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THE

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JOURNAL

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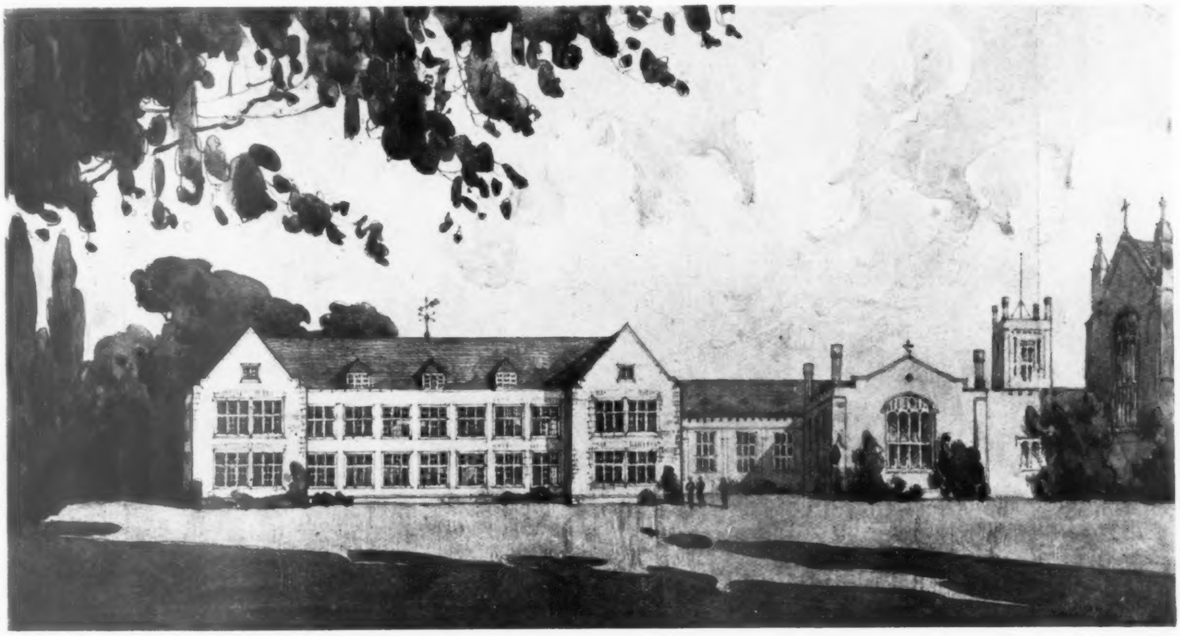
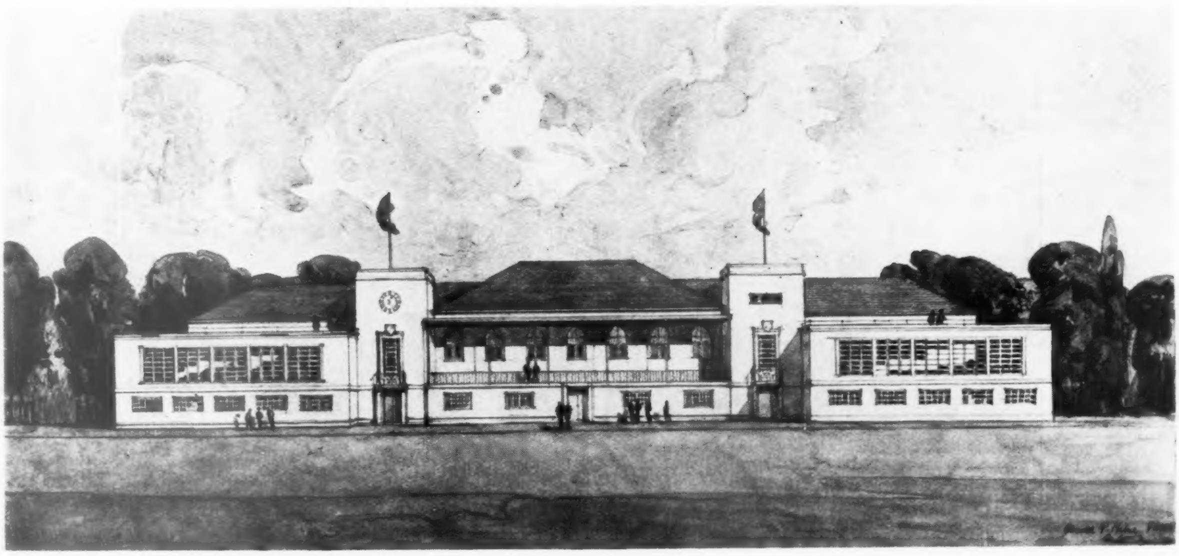
The Editor will be glad to receive MS. articles and also illustrations of current architecture in this country and abroad with a view to publication. Though every care will be taken, the Editor cannot hold himself responsible for material sent him.

