "life" and variation as a piece of natural stone; and weathering increases rather than modifies the difference. Large areas of plastic repair will in time develop the most depressing drabness of appearance, and projecting shoulders and details where natural stone would normally attract lichens may remain bright and assertive. The "making-out" of all but the smallest details, or of weather-holding defects in positions which cannot be pieced or where disturbance is undesirable, is to be avoided.

It is also imperative and difficult to ensure that plastic insertions do not commit the fault of dense pointing, by being less porous than the natural stone. The evaporation of moisture and deposition of salts are then concentrated at the junction between the filling and the stone, when it is the latter that will suffer.

As in so many other fields, since it is virtually impossible for site direction to be given on every detail by the architect, the only insurance that such details will be appreciated and looked after is the employment of a reliable firm of trained and experienced workmen.

Brickwork

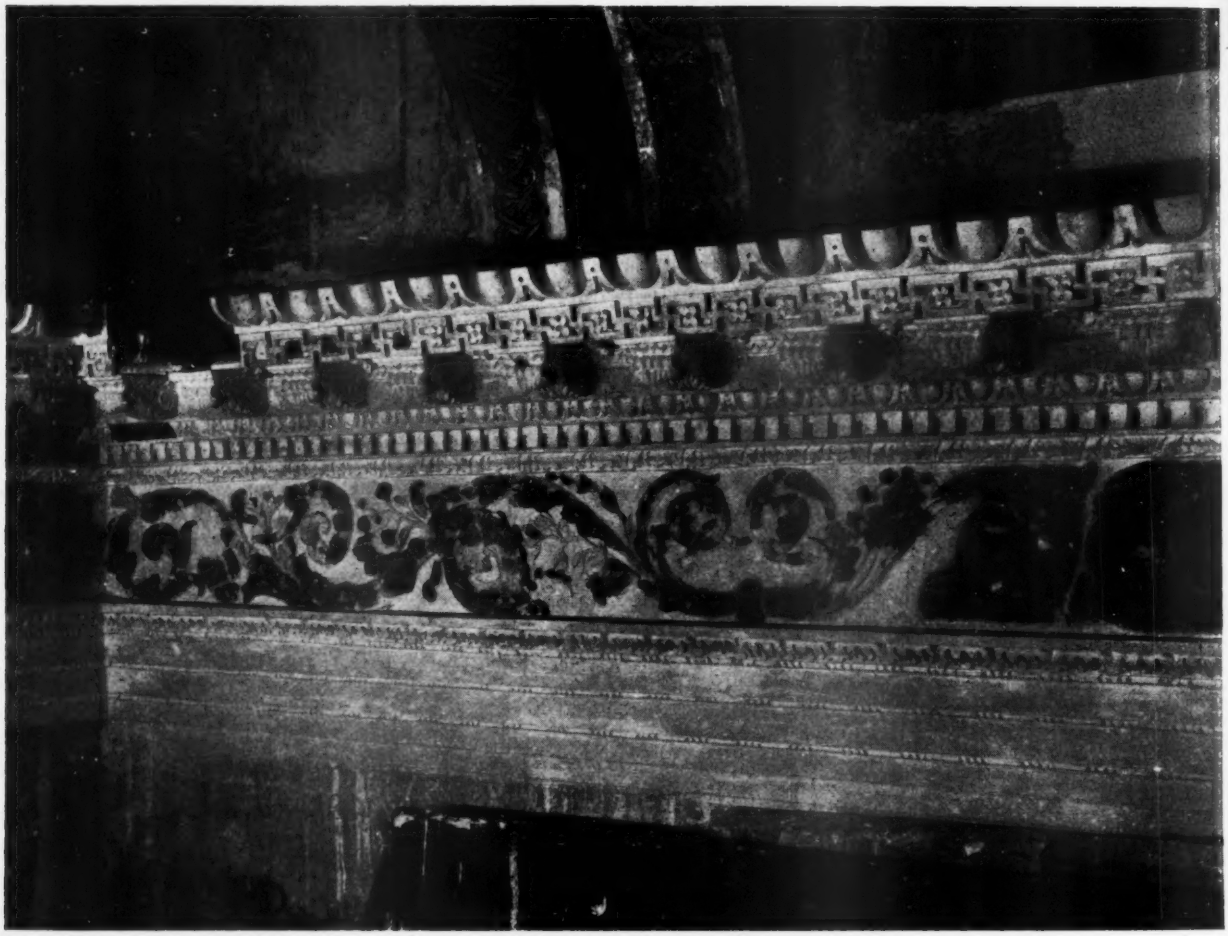
Mediæval bricks were rough in texture and irregular in shape, and laid in shallow courses with thick joints of lime-mortar. From the 13th to the 17th centuries, bricks were mostly imported from the Low Countries, and found ready use in East Anglia. In Tudor times, they were made locally in a wider variety of colours, and until 1600 or 1610, in courses of some 2 in. only. In the late 17th century, brick sizes were standardized, and the rude mediæval brick with its rough texture gave place to the smooth, crimson-coloured Georgian brick and pale, almost salmon-red "rubbers" for decorative work, often laid on an extremely fine bed of lime mortar.

In repairing old brickwork, it is essential to appreciate the value, as in stonework, of keeping the mortar softer and more porous than the bricks themselves. More old brickwork has been ruined by repointing with hard and impervious cement mortars, and by the consequent efflorescence and frost damage, than by any other cause.

As with stonework, vegetation and roots should first be cleared away; and if local rebuilding is necessary, the courses and bonding pattern must be carefully maintained. Old bricks from the inside of a wall may frequently be saved for re-use as facings, any newer bricks being used where they are invisible. In repointing brickwork, the joints should be raked out to a depth of at least ¾ in., and the walling very thoroughly saturated with water before neatly repointing with a fairly dry mix. Nothing is more unsightly than pointing spread over on to the face of brickwork, and it is better to keep the surface slightly back than to risk allowing this to happen. The bricklayer must understand that the bricks, and not the joints, are the important element, and that the pointing is purely a protective filling between them.

Rendering and plasterwork

Mediæval walls were frequently intended to receive a thin coat of external plaster, or many thick layers of limewash. This was not a hard, thick sheathing like modern rendering, and the freestone dressings, used to obtain accurate corners and surrounds to openings, may be found with only the slightest setting forward. Any renewed rendering should therefore follow the irregularity of the walls, and "die" against the quoin stones without steps and ledges. Another objection-



Above, repair of a plaster frieze at Chiswick House. (Architects: Ancient Monuments Branch of MOW).

able practice is the stripping of external plaster from timber-framed buildings, whose skeleton is thus unnecessarily bared to the world.

Rendering should always be thought of as a soft overcoat, and not an impervious casing to a wall. This overcoat absorbs moisture, and acts as a reservoir until it can dry out. A hard casing, once it has cracked, can on the other hand admit a stream of moisture which is then trapped behind it and cannot escape. In repairing old rendering, it is virtually impossible to "patch" locally defective areas of a large surface. Even if the greatest care is taken to

Left, re-fixing a Jesse ceiling on metal lath. (Both photographs on this page supplied by MOW.)

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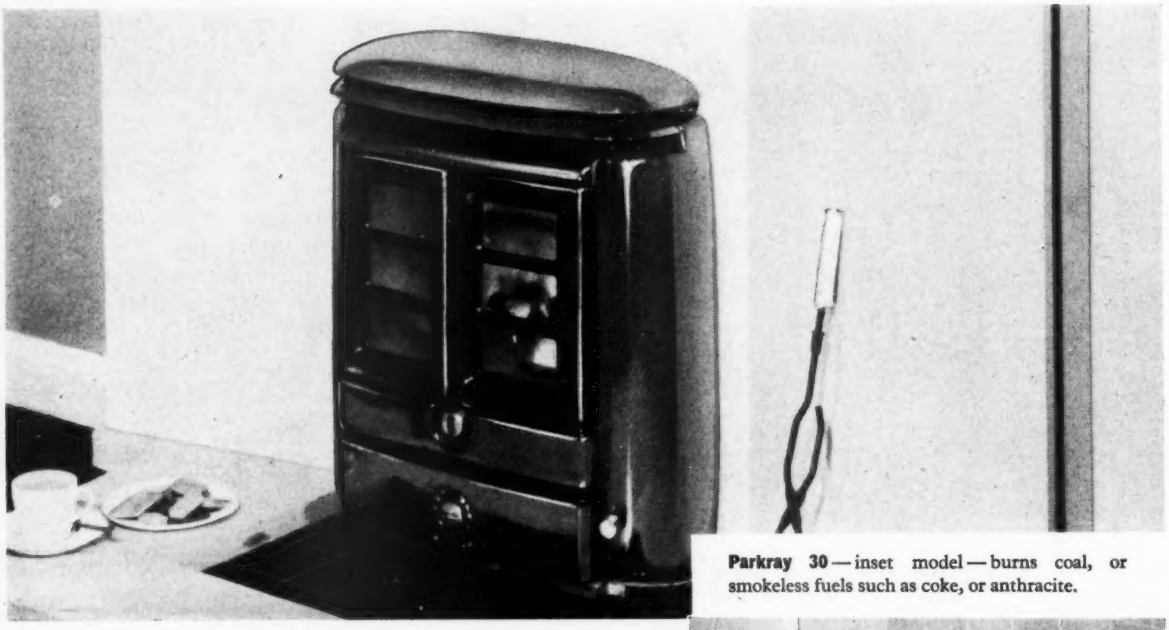

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make the repairs a good match, they will always weather differently. It is far better to keep new work to a minimum, to be confined within definite lines such as corners, where changes in colour and texture will be masked by the angles of the building. Indeed, it is remarkable how great a variation is acceptable and unnoticeable on different planes: a similar effect is sometimes seen when the ceiling and walls of a room are redecorated with variants of the same colour, and when very often the intended contrast is disappointingly undistinguishable!

Walling to be re-rendered should first be thoroughly cleaned and consolidated, and then heavily and evenly saturated with water immediately before rendering is applied. The mix is best kept on the weak side, and on brickwork a proportion such as one part lime to three or four parts sand is suitable. Rendering may be lightly "gauged" with Portland cement if desired, in the proportion of one part cement to, say, three parts of the remainder. The inclusion of hair is a very sound practice. Only just sufficient water should be used to make the mix workable. In applying the rendering, a wooden float is useful; and care should be taken not to "puddle" the surface, when it will craze and crack. A gentle brushing-down when the work is almost dry can help in removing any unpleasant "laitance" which may have found its way to the surface, and will give a pleasant texture by exposing the surface aggregate.

Limewash is an excellent protection for walling, if renewed at frequent intervals: an admixture of tallow is traditional in some areas. Roman cement, often found in old rendering, can also still be matched. It does not obtain quite such a permanent "grip" on brickwork, but has a much more pleasant colour and texture than modern Portland cement, and is less liable to cracking and crazing than its harder modern counterpart.

Internally, mediæval walls were coated with many thick layers of limewash—the precursor of modern wall plaster. By the 16th century, thick hair plaster was in general use; and in the 19th century came the wooden battening and counterbattening of walls for lath-and-plaster, which provides such a tempting spreading-ground for dry rot.

The foundation for plasterwork in historical times was usually battening—for the most part of hazel or riven oak. Battens may have failed either through tannic acid attack upon their fixing nails, or through timber rot and pests. Sometimes, stout battening which served originally for centering, as in an elaborate plaster cove, may have become unnecessary once the plaster set. Where large flat surfaces have lost their battens, and it is desired to avoid disturbing ornate moulded plasterwork, it is usually possible to clean out the batten channels, and to cast into the "key" thus given an entirely new plaster backing, reinforced by hessian or non-ferrous metal. Individual weak spots in plaster can be given extra support by brass cups and screws, countersunk into the work and plastered over, or by non-ferrous "stitches" twisted around nails above. To avoid disturbance, screws may be used: when it is impracticable to drive these at the required angles, they may be set in the upper face of the joists, carrying long wire loops of copper or brass to support the plaster.

Another frequent cause of failure is lack of adequate key. This may be caused by the fixing of battens direct on to flat surfaces such as beams, or very frequently merely by battens set at too close a spacing. On flat surfaces, large-headed galvanized nails will give improved key; and insufficiently spaced battens may sometimes be separated, basket-work fashion, by "weaving" short lengths of batten under and over them. When renewing plasterwork, adjoining old work should be undercut to dovetailed, clean edges to afford maximum "key."

Repair of wall-paintings

Particular care should be taken before stripping any plaster from mediæval walls to ensure that they carry no valuable wall-paintings, hidden under the coats of limewash. The exposing and repair of wall-paintings is an extremely delicate task, and should be entrusted only to experts. The names of recommended experts in this and other specialist crafts may always be obtained from bodies such as the SPAB, and the Central Council for the Care of Churches.

The first step in preserving wall paintings is of course to dry out the wall. Limewash and other coverings will then be carefully removed by the expert; and it is sometimes found that successive wall-paintings of different dates have been applied on successive layers of limewash. In this case, each will be photographed as traces are discovered; but the original painting on the plaster is likely to be the best preserved. The expert will next "fix" loose and flaking paint. A joint Committee of the SPAB and the Central Council for the Care of Churches are at present preparing detailed recommendations as to the best techniques to be adopted. Any temptation to excessive retouching and restoration must be resisted. The effects of any kind of varnish or heavy wax "sealing" of the surface may also well be disastrous. Where a wall painting has become seriously perished or is exposed to bright sunlight, it may be protected by screens, perhaps carrying a careful conjectural restoration of the mural. A glass covering sometimes detracts by its reflections, and may endanger the painting by trapping atmospheric condensation.