THURSDAY, MAY 19, 1938 NUMBER 2261 : VOLUME 87

PRINCIPAL CONTENTS

NEW BUILDINGS, CHELTENHAM COLLEGE

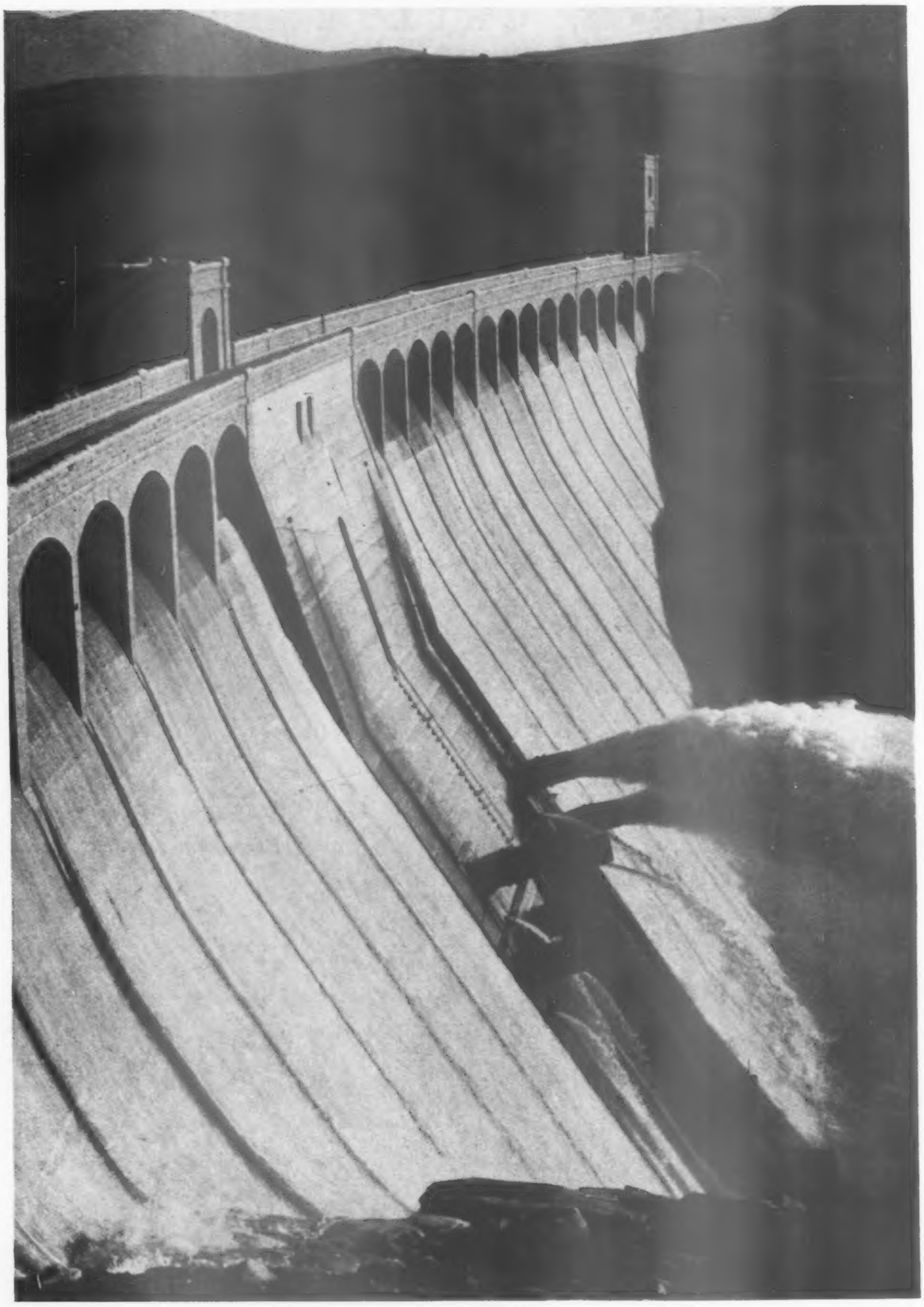




THE Centenary of Cheltenham College takes place in 1941 and to mark the event the Cheltonian Society proposes to give two buildings to its old school. A class room block, the first of these, is already in course of construction; the foundation stone was laid by Mr. Hore Belisha, Secretary of State for War, last week. The second is the reconstruction and enlargement of the existing gymnasium and cricket pavilion.

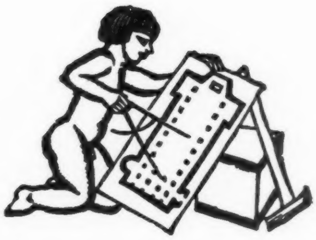
The class room building, shown at the top of this page, stands near the present College buildings and, in order to harmonize with them, is being built of Cotswold Stone. The gymnasium and the cricket pavilion, shown at the bottom, are to be finished with rough plaster, with stone dressings.

The architect for both buildings is Mr. Oswald P. Milne.



D A M

The Loch Loggan Dam outside Fort William.



THE PURSUIT OF SILENCE

THE title of this issue may be the better for some explanation. Other titles, SOUND-INSULATION and the rest, might have better described the greatest part of the contents. But they might also have encouraged someone to believe that the problems of Silence and Noise could be tackled stern first. This the JOURNAL was determined to avoid.

Silence, sound and noise are all relative, and distinctions between them must always to some extent be matters of taste and habit. Here it has been taken that sound is the necessary and desirable antithesis to silence without which civilized life could not continue ; and that noise is either the undesirable excess or purely a by-product of activity which no one wants but which no one yet bothers to prevent.

There are plenty of borderline cases and opportunities for differing views left after this distinction has been made. But it is one which obviously must be made ; and made soon, before steadily increasing volumes of noise over ever wider areas causes the loss of such powers of distinction as still remain to ordinary men and women.

Silence, in its aspect of being in reasonable degree an essential component of good health, has only been taken seriously for a few years. Medical opinion has recognized that its absence is one of the causes of the appalling frequency of nervous ailments, and has made and still makes its protest. But those who are trying to bring about remedial action are still apt to be regarded as cranks.

It is only too possible that the din will have to grow larger before it is made to grow less. And those who find it intolerable will be compelled to continue defensive—and therefore essentially secondary—measures.

Architects must naturally aid these defensive measures. They, with the help of research and invention, may be able to increase the number of small islands of silence in the flood of largely unnecessary noise. But unless they happen to be architects on a very grand scale their islands will remain islands, and somewhat waterlogged at that.

For the country at large, countryside as much as towns, the first remedy must be to prevent silence being broken.

Let us hasten to add that no graveyard hush is being advocated. There is plenty of sound on a farm and no one would suggest that cows must not moo, men laugh or butcher boys whistle (annoying though the butcher boy's whistle may be). What is necessary is the realization that where enormous numbers of people are carrying out activities hurriedly in an extremely small space, each unit of noise becomes significant, and the generation of any deliberately unattractive, or of avoidable mechanical, noise becomes actively anti-social.

Action based on this point of view can be the only effective action. It will be slow to begin, but there is good reason to suppose that once it starts its results will be rapid and cumulative. All that reformers need is a weapon, and within a year or two it appears that one will be perfected.

Legislation now exists against noise, but it must be unreasonable noise, and there is not yet a yardstick for the reasonable. The various objective noise meters which are now in existence are almost certain to provide it. Once accepted by the Courts and backed by public opinion, the noise-meter will both open people's ears and enable them to fix a standard to which manufacturers must conform or go out of business.