The magnificent "doom" paintings which occasionally still come to light in church buildings were only a part of a great decorative scheme, traces of which may be sought on other walls. A beautiful system of paintings has recently been discovered and restored at Kempley, in Gloucestershire. It is interesting to remember that individual pictures were often grouped to form a "conversation piece," with figure talking to figure, the whole being conceived as a single polychromatic decorative scheme covering the entire interior. The practice encountered in some countries of lifting wall-paintings from their sites and transporting them to art-galleries is strongly to be deprecated. They are essentially part of an architectural interior, which without them loses half its meaning and is left an empty shell.

Outline specification for masonry repairs to be carried out under architect's detailed site direction

1. PROTECTION AND SCAFFOLDING: Carefully erect shoring, protection and scaffolding, all as described in General Conditions, and as directed on site by the architect.

2. UNSAFE STONES: Carefully shore insecure sections of stonework and remove loose or dangerous stones and fragments, all as directed. Provide all necessary shores and supports, and cut out severely damaged stones where directed by the architect. These will include unsafe stones of cornice (*e.g.*, one stone has already fallen from the ..... angle of the .....) and the dangerously fractured masonry caused by additional load of columns added to the ..... face.

3. REPLACEMENTS: Stones removed or missing are to be replaced as directed with new stones from quarry and bed to be agreed with the architect, and as similar as possible in bearing strength, porosity, permeability and appearance to the original.

4. CUTTING: All new stones are to be correctly bedded, with their natural bed at right-angles to loads or thrusts, except where otherwise instructed. The lines of all mouldings, curves, angles, etc., are to be worked out of the solid, as directed No angle mitre-joints will be permitted; and, except where expressly otherwise instructed, no new stone shall be of less depth than 4 in. from the face of the wall.

5. JOINTING: New mortar joints are to be of narrow width, exactly matching the existing, and equal to a sample to be approved by the architect.
Joint-lines are to be maintained exactly as at present, and repairs are to be regarded as being to individual stones rather than to walling.

6. MORTAR: Mortar is to be as nearly as possible a match to the original, as approved after careful experiment. A trial section of pointing is to be completed for the approval of the architect, in a mortar composed of ..... parts fine crushed stone ..... parts lime putty or hydrated lime, mixed with just sufficient water, and 1 part Portland cement added just before use. All stone is to be thoroughly wettened before jointing, and dense and impervious mortar is to be avoided.

7. BACKING: All stone facings to brickwork are to be backed with a slurry of 3 : 1 stone-dust and cement, to prevent staining.

8. CRAMPS: Harmful iron cramps and fixings are wherever possible to be removed and replaced as directed either by bronze, Delta bronze No. 4, copper, or other approved non-ferrous metal. Cut away for key, and insert slate or copper cramps where directed, to afford all necessary additional support (*e.g.*, to cornice over ....). All cramps to be run in with Portland cement.

9. CARVING: Detailed carving where required in new work is to be done either on the ground or in position, as directed, and by professional stone carvers. Old carved work is to be re-incorporated where possible, and soundly and properly keyed and cramped into new stone wherever required.

10. FLASHINGS: Cut chases 1 in. deep where required by the architect, to take cover-flashings to cornices, etc., and to all water-holding projections such as window-heads, including positions where in several cases these have previously been omitted.
Attend upon and point up after specialist lead-work sub-contractor.

11. FALLEN MEDALLIONS, ETC.: Carefully re-fix fallen Coade stone decorative features wherever directed, securely cramped into walling as instructed on the site.

12. BALUSTRADE: Take down and re-assemble stonework of balustrade where directed; and point up the ends of steps where these are exposed by settlements, so as to exclude weather from the structure.

13. RE-POINTING: On completion of the required repairs, all loose and open joints throughout are to be carefully cleaned out, thoroughly wettened, grouted and pointed with mortar of mix as directed on site, filled solidly back as far as possible between stones and finished very slightly recessed from face of stonework, in accordance with a sample section to be approved by the architect. On no account, is any joint to be widened to admit pointing: the re-pointing is intended purely as filling, to prevent the permeation of moisture between individual stones into the walling behind. Stronger cement mortar may be used only as directed in very exposed positions. The intention in general is that moisture should be drawn from stones to evaporate at joints rather than being trapped and driven to the face of stones along impervious joint lines. The mortar for pointing should therefore throughout be slightly softer than the adjoining stones.

14. WASHING AND BRUSHING: Very carefully protect all windows, openings and points at which moisture damage might be caused to the interior. Provide and hang tarpaulins so as to deflect water from the foot of the building and avoid damage to foundations.
As directed in detail by the architect, wash off all *loose* soot and grime only by protracted washing with direct fine water sprays and subsequent brushing with bristle brushes, equal to a sample to be approved. Tenacious grime, the removal of which might possibly damage the face of the stonework, is at all times to remain; and no soaps or chemicals whatever are to be employed. The intention is for only such cleaning to be carried out as is necessary to the health of the stonework.

15. RENDERING REPAIRS: Examine all rendering from scaffolding, and hack off where loose, as directed by the architect. In view of the difficulty of matching, no patching of surfaces is to be undertaken; and re-rendering will be confined to complete wall surfaces between straight lines and wherever possible between corners of buildings.
Carefully re-fix all loose and fallen sections of composition string-courses, securely cramped to wall as directed.
Wetten all walling very thoroughly before re-rendering, to ensure the best possible adhesion. The mix of the rendering is to be of the nearest possible match to the existing, as approved after careful experiment. All materials used are to be thoroughly sieved before mixing, so as to exclude lumps which might otherwise cause scratching and marking of the surface. The rendering is then to be very thoroughly mixed with a minimum of water and applied with a wooden float; and when practically dry, it is to be brushed down to expose the aggregate and marked out with joint lines to match the existing.

16. COMPLETION: On the architect's detailed approval of the completed repairs, carefully remove all scaffolding, plant and equipment, taking great care to ensure that no damage is caused to the completed works. Clear away all rubbish and tidy site generally, clean all windows inside and outside, and leave all clean and tidy and ready for return of occupants on completion.

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working detail

APRON STAGE: THEATRE AT COVENTRY

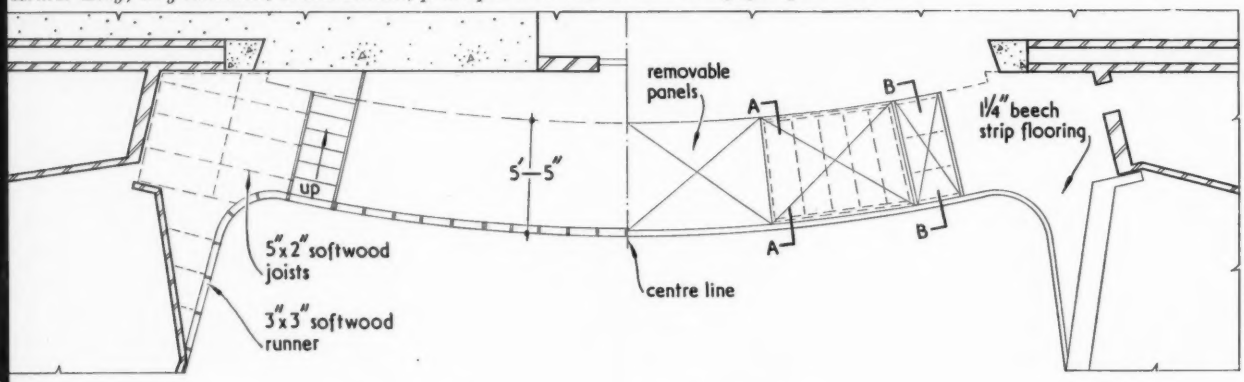
Arthur Ling, City Architect; David Beaton, principal architect; Kenneth King, group architect

The apron stage consists of six demountable panels (of which two are smaller than the others and cover the two flights of steps) and rests on the palier separating the auditorium from the orchestra pit and on mild-steel shoes bolted to the underside of the concrete subfloor of the stage. The palier is also demountable and is likewise divided into six sections which are secured to one another and to the floor by barrel bolts.

working detail

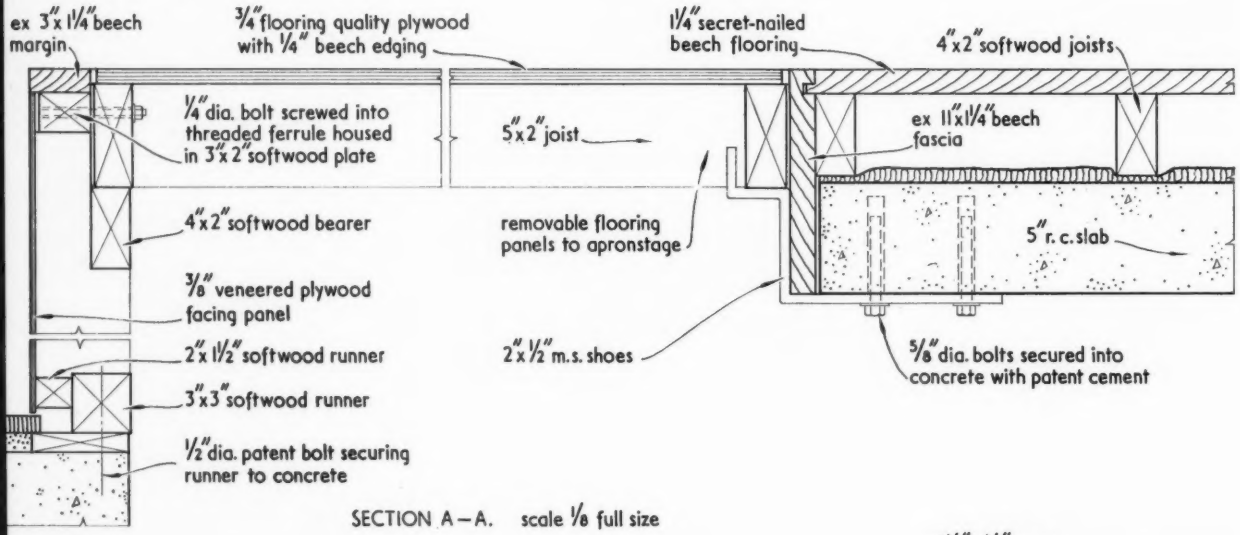
APRON STAGE: THEATRE AT COVENTRY

Arthur Ling, City Architect; David Beaton, principal architect; Kenneth King, group architect

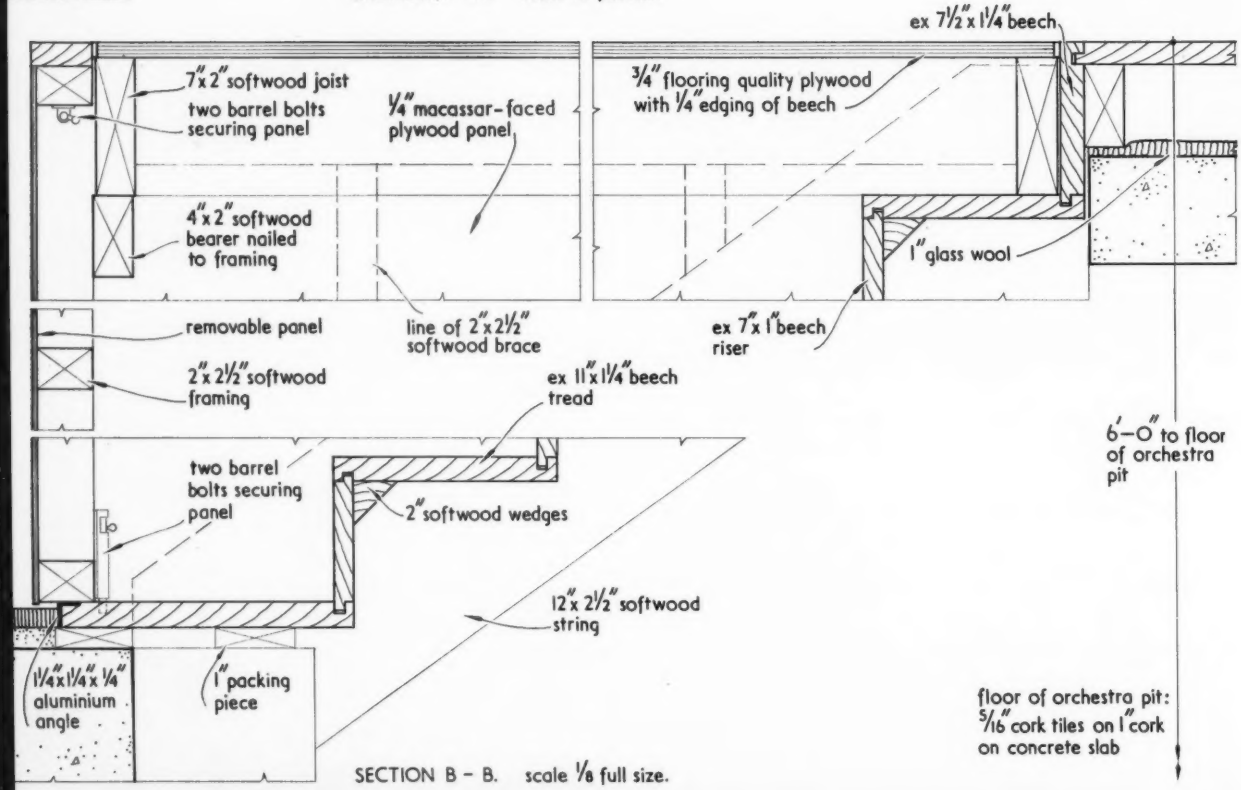


PLAN BELOW STAGE LEVEL. scale ⅛" = 1'—0"

PLAN AT STAGE LEVEL.