In fixing this standard decisions will have to be taken as to when to insist and when to apply pressure. Iron-shod vehicles will simply be forbidden, but railway trains will presumably be scheduled as grave offenders for which remedies must continuously be sought. Similarly, residential areas will almost certainly be scheduled for silence far more rigorously than business areas which must continue to be used despite the gravest disabilities.

It is in these last that the defensive measures which are the subject of the greater part of this issue will still be needed—as a second line of defence.

Today they are not the second but almost the only means of defending silence, and are therefore of great importance to architects.

In this issue, which has been made possible by the help of Dr. Constable and other officials of the National Physical Laboratory, the methods of research and testing of materials is described and the position now reached in the production of sound-insulating materials and equipment is stated.

For the public and the architect—both sharply concerned with cost—the technical aspect is only partially encouraging. It is possible with care to achieve a fairly satisfactory degree of sound-insulation at a reasonable cost. But beyond that cost mounts sharply in materials, skilled labour and loss of space.

Beyond that it becomes only too obvious that a screen from noise becomes the privilege only of the very rich, and that in common sense and in justice the way to achieve silence is to prevent the creation of avoidable noise and if necessary to penalize the person who makes it.

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NOTES & TOPICS

THE BILL

THE Registration Bill, as everyone now knows, passed its Third Reading by 166 votes to 32. And the result was the most interesting, almost the only really interesting, part of the affair.

*

Second Reading was most sharply memorable for me because of the headache it gave me. This time, fortified with aspirin and some sense of an historic occasion, I found the first unnecessary and the second difficult to sustain.

*

All of us know it was—in a professional way—an historic occasion.

*

Incessant mumbles came from the table as I took my seat. I heard something about herrings and superannuation, and found it difficult for quite a time to hear anything else. Only the strongest imagination could squeeze drama from the dry Gothic space below.

*

Mr. Muff cheered the House by references to the Rye-ber, a body which he knew was the Royal Institution of Something. Mr. Viant said he had been associated with the industry for forty years, and on being asked what industry, explained rather huffily that he was talking of the building industry. The House seemed to want him to talk about architecture or stop.

*

After that it became obvious that they wanted everyone to talk about architecture or stop—preferably, stop. The Speaker shared the feelings of the House. Sir Robert Tasker, after a brisk trot down an alley called Professional Blacklegs, was headed off a much longer road of Education, and an ineffectual dart towards Examinations brought him to a standstill. Mr. Ammon and Mr. Bossom closed the proceedings.

*

Between a Ministry of Health Provisional Order and the Registration of Still-Births (Scotland) Bill, Registration passed on to the Lords.

*

If, as is now almost certain, the Bill becomes an Act within a few weeks, architects will hurriedly forget the weariness and dreariness of it all. Before doing so they might find time for a graceful acknowledgment to the officials of societies promoting the Bill and to the M.P.'s who have helped it and voted for it. The work these men have put in has been enormous, incessant and wearisome beyond belief. It has lasted for years.

*

A letter from a reader cannot be forgotten at this moment. He wrote to his M.P. and asked him, with some tolerable statement of his grounds for doing so, to support the Architects' Registration Bill. In time he received a reply.

*

It ran :

> "Dear Sir,—With reference to your letter, the Hire Purchase Bill, as you may have seen in the newspapers, got its third reading here today.
>
> Yours faithfully ———"

EXTRAORDINARY EVENTS AT BEDFORD SQUARE

What has been going on at the A.A.? Rumours and counter-rumours are in the air, and in the dining room last week there were low murmurings, not wholly dietetic. It was obvious that at the beginning-of-term meeting Council had precipitated something hot. Unless my noted perception is failing that means yet another change of educational front. And yet another sudden disappearance?

*

Well, revolutions are healthy, they say, if they don't come along before the last revolution has had time to try out its theories. But what are we to have this time? More social psychology? Or more social life? Perhaps I would be thought altogether too romantic if I hoped for something on Bauhaus lines.