SECTION A—A. scale ⅛ full size



SECTION B—B. scale ⅛ full size.

working detail

CURTAIN WALL: OFFICES AT FALKIRK

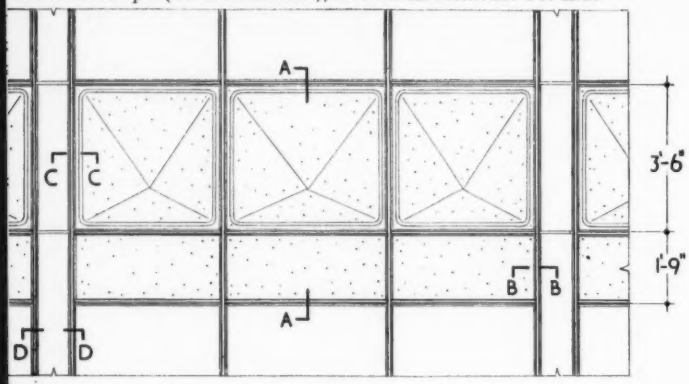
Architects Dept. (Scottish Section), British Aluminium Co. Ltd.

This detail illustrates certain refinements which are becoming common practice in the British curtain wall. Note in particular the incorporation of ventilation in the window head and of drips on all external horizontal members. Both the dished and the flat opaque panels are of aluminium alloy anodised to a dark grey colour.

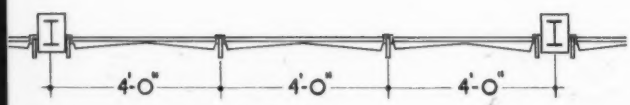
working detail

CURTAIN WALL: OFFICES AT FALKIRK

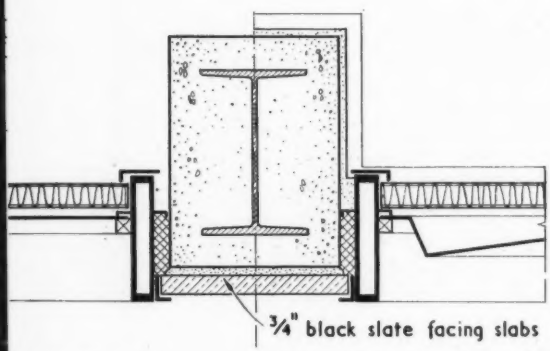
Architects Dept. (Scottish Section), British Aluminium Co. Ltd.



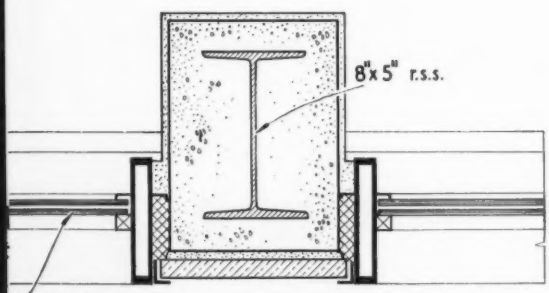
KEY ELEVATION. scale 1/4"=1'-0"



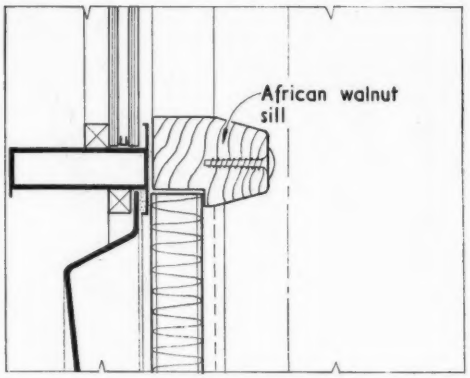
KEY PLAN. scale 1/4"=1'-0"

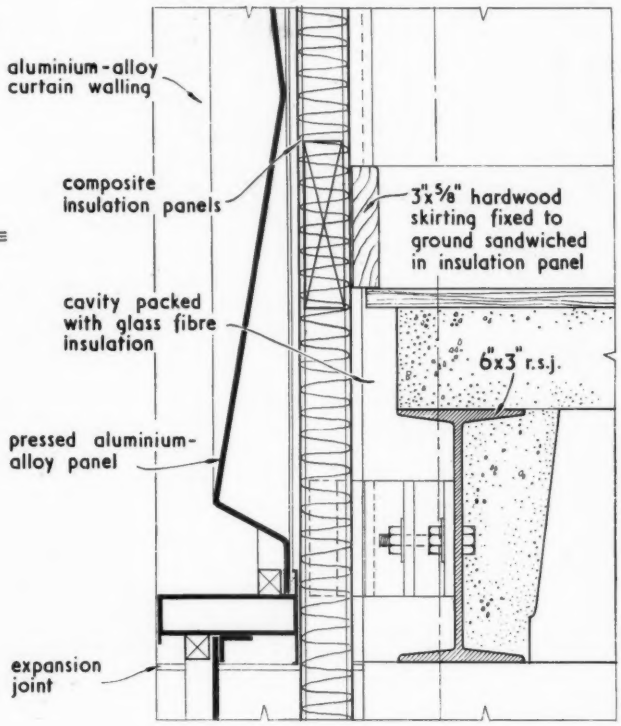


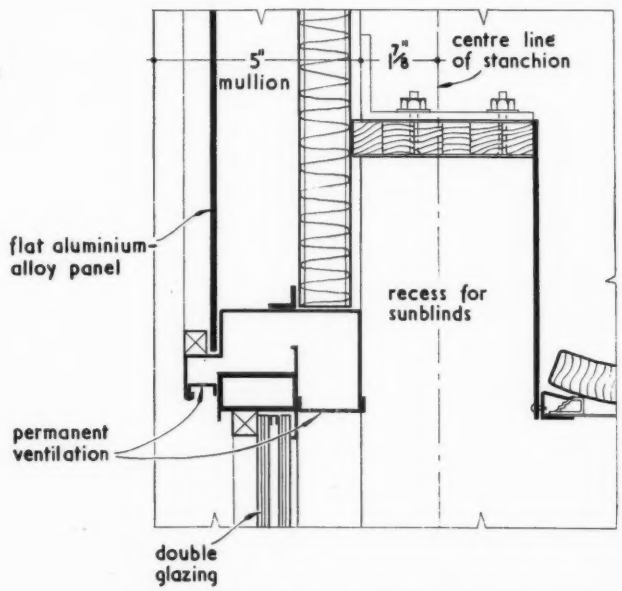
PLAN AT B-B. PLAN AT C-C. scale 1 1/2"=1'-0"



PLAN AT D-D. scale 1 1/2"=1'-0"







SECTION A-A. scale 1/4 full size

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Special features: metalwork, rainwater furniture, glass, bells and fire precautions

Repairing metalwork

Decorative wrought-ironwork is one of the most attractive, and at the same time one of the most vulnerable features of an old building. From time and neglect, it becomes either rusted and scaled, or else thickly encrusted and hidden by many layers of paint, which obscure its finer niceties and workmanship. The gates of the Victoria Tower of the Houses of Parliament, even in their short lifetime, were recently found to have an entirely unsuspected degree of ornamental detail under their overcoat of paint.

Flaking paint may safely be removed by a suitable stripping agent; and the ironwork must then be thoroughly de-scaled and treated with a good rust remover. Missing and damaged sections can meanwhile be made good wherever needed, but remembering that it is better to eke out the life of old work than to renew it in too wholesale a fashion. Circlets and collars and similar details are frequently found to have burst, and will require repair by welding. It is occasionally useful to resort to the use of other metals, as in flaunching off water-holding hollows with lead; and there may be a case for local renewals in non-ferrous metal such as brass or copper, in situations where iron would quickly again perish. But generally, the repair of wrought-iron is a straightforward blacksmith's job, and will mostly consist of straightening bent work and welding and strengthening joints attacked by rust.

Lead statue burst by rusting of the iron armature (Kedleston Hall, Derbyshire). The only remedy is renewal of defective portions of the armature, taking special precautions to avoid future moisture penetration.

Before being refixed, ironwork should be thoroughly protected with one of the rust-inhibiting paints, preferably in grey or black and with such occasional re-gilding as is needed. Gilt paint is a vastly inferior substitute for gold leaf, and will quickly tarnish and look mean: if genuine re-gilding is financially impossible, it is better to omit it than to cheapen the effect in this way.

The ends of railings, saddle bars and similar features where these are built into stonework can often be tipped with bronze or sleeved with copper, to avoid any recurrence of rust damage.

Any impediment to the free movement of features like gates should be cleared away, and the hinge pins, fixings and furnishings made good. Mediæval hinge- and key-plates are often of the greatest interest, and justify careful repair. If ornate wrought-iron hinges are no longer reparable as such, at least their decorative plates should be repaired and retained in position.

The better Georgian door-furniture was sometimes beautifully executed in brass, and likewise deserves painstaking attention. Crude modern locks and handles substituted for the old—especially the clumsy hasps and padlocks of the requisitioning military—are often very unsightly, demanding summary removal. It is not easy to find suitable replacements for missing door-furniture; but such details contribute much to the effect of a fine interior, and are worth much seeking.

Repairing rainwater furniture

The most neglected feature of all old buildings is undoubtedly rainwater furniture. If they are not constantly painted and properly maintained, cast-iron gutters and downpipes will quite rapidly rust; and the resultant outpouring of collected rainwater at concentrated points can easily do more harm than their absence altogether.

Wherever a roof can discharge harmlessly by means of widely projecting eaves or frequent spouts and gargoyles, it is sound policy to omit or even remove eaves gutters entirely. Where rainwater collection does seem essential, both gutters and downpipes must be kept in the best possible repair. In old buildings they are usually either of lead or cast-iron.

Lead is very long-lasting if properly fixed in reasonable lengths, and with adequate provision for thermal movement. It must be *continuously* supported. Sloping lead branch pipes will almost certainly otherwise droop and sag; and vertical downpipes need frequent and generous fixing by means of projecting lead "ears." Original lead rainwater furniture is an important architectural feature, and should always where possible be retained and set in order. Ornate lead rainwater-heads are often a particularly beautiful feature, but are heavy and do need frequent attention, especially to their fixings. Damaged and dented pipes can be removed and re-dressed, and punctures and similar damage repaired by lead burning.

With cast-iron rainwater furniture, the chief enemy is rust, due to inadequate painting. Downpipes especially are often found to have been set so closely

against walls that proper, regular repainting is quite impossible. They should always be refixed well clear of the wall by means of projecting lugs or "holderbats." Repainting with bituminous and similar paints offers an added protection.

Where renewals are needed, the question of future maintenance is important. Asbestos-cement is sometimes a useful substitute in positions where regular maintenance is impossible, provided there is no real risk of mechanical damage, for example by ladders. There is no need to paint the material—indeed, the habit of painting downpipes of all kinds in contrasting colours is more often objectionable than pleasing: except where they are a special feature, it is much better to use colours which will be "lost" against the wall. Continental practice often employs light-gauge galvanized iron, replaced at frequent intervals: but there is always a danger that perishable materials may not be renewed until damage has been caused. All rainwater pipes of any material should always be fitted so as to allow sufficient "slack" in the collars for expansion movements, and to permit the replacement of individual pipes when any are damaged.

Rainwater butts are a great nuisance, and a source of endless trouble. Where for some reason the soft-water storage they provide is specially required, they should still be seen as an intermediate reservoir *en route* for a proper soakaway, towards which a proper overflow and branch drain are provided.

Repairs to underground rainwater drains should be carried out in socketed pipes so as to maintain their alignment; and care must be taken to run them well clear of ground liable to excavation and settlements. The classical example is in the churchyard, where a position under the path is safest from disturbance.

Glass in old buildings

Early window glass was mostly thin, opaque and bubbly, and available only in small pieces, which had to be leaded together into larger sheets by means of thin lead "cames." Later crown glass, the most beautiful of all, was made by blowing and spinning a flat disc of glass. Squares were then cut from this for window glazing, the central part being discarded or relegated for use in outbuildings. The idea of employing this central "bullion" of the glass in prominent positions is purely a Victorian affectation. The concentric circles and twinkling curves of crown glass give a wonderful "life" and movement to a facade, which cannot easily be appreciated from photographs: it is the movement of the reflected pictures which lend the glass its unique attraction. New crown glass is at present unobtainable, but a very close imitation can be supplied by the manufacturers to special order, when the extent of the order permits.

Modern rolled sheet glass, by contrast, has irregular imperfections of no interest, and by contrast somehow just looks mean. Polished plate glass, especially in 19th century glazing, often owes much of its richness to bevelling of the edges, which should be carefully reproduced in any repairs. The etched glass of many a Victorian bar is already increasingly a rarity, and good examples may be a valuable as well as an attractive feature. All old glass indeed is valuable, and merits the most careful protection from damage during building work of any kind. The richest of all is of course the stained-glass window, which as well as being ancient may very well be an important work of art.

Stained glass is an extremely vulnerable as well as a beautiful material. Its enemies range from polluted atmosphere to small boys. Once a stained-glass window has been removed from its position, the materials are a sorry-looking heap, and their value may not be realized. In stained-glass as in any other art, substitution is by no means the same thing as repair. Instances have occurred, especially in Victorian times, of an astonishing lack of appreciation of this fact, modern coloured glass being inserted indiscriminately in the design, or even complete copies substituted for old windows. Since copies of damaged glass can only be a pale echo of the originals, it is essential for proper repairs to be carried out in good time.

In the case of really valuable glass, the first step is to photograph the window in position, and if possible in colour. This record is invaluable for reference in the subsequent work of restoration. The window is next removed and transported with the greatest possible care to the workshops, where further photographs may be taken, and a rubbing is made of the leadwork pattern.

The glass can then be dismantled. Some pieces may be found to be seriously eroded, but the effect of different atmospheres upon the same glass is markedly different, and impossible to predict. If the erosion is not too serious, the surface may be bleached clear, or cleaned with acids or caustics, and repolished with wire wool or abrasives. Since much ancient glass will be found damaged or misrepaired, it may well be desired to re-plan the layout and restore the original pattern of the window, making every effort to re-use all original glass to the best advantage. It may be necessary to fill in the gaps of the resulting jig-saw with small areas of new glass. These must be unostentatious and carefully matched, and any new artist's work which is unavoidable may be dated for identification. Old glass should be cut about as little as possible. Where a crack or break has occurred through an important detail such as a head, a join may be made by carefully nibbling away one edge and inserting a thin line of lead; or the damaged pieces may be sandwiched between two pieces of clear glass. In one recent stained-glass restoration, these were specially cast by the glazing contractors to match the irregularity of the ancient fragments, so as to avoid condensation spaces and uneven support. Similar plating may be necessary with coloured glass, to correct the tone of corroded original glazing which has been lightened by thinning.

The lead "cames" are meanwhile recast and rolled to the desired "H" section, with milled inner surfaces, and cut and bent to fit the joints of the window. The joints are soldered on both sides, and copper tags added where support for the heavy glass can be obtained from saddle-bars. The window is finally

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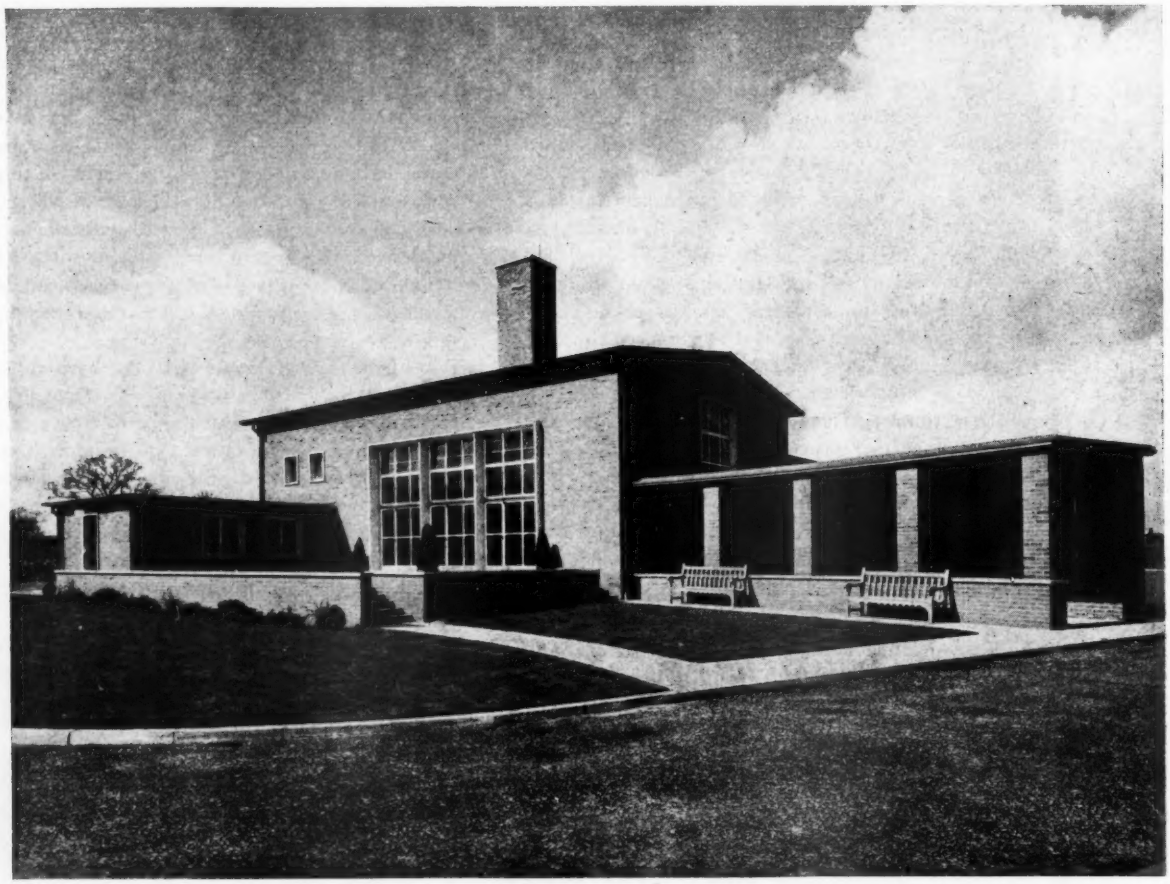

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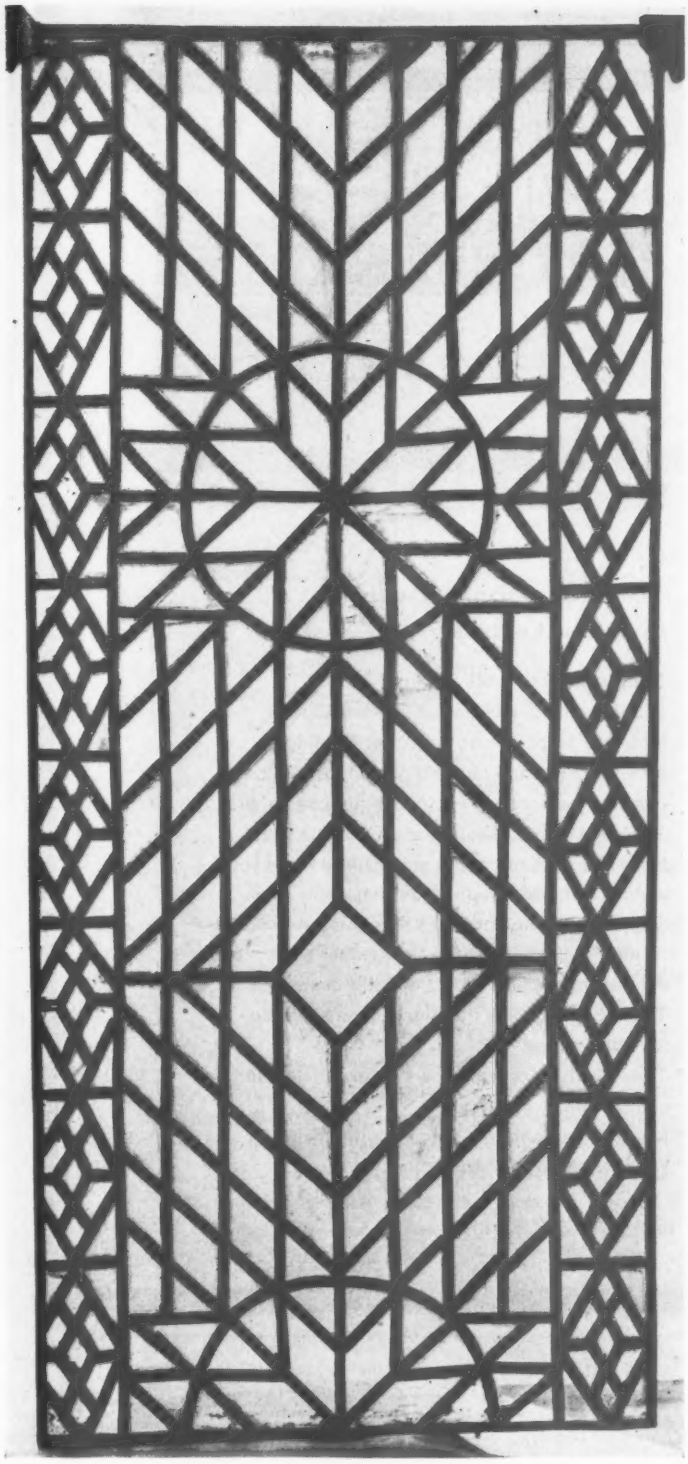

One of the seven Commonwealth windows in Halifax Parish Church which has recently been restored. Note the careful manner in which the window's inherent irregularities have been preserved. (Gordon G. Pace, architect.)

made weatherproof by brushing in a cement consisting of linseed oil, red lead and whiting. Both sides are carefully cleaned down, and the window is ready for re-fixing.

Original "ferramenta" should whenever possible be retained, but in many cases, old ironwork will be found to have rusted and split the mullions. Saddle-bars may then be "tipped" with a non-ferrous metal such as delta-metal: they are usually allowed $\frac{1}{4}$ in. to $\frac{1}{2}$ in. bearing at each end. It is never desirable to run iron saddle-bars continuously through a mullion; and vertical bars should stop short of the sill to avoid standing water and consequent trouble from rusting. Where saddle-bars would interrupt a delicate design, special ones may be made and bent to follow a main line of the pattern.

The repaired glass is at last painstakingly refixed in the window. After each section has been accurately centred with wooden wedges, the whole is fixed and pointed into place.

If it is at all possible to make arrangements for the regular, careful inspection and washing of the reinstated window in future, so reducing further repair and maintenance to a minimum, this is the time to do it. When the work has been well done, the effort of restoration will be found well worth while, as the original colours and design of the window can be seen to glow again from their traceried frame.

Maintaining church bells

A special problem in the care of churches is the repair of damage caused or aggravated by the ringing of bells.

Bells are heavy pieces of mechanism, and when rung on the "English" pattern are swung in complete circles, so that the stresses set up are by no means negligible. In a sound and rigid frame, the swinging of a bell will set up a maximum vertical force of about four times and a horizontal force of some twice the weight of bell metal. The vertical load is of relatively little consequence, but its horizontal counterpart can be very significant. Should the bell-frame be in any way springy, or touching the walls of the tower, extra swaying and hammering forces are also set up. Further trouble may be caused when the rhythmic swing of heavy bells coincides by mischance with the natural "period" of a slightly swaying tower, like that of soldiers crossing a bridge. The movements of the upper levels of a tower while the bell-metal is hurling in its circles are sometimes quite spectacular, and cannot be ignored.

Reductions in the structural forces set up by bell-ringing can be secured either by altering the position of the frame, or by re-setting individual bells. In general, the sideways forces set up by the bells will vary with the cube of their height above the floor. Very substantial reductions can therefore be obtained by lowering the position of the bell-frame. From a ringing point of view, the rim of the upturned bell in its striking position is best kept approximately level with the belfry window sills.

The heaviest bells may also be arranged to swing in

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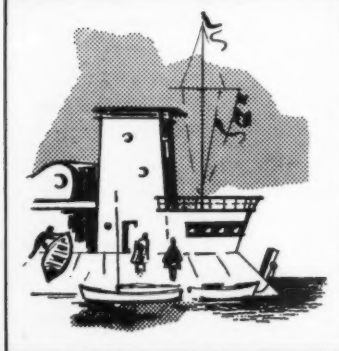

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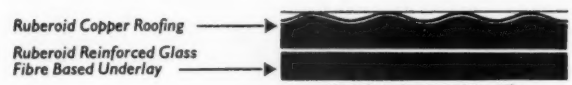
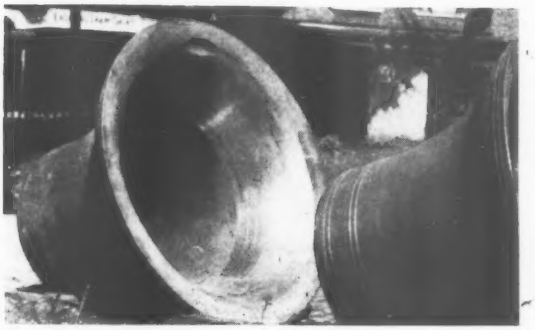


(An enlarged cross section of the Ruberoid Copper Roof)

Ruberoid Copper Roofing consists of 42 SWG copper (·004") with an indented surface, laminated with glass fibre based bitumen sheeting. It is employed always with Ruberoid Reinforced Glass Fibre Based Underlay to which it is bonded with bitumen compound.
Technical literature available on request.

such a way as to cancel one another's movements and on the stronger axis of the tower. This is usually from east to west, along the line of the unperforated north and south walls. Bell cages are also best set on main beams at right angles to the swing of the heaviest bells;



Bells must be periodically quarter-turned to avoid uneven wear on the rim. The dent in this one was caused by too long a disregard of this, during some period in the past.

and the head of the frame should always be kept clear of the wall. Very occasionally, too, the heaviest bells can be tamed by "tucking them up." This entails raising them in their mountings so as to reduce the radius of their rotation: but as the practice makes for sluggish ringing, it is not popular with campanologists. Adequate access is essential to any belfry whose bells are to be used. The bell-frame should be of the stoutest construction, and of metal. Wooden frames need frequent inspection, to ensure that bolts and joints are tight and secure. Steel frames must be repainted periodically with a suitable rust-inhibiting paint. In all cases, the whole unit must be very securely and firmly fixed as a solid and integral part of the tower.

The bell-mountings and pivots equally require checking at frequent intervals and of course like any piece of moving machinery, they need adequate oiling. The bells themselves are subjected to heavy local wear by the beating of the clappers, and must therefore be periodically "quarter-turned" to spread this evenly around the rim. The replacement of an ancient bell which has become damaged or cracked is always a ticklish problem: if it is decided to unhang the bell, it may often remain as an interesting display feature in the body of the church.

It is sometimes a heavy responsibility for the architect to decide whether or not structural harm is being caused by ringing. Careful observation during and after trial, with periodical inspection and marking of structural movements by means of tell-tales, should however enable a firm decision to be taken. Where it is not possible to allow full-scale ringing, it may be necessary to restrict the use of the bells to chiming only, which can cause little harm to all but the most delicate and precarious of structures.