*

Or perhaps . . . could that possibly have been a flower-sprinkled warning I heard at the General Meeting last January? A Beaux Arts revival, they said. Gad, Sir, and why not? Back to *poché*, *esquisse-esquisse*—back to the still-born *projet*.

*

Of course, gentlemen, you realize this means WAR?

ARCHITECTURAL REVIEW JUNIOR

Another news item from A.A. is that a new journal, produced by a group of students, is now well under way. Not a revival of the old chit-chat magazine that used to appear, some terms back. Serious stuff this time.

*

The idea, so one of the editors explained to me, is to link up eventually with other schools and make an open forum for students to speak for themselves on how they should be taught architecture. First timely appearance is at the end of this term, and I look forward to the leading article.

*

I look forward to some lively architectural criticism, too. Architecture these days needs a good supply of bold critics. Here is a training ground for them, an opportunity to consolidate the younger generation's line of action and

Stoke-on-Trent. "Always Merry and Bright."

perhaps to check any suspicion of romantic whimsy from creeping in.

*

There are to be articles by eminent non-students as well, perhaps even by members of school staffs, and eight pages are reserved for photographs of important new buildings, if any. The publishers are Lund Humphries, of plastic bindings and bleed-off fame. The price, 1s. 6d. three times a year.

A.B.S.

Which reminds me of another appeal I have to make. It seems that the Architects' Benevolent Society isn't able to do half the good works it wants to do just because YOU, and every other reader, don't pay your yearly 2s. 6d. I am told that if every architect with a job paid this paltry sum once a year, A.B.S. would be in a strong position.

*

Really that half-crown would help turn the wheels around. Won't you sit down now and send it to the Secretary, Architects' Benevolent Society, 66 Portland Place, W.1. ?

A.R.P.

Architects are to be asked to help in making Air Raid Precautions as effective as they can be made. If through their principal society they agree to give this help, as I understand they have done, their responsibility is a grave one.

*

Their first duty is to learn the true facts concerning those problems of precautions of which they have no technical knowledge—such as the effect of bombs and the efficiency of masks and underground shelters. Their second duty is manifestly to make sure that every precaution recommended under their authority is exactly as effective as it is stated to be.

*

This second point is emphasized by the exhibition now at Charing Cross and jointly arranged by the Building Centre and the Home Office.

*

The exhibition is really in two halves—a typical gas-resisting room in a typical existing house ; and various proprietary shelters and gas-tight windows.

*

The question naturally raised by the first is whether data has been collected as to the behaviour of (1) an old brick or stone terrace house, and (2) a modern house with cavity walls, under the blast of bombs at various distances. Surely this is the first question architects ought to ask.

*

The second question is raised by firms describing their windows, etc., as "gas-tight." They may well be gas-tight ; but in my view no proprietary product designed to help A.R.P. should be allowed to be sold save under a Government certificate stating its exact efficiency.

PRACTICAL EXPERIENCE

In the meantime, I hear that Mr. Skinner of Messrs. Tecton has gone to Barcelona in order to collect first-hand evidence for an A.A.S.T.A. report on A.R.P. on which he has been collaborating.

*

As an air raid was reported during his visit (a mere thirty killed) his evidence should be of value.

SMILES FROM STOKE-ON-TRENT

I have always believed that the Potteries had a strong sense of humour. The picture postcard above, sent me yesterday, removes my last doubt.

LONG DEFERRED REPORT

The Bressey Report was at last published on Monday. Its recommendations are based upon the deflection of traffic from London's central points by means of ring roads and are tremendous in scale—nearly 800 miles of roads being considered.

*

No hard and fast alignments are recommended but the separation of through from local traffic is consistently emphasized.

*

Presumably Sir Charles must envisage *ad hoc* legislation in order to drive his new routes, as town planning and other existing Acts are quite inadequate. It has fortunately long been realized that to do anything that matters with London's traffic some very special legislation would be necessary.

SOUTH BANK

The scheme sponsored by *The Star* for improving the South Bank of the Thames has aroused great interest, and I understand is being examined by people prominent in local government.

*

The scheme, prepared by H. Spence-Sales and John Bland, was described in detail in the JOURNAL in the week before last and has now even reached the status of being the subject of a cartoon. As Sir Percy Harris, M.P., has pointed out in a letter of support, such redevelopment is *the* key to the proper replanning of London.

*

The Star is to be congratulated upon promoting a plan which attempts to solve the problem in a practical and unfanciful way.

ASTRAGAL

NEWS

POINTS FROM THIS ISSUE

THE ARCHITECTS' DIARY

Thursday, May 19

GARDEN CITIES AND TOWN PLANNING ASSOCIATION. *At the Housing Centre, Suffolk Street, S.W.1. Exhibition of books on planning. Until May 31.*

COLLEGE OF ARTS AND CRAFTS, *Birmingham. At the Museum and Art Gallery. Exhibition of Students' Work. Until May 21.*

R.I.B.A., 66 *Portland Place, W.1. The Dramatic Society will present "Bon Ton or High Life above Stairs," by David Garrick, preceded by "The Waxen Man," by Mary Reynolds, at 8.30 p.m. Also, May 20 and 21.*

GLASS CONVENTION. *At Droitwich. Until May 21.*

Friday, May 20

LONDON SOCIETY. *Visit to London's Green Belt (Eastern Section). Depart from Lancaster House, S.W.1, at 1.45 p.m.*

TOWN PLANNING INSTITUTE. *At Caxton Hall, Caxton Street, S.W.1. Discussion on Sir Gwilym Gibbon's book on "Problems of Town and Country Planning," to be opened by Professor Patrick Abercrombie and E. R. Abbott, to which the author will reply. 6 p.m.*

Tuesday, May 24

R.I.B.A. *Visit to the Building Research Station by the Science Standing Committee. The party will meet outside Watford Junction Station at 2.40 p.m.*

Wednesday, May 25

NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY. *At the London School of Hygiene and Tropical Medicine, W.C.1. "Industrial Relations in the United States and Great Britain." By D. L. Palmer. 5.30 p.m.*

ROYAL SOCIETY OF ARTS, *John Street, Adelphi, W.C.2. "The Artistic Future of the Film." By E. W. Mason. 8.30 p.m.*

THE REGISTRATION BILL

THIRD READING

The Official Report of the Third Reading of the Architects' Registration Bill in the House of Commons on Friday last is printed on this and the three following pages, by permission of the Controller of H.M. Stationery Office.

CLAUSE 1.—(*Use of title "Architect."*)

LIEUT.-COLONEL HENEAGE : I beg to move, in page 2, line 16, to leave out from the second "the," to the end of the sub-section, and to insert

"Local Government Superannuation Act, 1937, or the Local Government Superannuation (Scotland) Act, 1937."

As the Bill stands, its provisions apply to some local authorities and not to others, and we have the anomalous position that a local authority in an area with, perhaps, 2,000 inhabitants will have exemption, whereas a local authority which controls an area with, perhaps, 5,000,000 or 6,000,000 people will not. A catchment board functioning over an area so large that a penny rate will raise £150,000 will not be able to have exemption under this Act, whereas a small local authority, where a penny rate raises, perhaps, no more than £200, will get exemption. It is in order to do away with such anomalies that it is proposed in this Amendment to introduce the Local Government Superannuation Act, 1937, because under that Act a local authority is defined as :

"The council of a county, county borough, metropolitan borough or county district, the common council of the City of London and any other local authority within the meaning of the Local Loans Act, 1875."

The introduction of the Local Loans Act, 1875, will obviate the anomalies which otherwise the Measure would create.

MR. BOSSOM : The promoters of the Bill are willing to accept this Amendment.

Amendment agreed to.

CLAUSE 2.—(*Date of application for registration.*)

MR. EDMUND HARVEY : I beg to move, in page 2, line 38, at the end, to insert

"or in any part of the British Empire."