Fire precautions and lightning conductors

An important aspect of the care of buildings is lastly proper protection against fire. Adequate fire-fighting equipment must always be installed, and properly maintained in good condition. In general, the lighter and more portable hoses and extinguishers are the more likely to be useful in those urgent, early minutes of a fire when a building can quickly be saved or lost.

Chemical extinguishers are excellent; and the local Fire Officer is always glad to advise on their provision and positioning. Frequent checking and replacement is however an important item of maintenance, easily forgotten at future peril. If a property is not easily accessible to the fire brigade, or lacks a telephone or other means of warning, provision must be made for heavier fire equipment such as water tanks, hoses and pumps.

It has not infrequently been found, after a serious fire in an old building, that more damage was caused by the firemen's hoses than by fire. Superheated stonework may be quite sound and capable of re-use until played upon by cold water, which turns to steam with explosive force. If a burning building is throughout quite definitely well beyond saving on the arrival of the brigade, and is jeopardizing no one else, it may be possible by exercising the greatest possible self-control to save the whole of the external walls—thus making extensive savings in rebuilding costs! Rose-tinted stonework is not necessarily harmed in any way, as many a wartime relic today will testify. It is also necessary to take special precautions to dry out the structure after firemen's hoses have been at work: or dry rot may easily occur as soon as the moisture content is reduced to a suitable level. One fire is sufficient without a second insurance claim.

A frequent cause of fire and sometimes of serious structural damage is lightning. Any building on high ground or in an exposed position must have a proper lightning conductor. A building standing in country opened up by the felling of trees may be particularly vulnerable. The lightning conductor is generally of copper tape, with riveted joints; and all bends must be of easy radius. It must of course be kept clear of thatch and other combustible materials, and is designed to link metal sheets and similar temptations into a continuous chain, terminating in an earth connection set well away from the building. The earthing rod, although unseen, is the most important link in the defence of the building, and must be carefully tested whenever the installation is checked.

Conclusion

In the repair and conservation of old buildings, the greatest need is for that "daily care" called for by William Morris, who founded the SPAB eighty years ago.

If an adequate force of architects and craftsmen can be kept at hand, trained and experienced in the traditional techniques and specialist problems of ageing structure, there is no doubt that the cost to the nation of saving and repairing old buildings can be kept to a fraction of what it might otherwise be. The greatest enemy is neglect: the most potent ally, informed maintenance. The JOURNAL *hopes that this brief summary of some repair techniques available to the architect may contribute to solving a problem which becomes daily more specialized and more important.*

ROEHAMPTON PRE-VISITED

If you drive across Richmond Park towards the towering slabs and point blocks of the LCC's Roehampton estate, you will feel that this is what the approach to a city ought to be like—open country leading to rolling parkland punctuated by buildings. Although the landscaping here is not yet complete, enough has been done to give a good idea of what the scheme will look like, with its mature trees, its large areas of grass, its visual surprises, its flag-bedecked marquee. . . . But, no, the marquee was a temporary affair, set up last week by Wates Ltd., who took the Press in a fleet of cars to admire the scheme amid drinks and handouts. Wates were doubtless delighted at getting their part of the contract finished ahead of time, but it is a pity that they—and not the LCC—were responsible for this Press outing. A lot of emphasis was given to the builders' efficient organization and not nearly enough was said about the architectural side of the best piece of local authority housing in the country. Although there was a good turnout of clerks of works, many of the architects concerned were missing. This, apparently, was the result of some bureaucratic activity by the LCC Clerks Department.

*

ASTRAGAL, who attended the Press gathering, got tired of being told nothing very much by the appointed guides—a team of public relations officers from a publicity firm—and wandered away to inspect the scheme by himself. Some of the things he found were disappointing. What could be more disenchanting than the approaches to the slab blocks of maisonettes? The entrances to the blocks are hardly distinguishable from the tenants' stores adjoining them; the access balconies are sordid bleak places, and there isn't any relief from the spartan *matières brutes* once you get inside the maisonettes. It would need courageous treatment to turn them into homes.

*

One other grumble. Did somebody think that all that varnished softwood might be æsthetically exciting, with its exposure of honest grain patterns? It probably seemed all right on the drawing board, but on the site it has become a tribute to low standards of timber and workmanship. If there *is* any honesty here, it is merely the honesty of loose knots, shakes, ill-met mitres, treacly finish and shudder marks—some of which are echoed in ASTRAGAL's memory.

*

These are not faults that should be overlooked. But they are faults that are easy to forget when you look at the scheme as a whole and compare it with any other local authority work in this country.

BOSTON TEA-TABLE TALK

Not so far away from Roehampton as the crow flies (over Kew, the gasworks, the unpleasing decay of Brentford High Street and the neat gardens of the factories on the Great West Road) is a suburb called Boston Manor. Its inhabitants eat, drink, watch television and make love in a respectable suburbia that is not nearly Arcadia and not entirely subtopia. The most subtopian areas are the lovers' lanes. One of these is a dreary bit of Man-defiled back-garden-land overlooking the twinkling lights of tube-trains being put away for the night; the other is a God-defying canal walk which skirts the grounds of the old Boston manor house itself—a scrubby bit of waste land which invites suicidal thoughts rather than romantic ones, and yet is a gift to any imaginative planner.

*

How could all this be changed? The question has been answered in the magazine *Architecture and Building*. In the current issue we are shown what could be made of Boston Manor if the present housing was destroyed and replaced by the "urban renewal" we hear so much about nowadays. We are shown convincingly how the population of a dormitory suburb could be doubled in size and a better environment provided. The new "living suburb" would have a great shopping centre above those twinkling railway sidings; a vast car park would be sandwiched between the shops and the railway; cars and walkers would be segregated; offices would provide the employment now lacking, and dwellings would range from 30-storey tower blocks in open parkland to one-storey houses with patio gardens. The planners of this project (Chamberlin, Powell and Bon; Graeme Shankland and David Gregory Jones) say there is nothing visionary about the scheme. They claim it is the kind of suburb city dwellers would be living in today, if only their needs were considered worthy of the imagination and funds put into rocket research.

*

Until the RIBA's proposed Regional Planning Authority is put into practice, who would operate a Boston Manor project? One or two people would probably object to the destruction of 3,700 semi-dets. Still, it is a bold scheme and will, one hopes, spur those Councils that are looking for sites for new towns to turn their eyes towards the deserts of suburbia.

CONCRETE GALORE

A firm of architects ASTRAGAL knows recently did a job on the Isle of Wight which involved 10,000 yards of excavation and 2,200 tons of reinforced concrete. Competitive tenders were received within a week of instructions being received, and the cliff-top site (which was on a 30 deg. slope, 400 feet above sea level) was handed over within six months. Congratulations to John A. Strubbe and Partners who did this quick job with their engineering consultants.

What *is* the job? You won't ever find it illustrated and analysed in the JOURNAL'S pages, for it was the static rocket test site for the Black Knight space missile, and quite naturally nothing must be disclosed. We certainly don't want the Russians to find out how we light the blue paper or when we retire immediately.

WHAT, NO ARCHITECTS?

In his Third Programme talk, *What Kind of Art School?* Basil Taylor gave a prosy mulling over of recent ministerial pronouncements on art student training. His talk sounded like a plea for the *status quo*—including the retention of industrial design as part of the art-school curriculum. For a long time we have been kidding ourselves that progressive opinion—and Basil Taylor is certainly that—agreed with us and the Bauhaus tradition that industrial design had more to do with architecture than with the fine arts. But just look around you. Although the Central School was founded by Lethaby it has never had an architectural department, and the Royal College got rid of its architecture section when it put an architectural knight on its staff. Are architects happy about buildings being equipped with the work of students from schools bursting with action painting, stained glass and fashion design?

WHEN DID YOU LAST MAKE YOUR SISTER?

I don't know who watches the BBC Sunday night art films, which are produced by John Read, but if the man-in-the-street was looking in this week he will have had a nasty shock. There was Reg Butler, the man who caused all that fuss with his political prisoner in five-shillings'-worth of bent wire, working away in what looked like a Frankenstein-type blast furnace. Apart from showing a lot of people that his sculpture involves some hard work, Mr. Butler gave a sincere and easy-to-understand explanation of what he is trying to do with his figures. It was a little naive of him to say that " some of them seem to be almost completely misunderstood by the average person " —and he walked smack into a lot of forgivable ribaldry when he said, in effect, that as he didn't have any sisters he liked making imaginary ones. But a cheer must have gone up in many homes at the statement that " one of the most exciting things in the world is a girl, and my work is often a celebration of that fact."

*

This excellent film wasn't nearly long enough. It would have been nice to hear Mr. Butler talking about specific examples of his work, other than the political prisoner. But perhaps the film was just long enough for the average consumer to get the idea that this modern stuff isn't all tripe. At its very lowest level it will have intrigued the viewer with its pictures of the sculptor looking first like a flame-throwing space man and then like a passable imitation of Humphrey Bogart in that familiar peaked cap.

NO BRICKS AND TOO MANY TERMITES

So familiar is modern architecture in West Africa today, indeed so accustomed are we to seeing really first-class building in Ghana and Nigeria, that it came as a bit of a shock to ASTRAGAL, listening to Max Fry's radio talk on Sunday night, to realize that it is only 14 years since he and Jane Drew planned their first teacher training college at Amejofi. Since then, many architects have left their mark, and a complex building industry has grown up. All this should please Fry, for, modest as he is, he must realize that much of it is due to his pioneer efforts. Yet there was more than a little nostalgia in Fry's talk about those early days, when the problems were new, the solutions exciting, and Ghana merely a twinkle in Nkruma's eye. And then again, seldom can architects have been given such dramatic sites to build on as in those early days: Amejofi, Cape Coast, and the superb Aburi Ridge, with the late Tome Barton to guide, protect and encourage. No wonder Fry was a little sentimental to the bad old days.

FRENCH FINISH

It is always interesting to see how the other half (or halves) think, but it can also be rather disappointing. A new magazine devoted to *avant-garde* ideas among the countrymen of Aalto and the Sirens ought to produce some pretty new and high-pressure thoughts. But when ASTRAGAL unfolded the cardboard pages of the first issue of *Le Carré Bleu*, he found that the contents were as French as the title, and their connections with Finland were very hard to find.

*

Reading between the French lines, *Le Carré Bleu* is a northern outpost of the Parisian *Groupe Espace* connection, the abstract art movement which has branches everywhere except in England. The text makes great play with the idea of Internationalism —complaining, for instance, that there wasn't enough of it at Berlin's *Interbau* (most people complained that it was *too* international, and didn't pay enough attention to German conditions). It is interesting to see a new periodical of this sort phrased in French and orientated towards Paris, at a time when most seem to be phrased in American and orientated towards Rome. Perhaps there's life in little old Paris yet—in spite of loud announcements that it is no longer the art-capital of the western world.

ASTRAGAL

DIARY

Masterpieces of Byzantine Art. Exhibition at the Victoria and Albert Museum. Monday to Friday 10 a.m.-6 p.m., Sunday 2.30 p.m.-6 p.m. Admission 2s.
OCTOBER 1 TO NOVEMBER 9

Brixton School of Building Old Boys' Association. Dinner at the Windsor Castle Restaurant, Victoria. 6 p.m. Ticket 16s. 6d. each from the Secretary, L. Wilder, c/o Brixton School of Building, Ferndale Road, S.W.4. OCTOBER 3

The RIBA Form of Contract. Talk by Michael Chavasse. IQS meeting at Caxton Hall, S.W.1. 6.30 p.m. OCTOBER 3

Motorways, their landscaping, design and appearance. Rees Jeffreys Triennial Lecture by G. A. Jellicoe. At the ICI, 1, Great George Street, S.W.1. 5.30 p.m. OCTOBER 9

The Architectural Expression of Structural Concrete. Talk by W. A. Gibbon. At the RCA, 94, Petty France, S.W.1. 6 p.m.
OCTOBER 15

Architecture in Jamaica. Talk by David Oakley. At the AA, 34, Bedford Square, W.C.1. 6.15 p.m. OCTOBER 15

Architects' Christian Union. Informal reception at the RIBA, 66, Portland Place, W.1. Guest speaker: the Rt. Rev. Hugh R. Gough, Bishop of Barking. 6.30 p.m.
OCTOBER 16

Building Contracts Today. A course of six weekly lectures by Donald Keating, B.A. Organized by the Brixton School of Building in collaboration with the Building Centre. At the BC, 26, Store Street, W.C.1. 6 p.m. Fee for the course, £1. Applications to the Secretary, Brixton School of Building, Ferndale Road, S.W.4.
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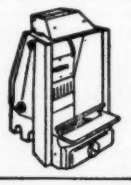

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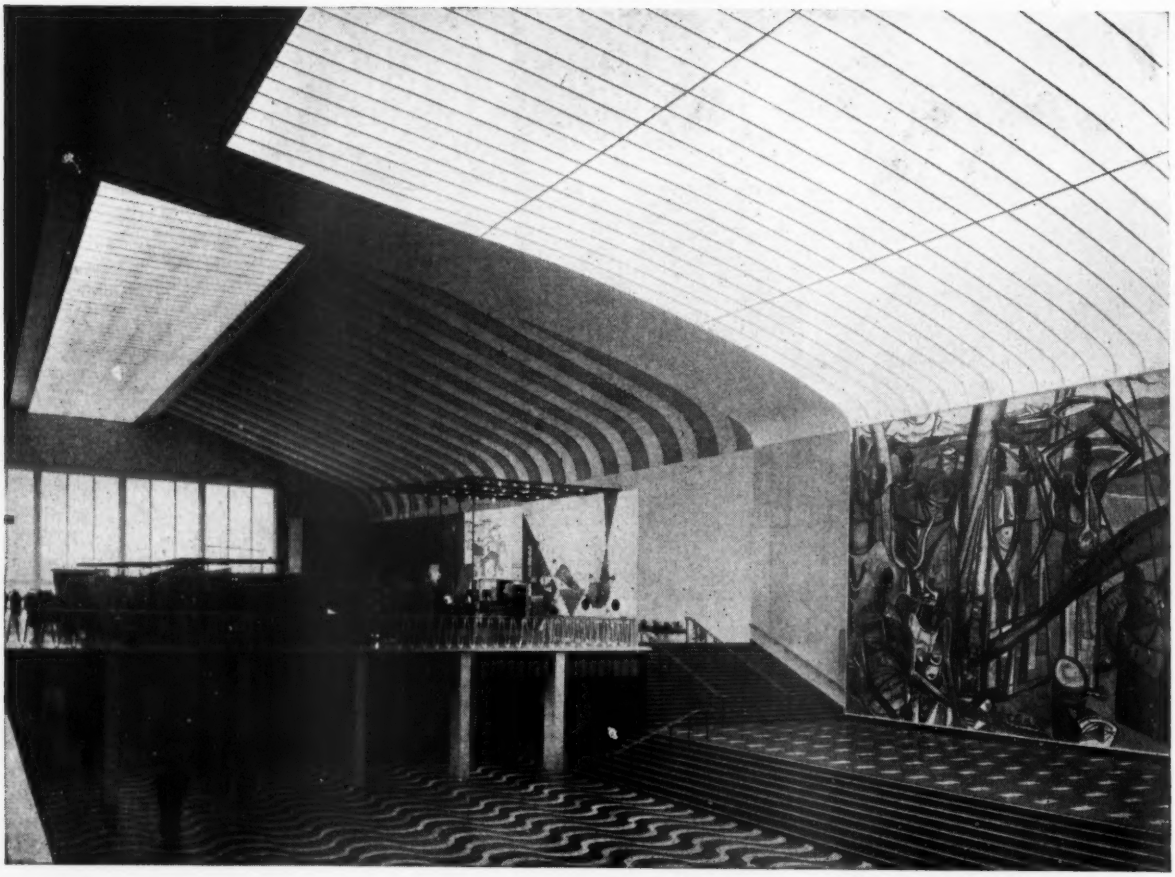
THE LCC's ROEHAMPTON HOUSING ESTATE

Below is an air view of part of the LCC's Roehampton Estate, showing the wide variety of housing types, but unfortunately giving little hint of the excellent landscaping; pictures of this will have to await next spring. Above left, some of the point blocks of flats rising amongst trees behind old people's houses. Above right, the maisonette slab blocks, with the boiler house roof and chimney in the foreground. (*See* ASTRAGAL'S *comments on page* 471).



Part of the Belgian Congo Pavilion which incorporates the largest single Lumenated Ceiling installation in Europe. Some idea of the scope of this installation can be obtained by comparing its size with that of the figures in the foreground.

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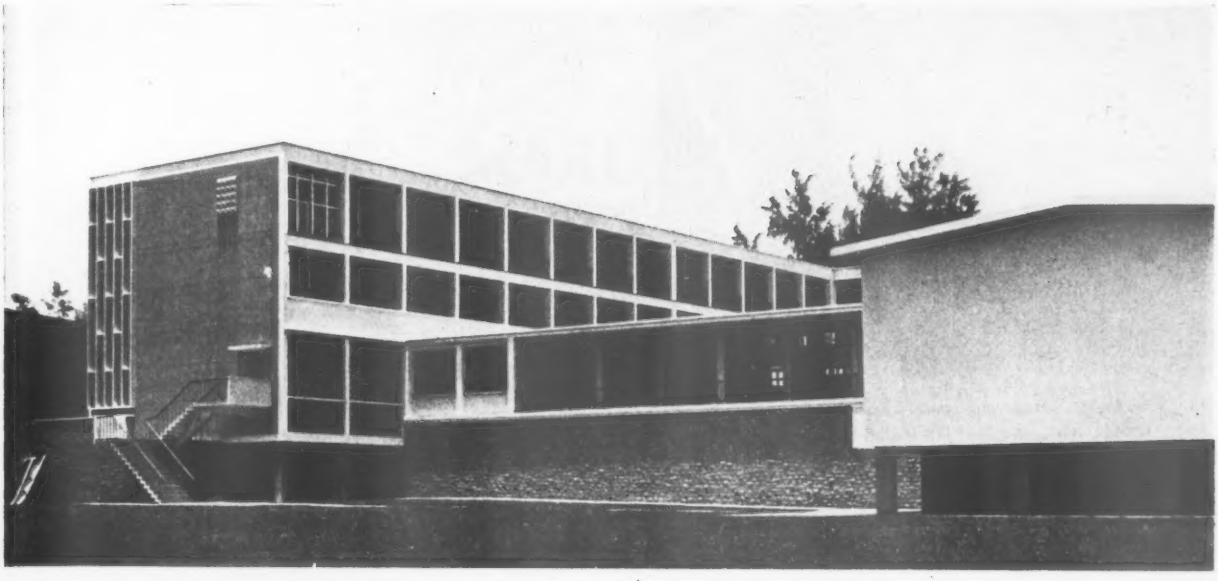
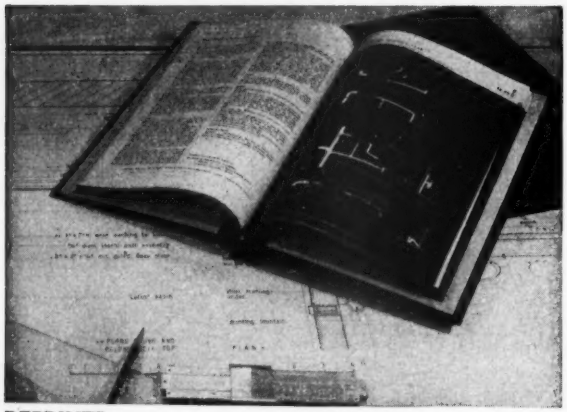


Owing to increasing educational demands in Hong Kong, the Grantham Teachers Training College, built in Kowloon in 1952 to accommodate 100 students, has recently been extended to cater for 320. Extensions comprise a lecture hall for 320, a library, five special classrooms for music, handwork, pottery, etc., 10 tutorial rooms, a staff room, lavatories and stores, and enlargements of dining hall and students' common room. The structure of the extension is framed reinforced concrete with brick panel walls and part stone facings in local granite. Screens are of precast hollow pots. The extension cost £46,875 and took 9 months to build. Designed by Hong Kong Architectural Office; architect in charge, F. G. Farrow; assistant, J. Lei.



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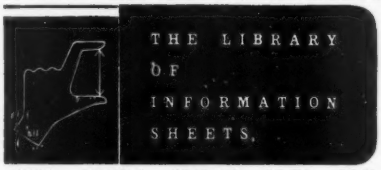
Ronald Leach, A.R.I.B.A., has closed his office at 163, Canterbury Road, Westgate, Kent, and opened a new office at 16, Harold Avenue, Westgate, where he will be pleased to receive trade catalogues. The telephone number will remain Thanet 31048.

G. L. Thompson, F.R.I.B.A., 22, Park Street, Selby, would like to receive trade catalogues, etc., at The Yorkshire Penny Bank Chambers, 46a, Coney Street, York, where he has opened a second office.

Correction

In our article on the Marlborough Children's Convalescent Hospital, published on September 11, it was stated that "Supercoust" plaster tile suspended ceilings were carried out by Clark & Fenn Ltd. The tiles used were in fact "Echostop" plaster acoustic tiles, manufactured and fixed by Clark & Fenn.



15.B1, 15.C1-4, 22.D1-6, 27.F1, 28.D1, 28.E10. *REFERENCE BACK*

Readers are asked to note that the manufacturer's address is now Bowater House, Knightsbridge, London, S.W.1. Telephone: Knightsbridge 7070.

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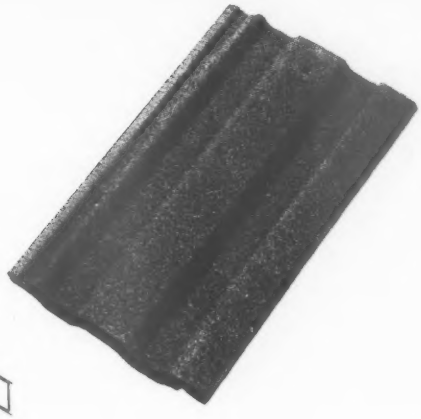

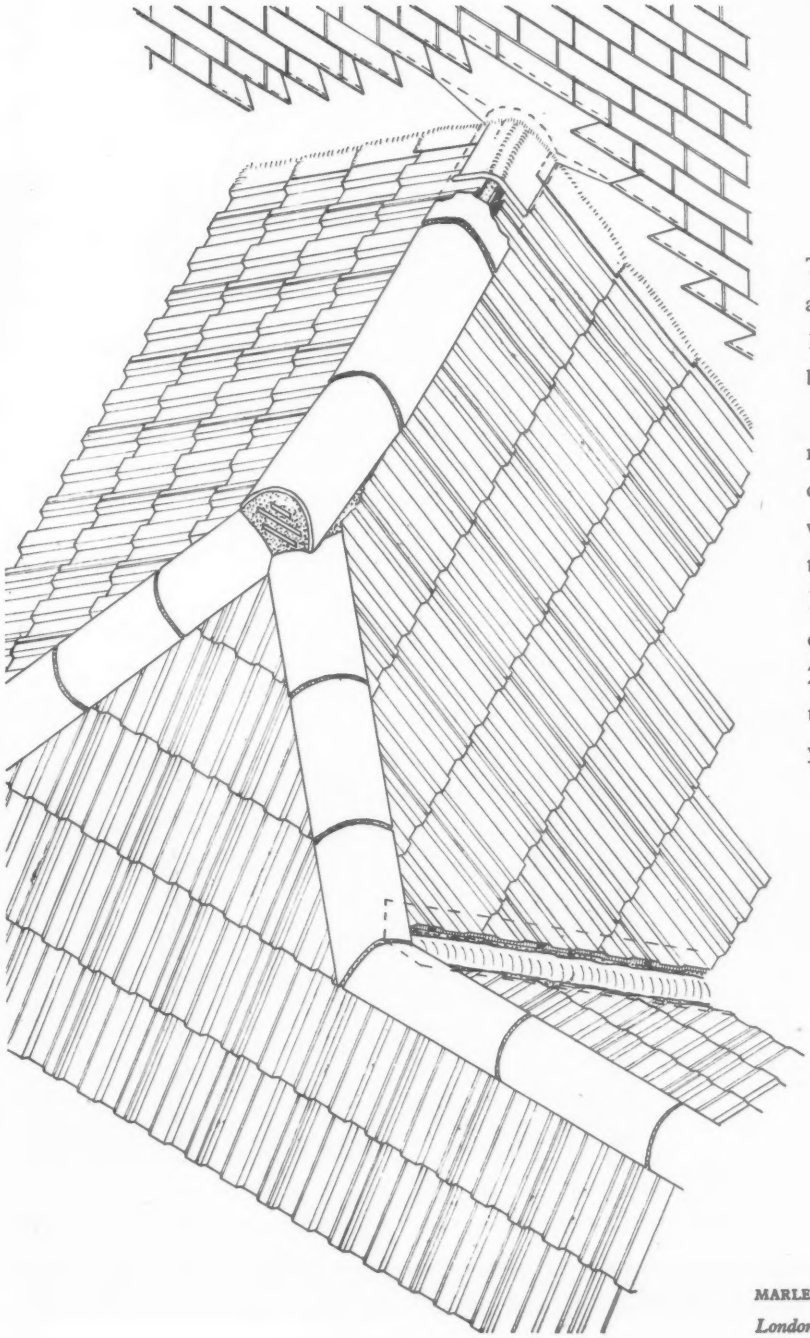

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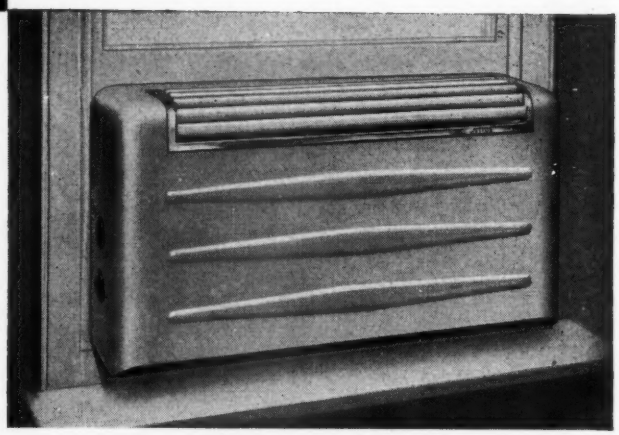

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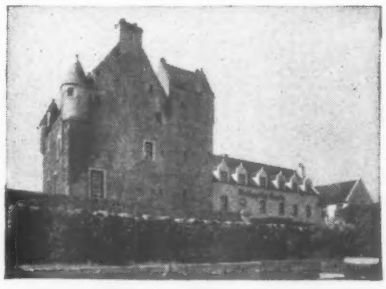

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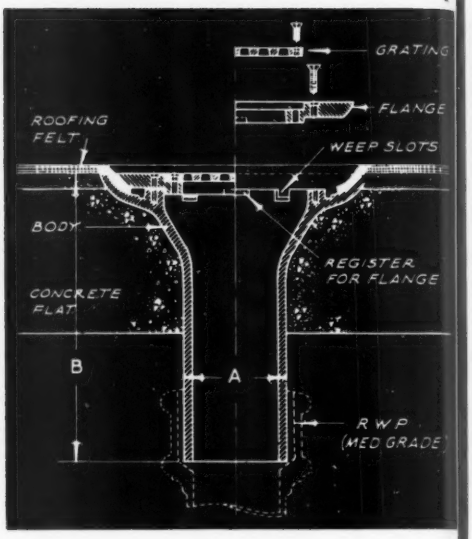

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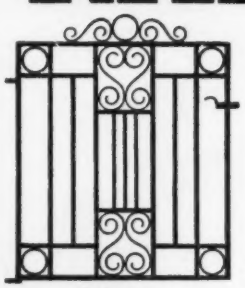

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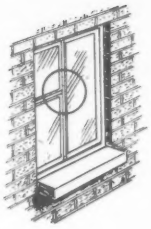
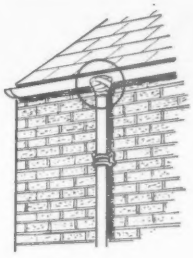


SO MANY USES FOR
SYLGLAS
GLAZING & SEALING TAPE
A PRODUCT OF OVER 30 YEARS' EXPERIENCE IN WATERPROOFING—SOLVES A HUNDRED-AND-ONE PROBLEMS



WEATHERPROOFS *window-frames, joints in corrugated roofs, garages, outhouses.*
REPAIRS *drainpipes and guttering — can be painted without difficulty.*
GLAZES *greenhouses and conservatories — eliminates the need for painting glazing bars.*

Available as tape — in a variety of widths — or as cord, SYLGLAS is extremely flexible, adheres to any dry surface and will not become loose even if subjected to continued vibration by machinery. It is the simple, speedy and economical answer to your glazing and sealing problems. And remember, SYLGLAS makes a *permanent* job — it is *not* a temporary repair.

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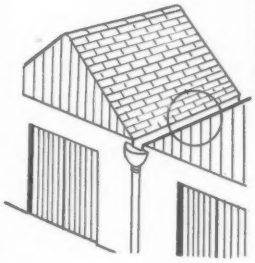

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1 lb. tins 2/9, 4 lb. tins 9/-, 7 lb. tins 15/2, 28 lb. drums £2.16.0.

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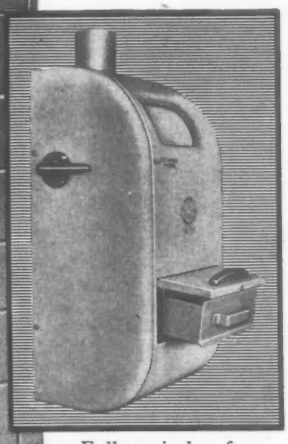
The flush mounting Bunnie Incinerator has all the features that have made the surface model so popular and is ideal for new buildings under construction.



- Hygienic
- No smell—patent fan device removes fumes and odours
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- Big capacity
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- Long life
- No maintenance of working parts
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Full particulars from

Wandsworth

THE WANDSWORTH ELECTRICAL MANUFACTURING CO. LTD. (Dept. A.J.1)
Albert Drive, Sheerwater, Woking, Surrey. Tel: Woking 3506

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ROOF & WALL FIXING & SEALING WASHERS by DOWTY

Patents Pending

A successful replacement for all shapes of lead, steel and bitumen washers • Will fit hook bolts, seam bolts or drive screws • Impervious to weather and forms a watertight seal on all flat, convex and concave surfaces • Will not damage protective surfaces and are ideal on aluminium, steel or asbestos • The erector needs only one washer which is light in weight and needs no alignment • Their resilience prevents fasteners working loose and protects roofing from the pressures of sudden wind • Neat and pleasing in appearance after assembly.

Illustrated literature and price lists available on request

DOWTY SEALS LTD · ASHCHURCH · GLOS.

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Obtainable from The British Screw Co., Ltd., 153, Kirkstall Road, Leeds 4.

Beauty and durability combined

All the old-world charm of the English countryside is embodied in the picturesquely rustic appearance of a Broughton Moor Westmorland Green Slate roof. Rugged texture allied to harmonious shades of coloration—Light Sea Green, Olive Green and Mixed Shades—and great durability make them the ideal architects' slate for every type of edifice. Immediate delivery.

BROUGHTON MOOR
Light Sea Green
and
Olive Green Stone

is eminently suitable for interior or exterior use where great durability and unique appearance are of paramount importance. Architects may specify its use for Facings, Foundation Stones, Paving and Flooring, Steps, Cills, Shop Fronts, Surrounds, Pilasters, Fireplaces, etc. Ask for these Technical Pamphlets:

1. Floorings
2. Facings
3. Coping
4. Cills
5 Riven Face Slabs.

SPECIFICATION.—The roof to be covered with Broughton Moor Light Sea Green Best Quality (coarse grained) Westmorland Slates, to be obtained from the Broughton Moor Green Slate Quarries Ltd., Coniston, The Lake District, Lancs., in random sizes about 18" to 9" long, proportionate and random widths, laid to a 3" lap in regularly diminishing courses from eaves to riged. Each slate to be securely fixed by two stout copper nails and wide slates are to be used on the hips and verges.

Alternatives: Seconds, Thirds, Special Peggies; Olive Green and Mixed Shades.
Ridging: "Bromoor" purpose-made of crushed and moulded slate from the same veins is recommended.

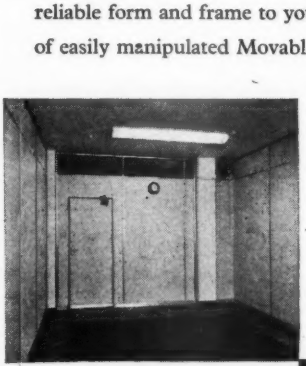
Technical information, samples and prices on request.

BROUGHTON MOOR
GREEN SLATE QUARRIES Ltd.
CONISTON, THE LAKE DISTRICT
LANCASHIRE

Telephone: Coniston 225/6

wondering what to do with all that beautiful SPACE?

We withdraw from any competition with the architect regarding the structural needs of any area of emptiness. May we suggest, however, that we *can* offer you reliable form and frame to your imagination in the shape of easily manipulated Movable Walls.



THEIR SURFACES?
The unique advantage of an Intercon wall lies in the core, which can accommodate any type of surface in any known finish. Our own range is very wide, and includes natural or stove enamelled hardboard, polyvynilchloride, laminated plastics, melamine and real wood veneers.

HEIGHT?
The distance between floor and where you put the ceiling is immaterial. Height is unlimited.

SOUND?
Rubber seals at Wall and Ceiling to improve sound reduction, which is already good, and to take up plastering discrepancies.

INSULATION?
Where thermal insulation is required there is a cork core or where protection against X-rays is desired a lead sheet core.

WIRING?
Electrical wiring may be run within partitions through the tubular chipboard core.

GLAZING?
Any type of glass, single or double, neatly housed in rubber.

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If you wish any further details or information, please write for our brochure or 'phone to:—

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CLASSIFIED ADVERTISEMENTS

Advertisements should be addressed to the Advt. Manager, "The Architects' Journal," 9, 11 and 13, Queen Anne's Gate, Westminster, S.W.1, and should reach there by first post on Friday morning for inclusion in the following Thursday's paper.

Replies to Box Numbers should be addressed care of "The Architects' Journal," at the address given above.

AIR-MAIL SERVICE available on request:
In response to requests from a number of Overseas subscribers for air-mail delivery of Public and Official Appointment details and Other Appointments Vacant, we have been pleased to arrange that cuttings of all such classified advertisements appearing in the A.J., shall be despatched by air-mail on Wednesday of each week (one day prior to A.J. publication date). The cost of this special service to Overseas subscribers will be 5s. for four weeks (1s. 3d. for each additional week) and prepayment should be sent by readers wishing to take advantage of this service. The charge we are making represents only the actual cost of the postage involved.

Public and Official Announcements

30s. per inch; each additional line, 2s. 6d.

LONDON COUNTY COUNCIL
ARCHITECT'S DEPARTMENT

Vacancies for: (1) ARCHITECTS, Grade III, starting salary up to £1,090 a year. (2) ARCHITECTURAL ASSISTANTS, starting salary up to £860.

Full and interesting programme of houses, flats, schools and general buildings.

Application form and full particulars from Hubert Bennett, F.R.I.B.A., Architect to the Council, the County Hall, S.E.1, quoting ref. AR/EK/36/58. (1428) 1074

BOROUGH OF SOLIHULL
BOROUGH ENGINEER & SURVEYOR'S DEPARTMENT
ARCHITECTS

(*a*) SENIOR ASSISTANT ARCHITECT, Grade A.P.T. IV (£1,025 × £50—£1,175).
(*b*) ASSISTANT ARCHITECT, Special Grade (£750 × £40—£1,030).

Applicants for appointment (*a*) should be fully qualified and have had adequate experience. Applicants for appointment (*b*) should have passed parts 1 and 2 of the R.I.B.A. Final or Special Final examination or the equivalent at one of the recognised schools of architecture, and have had at least five years' experience including period spent on theoretical training.

Commencing salary according to experience. Usual local government conditions. In appropriate cases housing accommodation will be made available as soon as possible and half removal expenses paid.

Applications with names of two referees to the Borough Engineer and Surveyor, 90, Station Road, Solihull, Warwickshire, by Friday, October 3rd, 1958.

W. MAURICE MELL,
Town Clerk.
1456

METROPOLITAN BOROUGH OF BATTERSEA

Applications are invited for the following appointments to the permanent staff:—

(*a*) ASSISTANT BUILDING SURVEYOR, A.P.T. Grade III, £845—£1,025 per annum.
(*b*) ASSISTANT ARCHITECT, A.P.T. Grade III, £845—£1,025 per annum.
(*c*) ASSISTANT BUILDING SURVEYOR, A.P.T. Grade II, £725—£845 per annum.
(*d*) ARCHITECTURAL ASSISTANT, A.P.T. Grade I, £575 to £725 per annum.

London weighting (£30 per annum at age 26 and over) is payable in addition for each appointment.

For appointments (*a*) and (*c*) preference will be given to probationers and Associate Members of the Royal Institution of Chartered Surveyors (Building Sub-division). The successful applicants for (*a*) will be engaged upon the conversion and improvement of house property and (*c*) the maintenance of the Council's establishments

For appointment (*b*) applicants should be Associates of the R.I.B.A. and have had several years' office experience. The successful applicant will be engaged on a large programme of new construction and development. The work of the department includes public buildings and multi-storey flats.

Previous Local Government experience is not essential. The commencing salary in each case will be according to professional qualifications held and to experience.

The appointments are subject to the Local Government Superannuation Acts, 1937-53.

Further particulars and application forms obtainable from the Borough Engineer and Surveyor, Town Hall, S.W.11, closing date 10th October, 1958. 1507

TEMPORARY PLANNING ASSISTANT (£560 to £880 according to age and experience) required in City Planning Office (Civic Design Section) of Corporation of London. Candidates should have a sensitive and contemporary approach to design and an architectural background—duties include assistance with redevelopment proposals for Barbican and other needs in the City of London and work of a general nature.

Local authority experience not essential. Applications with full details and copies of two recent references to City Planning Officer, Guildhall, E.C.2, within 14 days. 1529

CITY OF STOKE-ON-TRENT
CITY ARCHITECT'S DEPARTMENT

Applications are invited for the following vacancies:—

(*a*) ASSISTANT ARCHITECT, Special Grade (£750—£1,030).
(*b*) ARCHITECTURAL ASSISTANT, A.P.T. Grade I (£575—£725).
(*c*) ASSISTANT QUANTITY SURVEYORS (2), A.P.T. Grade III (£845—£1,025).

Applications, stating date of birth, particulars of education, details of training and experience and enclosing copies of two recent testimonials should be forwarded to J. R. Piggott, T.D., F.R.I.B.A., City Architect, Kingsway, Stoke-on-Trent, by Wednesday, 8th October, 1958.

HARRY TAYLOR,
Town Clerk.
1490

CITY OF LEICESTER
EDUCATION COMMITTEE
LEICESTER COLLEGE OF ART

Applications are invited from Architects with special interest in Design for a post of Studio Master in the School of Architecture, to commence as soon as possible. Teaching experience is not essential. The post is full-time but private practice is allowed as far as responsibilities and teaching duties permit. Salary—Burnham Scale, Grade B (£650 × £25—£1,025 per annum, with appropriate increments for experience and training).

Applications (no forms) stating age, training, qualifications, and experience, together with names of two referees and copies of two recent testimonials, should be sent to the Registrar, College of Art, Leicester, by 6th October. 1489

BOROUGH OF HARROW

Applications are invited for the undermentioned appointment in the Department of the Borough Engineer & Surveyor:—

ARCHITECTURAL ASSISTANT, A.P.T. Grade II (£725 to £845 per annum, plus London weighting).

Candidates should have passed the Intermediate examination of the Royal Institute of British Architects.

The appointment will be subject to the provisions of the Local Government Superannuation Acts; the passing of a medical examination and to the National Joint Council's Scheme of Conditions of Service.

The Council is unable to provide housing accommodation for the successful candidates.

Canvassing will disqualify.

Forms of application are obtainable from me, to whom they should be returned not than than Saturday, 4th October, 1958.

D. H. PRITCHARD,
Town Clerk.

Town Clerk's Office,
Harrow Weald Lodge,
Harrow, Middx. 1488

LANCASHIRE COUNTY COUNCIL

Applications are invited for the following appointments at MANCHESTER.

(1) SECTIONAL PLANNING OFFICER, salary within Special Scale/A.P.T. Grade IV (£750—£1,175 per annum).

Candidates should possess a recognised qualification in architecture, civil engineering, surveying and/or planning. A thorough knowledge of Town and Country Planning legislation is essential and experience in Town Map preparation would be an advantage.

(2) PLANNING ASSISTANT.

Applicants should be studying for, or possess a qualification in planning, architecture, civil engineering or surveying and appropriate experience is desirable.

Salary rising to £1,030 per annum (N.J.C. Special Scale) for qualified applicants. Candidates not yet fully qualified will be appointed on the appropriate grade and subject to satisfactory service will progress to the Special Scale on obtaining the final qualification.

Applications stating appointment applied for giving age, qualifications, present appointment, experience, etc., and two referees to the County Planning Officer, East Cliff County Offices, Preston, by October 1, 1958. 1486

COUNTY OF EAST SUFFOLK
COUNTY ARCHITECT

The appointment of County Architect will fall vacant in April, 1959, and the County Council invite applications for the post which carries a salary of £2,445 × £105 (2) × £60 (1)—£2,715 per annum, plus travelling and subsistence allowances according to scale.

Applications from members of the Royal Institute of British Architects who have had wide architectural experience with a local authority and who must possess administrative ability, must be received by 20th October, 1958.

Full particulars from G. C. Lightfoot, Clerk of the County Council, County Hall, Ipswich. 1510

PADDINGTON BOROUGH COUNCIL
ASSISTANT ARCHITECT (£780 to £1,060)

Starting salary according to qualifications and experience of the successful candidate who should preferably be A.R.I.B.A., with experience in the design and supervision of building works of some magnitude and a knowledge of local authority requirements. Applications should state age, qualifications, present and past appointments with dates, names and addresses of three referees. Applications should reach me by 4th October, 1958 (quoting A.387).

W. H. BENTLEY,
Town Clerk.

Town Hall,
Paddington, W.2. 1509

CITY OF BIRMINGHAM EDUCATION COMMITTEE
COLLEGE OF ART AND CRAFTS
Principal: MEREDITH W. HAWES, *A.R.C.A. A.R.W.S., N.R.D.*

A full-time SENIOR LECTURER in INTERIOR DESIGN is required in the School of Industrial Design of the College, to train students up to the Ministry of Education's National Diploma in Design. Experience as a practising designer essential. Teaching experience would be an advantage.

To commence duty as soon as possible, but in any case not later than 1st January, 1959.

Salary in accordance with Burnham (Further Education) Scale of Salaries for Senior Lecturers: Men: £1,350 × £50—£1,550; Women: £1,080 × £40—£1,240 plus equal pay increments.

Further particulars and application forms may be obtained from the Principal, College of Art and Crafts, Margaret Street, Birmingham, 3 (s.a.e.).

Closing date: 14th October, 1958.

E. L. RUSSELL,
Chief Education Officer.
September, 1958. 1487

LANCASHIRE COUNTY COUNCIL

PLANNING ASSISTANT required at BURY. Applicants should be studying for, or possess a qualification in planning, architecture, civil engineering or surveying and appropriate experience is desirable.

National Joint Council Conditions of Service. Salary rising to £1,030 (N.J.C. Special Scale) for qualified applicants.

Candidates not yet fully qualified will be appointed on the appropriate grade and subject to satisfactory service will progress to the Special Scale on obtaining the final qualification.

Applications giving age, qualifications, present appointment and two referees to the County Planning Officer, East Cliff County Offices, Preston, by October 1, 1958. 1485

TYRONE COUNTY EDUCATION COMMITTEE

Applications are invited for the following appointments in the office of the Chief Architect, Peter M. Bone, Dip. Arch. (Leics.), A.R.I.B.A.:—

(*a*) SECTION ARCHITECT. Salary up to £1,250 according to qualifications and experience.

Applicant should be capable of contemporary design of a high standard, and will be required to take complete charge of the design, working drawings and supervision of contracts. Possession of a car is essential and appropriate travelling expenses will be paid. Removal expenses may be granted to married applicants.

(*b*) TRACING & FILING CLERK. Salary up to £538 according to qualifications and experience.

Application on forms from Chief Education Officer, Education Offices, Omagh, should be lodged with him within two weeks of the appearance of this notice. 1484

BOROUGH OF WARWICK
BOROUGH ENGINEER'S AND SURVEYOR'S DEPARTMENT
APPOINTMENT OF CLERK OF WORKS

Applications are invited from persons who have had experience of supervising large scale Housing Contracts for the appointment of Clerk of Works.

Remuneration to be £780 per annum paid weekly.

Applications stating age, qualifications, experience and past appointments, together with names of two referees, to be submitted to the undersigned by Friday, 3rd October, 1958.

HECTOR SETON BROWN,
A.M.I.C.E., A.M.I.W.E.,
Borough Engineer and Surveyor.

23, Jury Street,
Warwick.
15th September, 1958. 1491

ARCHITECTURAL ASSISTANTS
REQUIRED BY
THE WAR DEPARTMENT

Two Architectural and Civil Engineering Assistants are required by the War Department (Eastern Command) for employment in HOUNSLOW on design and detailing work in connection with construction and maintenance of all types of Barrack Buildings.

Salary Scale: £550 (age 21) to £870 per annum.
Five-day week: 18 days' annual leave.
Starting salary according to age.
Prospects of promotion with salaries of £1,050 per annum and above.
Opportunities for permanent posts leading to pensions (non-contributory).
Qualifications:
(*a*) Ordinary National Certificate or equivalent.
(*b*) Satisfactorily completed a normal Apprenticeship or Pupilage, or had equivalent training of not less than 3 years' duration.
(*c*) Must have at least one year's experience in a Drawing Office.

Applications stating age, training and experience, to Chief Engineer, Headquarters, Eastern Command, Hounslow, Middlesex. 1506

BOROUGH OF EALING
PROPOSED ERECTION OF 12 FLATS FOR ELDERLY PEOPLE IN 2 BLOCKS AT ELM TREE ESTATE

Forms of Tender, Specification and Bills of Quantities obtainable from the Borough Surveyor, Town Hall, Ealing, W.5, upon payment of £5 returnable on receipt of a *bona fide* tender.

Tenders to be delivered to the Town Clerk, Town Hall, Ealing, W.5, not later than 9.30 a.m. on the 30th October, 1958.

E. J. COPE-BROWN,
Town Clerk.
1483

RENEWED ADVERTISEMENT
URBAN DISTRICT OF FELTHAM
ARCHITECTURAL ASSISTANT

Applications are invited for the appointment of an Architectural Assistant on the Council's unestablished staff at a salary within Grade A.P.T. III of the National Scales (£845—£1,025 per annum) plus London weighting. Applicants must be suitably qualified.

Forms of application, obtainable from the undersigned, must be returned accompanied by copies of two testimonials not later than 14th October, 1958. Canvassing directly or indirectly will disqualify and applicants must disclose, in writing, whether to their knowledge they are related to any member of or the holder of any senior office under the Council.

M. W. COUPE,
Clerk of the Council.

Council Offices,
Feltham, Middlesex. 1528

Applications are invited for the post of Officer-in-Charge of the Scottish National Buildings Record, Edinburgh. The work consists of preparing and compiling records, photographs, drawings, etc., relating to all types of Scottish architecture from medieval times to the present day.

Experience in the study, analysis and documentation of architectural history is essential. Knowledge of Scottish Historial Architecture would be an advantage. Salary £845 (linked to age 30) × £25—£880 × £30—£940 × £35—£1,002.

Further particulars of the post may be obtained from Establishment Officer (B), Ministry of Works, 122, George Street, Edinburgh, with whom applications together with details of previous experience should be lodged not later than 2nd October. 1506

THE UNITED NEWCASTLE UPON TYNE HOSPITALS
APPOINTMENT OF STAFF ARCHITECT

The Board of Governors has resolved to establish an architectural department and, in the first place, invites applications for the full-time appointment of STAFF ARCHITECT. The salary-scale will be £1,225 × £45 (5) to £1,450 per annum; the conditions of service will be as set out in Whitley Circular P.T.B. No. 66 and the post will be superannuable.

The man who is appointed will be required to devote the greater part of the initial period of his service to the preparation of a master-plan for the development of the Royal Victoria Infirmary in Newcastle but will also have the opportunity of carrying out a few small building schemes during this period. Upon the completion of the master-plan, he will be required to liaise with private architects and others in putting the plan into effect over a period of years and will himself be expected to carry out suitable parts of it with the help of a small architectural staff acting under his direction. A considerable development programme is envisaged within the next ten years.

Applicants for the appointment must be Registered Architects and Associate Members of the R.I.B.A. The possession of a wide and intimate knowledge and experience of the planning and construction of all types of hospital buildings is an essential qualification, as is also an ability to liaise with private architects and others to initiate a works organisation and to supervise technical staff.

The appointment will be terminable by three months' notice from either side and the successful applicant will be required to pass a medical examination before the appointment is confirmed.

Applications should furnish all relevant details including age, training, qualifications, past and present appointments, present salary and professional experience, should give the names of three referees and should reach the House Governor and Secretary not later than October 31, 1958.

United Newcastle upon Tyne Hospitals,
Royal Victoria Infirmary,
Queen Victoria Road,
G.P.O. Box No. 141,
Newcastle upon Tyne 1. 1538

ESSEX COUNTY COUNCIL
ILFORD COMMITTEE FOR EDUCATION

Applications are invited for appointment to the following posts in the Education Architects' Section of the Borough Engineer's Office:—

(*a*) ASSISTANT ARCHITECT, A.P.T. Special Grade (£750 × £40—£1,030 per annum).

(*b*) ASSISTANT ARCHITECT, A.P.T. Grade I (£575 × £30—£725 per annum) plus appropriate London weighting in each case.

The posts are superannuable and subject to medical examination.

Commencing salaries will be fixed within the grades according to experience.

Applicants for post (*a*) must be Associates of the R.I.B.A. and have had experience in the design and development of school buildings.

Applicants for post (*b*) must have passed the Intermediate R.I.B.A. examination or its equivalent at a recognised School of Architecture.

Applications should be made on a form to be obtained from and returned to the Borough Engineer and Surveyor, Town Hall, Ilford, together with copies of not more than three recent testimonials, within 14 days of the appearance of this advertisement. 1527

BOROUGH OF EDMONTON
BOROUGH ARCHITECT'S DEPARTMENT
JUNIOR ARCHITECTURAL ASSISTANT (temporary) required. Candidates should be about 18-20 years of age and have achieved some progress in their studies for professional qualification. Excellent opportunity of gaining valuable experience in a Borough Architect's drawing office dealing with all aspects of building. Salary on Higher/General grade rising to £560 plus London weighting with opportunities for promotion.

Time off and financial assistance for studies. Alternate Saturdays free.

Applications on forms obtainable from Town Clerk, Town Hall, Edmonton, must be delivered by 10th October. 1540

DRAUGHTSMAN £425 (at age 21 or over) × £25 (6) × £30 (2)—£635, plus London Weighting £20—£30. Applicants must have had suitable architectural training for at least three years and be capable of making details of Building work. Will act as Junior Architectural Assistant in a group undertaking development and alteration work to existing and future hospitals.

Applications stating age, present salary, qualifications and experience (with dates) together with the names and addresses of two referees should be sent to Secretary, North East Metropolitan Regional Hospital Board, 11a, Portland Place, W.1, within 14 days. 1539

HACKNEY BOROUGH COUNCIL requires TECHNICAL ASSISTANTS with architectural or building surveying experience for interesting work in connection with the conversion and improvement of property for multi family occupation. Salary A.P.T. II commencing at £755 per annum. Application in writing to Housing Manager, 219, Mare Street, Hackney, E.8. 1516

HERTFORDSHIRE COUNTY COUNCIL
COUNTY ARCHITECT'S DEPARTMENT
ASSISTANT QUANTITY SURVEYORS (Special Class, £750—£1,030) required. Previous Local Government experience not essential.

Applications, with names of two referees, to County Architect, County Hall, Hertford, Herts., not later than 6th October, 1958. 1508

SURREY COUNTY COUNCIL

Applications invited for appointment of ASSISTANT ARCHITECT, Special Grade, £750—£1,030 p.a. plus £30 p.a. London Allowance. Must be A.R.I.B.A.

Full details, present salary, and three copy testimonials to County Architect, County Hall, Kingston, as soon as possible. 1498

BOROUGH OF WIMBLEDON

ARCHITECTURAL ASSISTANT, Grade Special Classes, £750—£1,030, plus London Weighting. Form of application from Borough Engineer and Surveyor, Town Hall, Wimbledon, S.W.19, returnable by 3rd October, 1958. Canvassing disqualifies. 1446

LONDON COUNTY COUNCIL
ARCHITECT'S DEPARTMENT

Applications are invited for position of ASSISTANT SENIOR ARCHITECT, Housing Division, salary scale £1,482—£1,850. Officer appointed will assist Principal Housing Architect and Assistant Housing Architect in direction of Division (current overall programme of work £75 million) and take more immediate control of some groups in relation to programme and design. Advanced ability in design and wide contractual and organisational experience required.

Further particulars and application form (returnable by 15th October), from Hubert Bennett, F.R.I.B.A., Architect to the Council, County Hall, S.E.1, quoting reference AR/EK/44/58. 1531

Architectural Appointments Vacant

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0479
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0523
1094
0926
0908
0787
0927
0928
0542
0550
0653
0558
0559
0563
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