It is not in any spirit hostile to what I believe to be a most valuable Measure that I am moving this Amendment, but I think the framers of the Bill have overlooked a possibility of hardship and injustice which I am sure they would not wish to happen in the case of an architect who has been practising for a long time in the Dominions, or India, or in some of our Colonies, and has then for personal reasons, possibly for reasons of family or health, come back to England and still has the probability of being able to do very good architectural work for a number of years. It would be a great pity if such a man were placed in the position of young students of 20 or 21, and I feel sure the framers of the Bill would be willing to meet a case of this kind. We want to see the widest possible interchange of professional thought in the Empire. Great services may be rendered by men who have had this Empire experience. We have in this House a distinguished architect who has had a large overseas practice. I will not bring a blush to his face by indicating his name. We all know that the profession has gained greatly by such experience, and I hope that it will be possible to meet the case I have put forward. There may not be many men in this position, but I think the Bill should provide for them.

SIR ROBERT TASKER : I beg to second the Amendment.

As I understand that the Amendment is to be accepted, I do not propose to weary the House with any comments.

Amendment agreed to.

Motion made, and question proposed, "That the Bill be now read the Third time."

MR. MUFF : As one who served on the Committee which considered this Bill, I am hopeful—

SIR R. TASKER : I wish to raise a point of Order before we come to the Third Reading. No provision seems to have been made in the Standing Orders for Private Members' Bills, and perhaps because of that oversight, 15 Members who had been selected to serve on the Committee which considered this Bill found themselves in the position of receiving only 24 hours' notice of the meeting of the Committee. I have consulted Erskine May's volume on Parliamentary practice, but that seems to be singularly silent about the procedure in the case of a Private Members' Bill. All that I can find is a reference to Private Bills, and I understand there is a distinction between a Private Bill and a Private Member's Bill. The Selection Committee having chosen the Members, the Chairman of the Committee, of whose conduct I am not complaining, then fixed the day for the first meeting, and the day selected left those Members with only 24 hours in which to prepare for their work on the Committee. A reference to the Official Report of the Committee proceedings shows that three Members requested that the Committee might be adjourned in order that there might be more time, and I do know that my hon. Friend the Member for Ealing (Sir F. Sanderson), who very much desired to take part in the proceedings, was unable to do so. I wish to know whether some steps can be taken to ensure that Members have reasonable time in which to make preparations to perform their duties on a Committee.

MR. SPEAKER : As I understand it, the hon. Member is complaining that there is an omission in the Standing Orders, that there is nothing in Standing Orders as to the interval that should be allowed between the appointment of Members to a Committee and the sitting of the Committee. It is a question, therefore, of amending the Standing Orders.

SIR R. TASKER : May I then ask for your guidance ? I confess that I am at a loss to know how I am to alter these Standing Orders.

MR. SPEAKER : I suggest that the hon. Member might consider putting a Motion upon the Order Paper proposing to make the alterations which he considers necessary.

MR. MUFF : I was observing that, having served upon the Committee, I did not wish to detain the House, or even to oppose the Third Reading ; but, now that we have reached the Third Reading of the Bill which consolidates this body, the R.I.B.A., I venture to hope that the Institute will use its new powers mercifully. We have not been able to raise the question of examinations on this Bill and I shall not raise it this morning, nor have we been able to raise the question of the sum which is vested for ensuring that young students may be helped with scholarships in order to become successful architects. I recognize that the Institute has a prevailing interest in the administration of this matter which should not be wholly theirs. I make a final appeal that the R.I.B.A. will administer their great, vested, preponderating interests to the benefit of this great profession. Some of their members have been responsible in the past, just as others have been, for monstrosities in the construction of buildings, but I hope they will use mercifully the increased power, which they are now receiving as an addition to their already almost overwhelming power, upon those who have also contributed to making our buildings more beautiful.

MR. VIANT : I rise to make a few observations in opposition to the Bill. I was a Member of this House in 1926 when a similar Bill was first introduced, and I opposed it with others on that occasion. We were successful, as we had been before a select Committee for some considerable time, in obtaining various concessions in respect of the framing of that Bill. Speaking for myself, and quite a number of others who have strenuously opposed this Bill at each stage, I want it to be understood that we take no exception whatever to the setting up of a standard for the profession. [HON. MEMBERS : "Hear, hear."] We are evidently all agreed upon that. I want the House to be aware that many hon. Members who have not been present and listened to the Debates have voted for the Bill because they desire a standard of architecture, and of qualification for those who wish to enter the profession.

Arguments were used on the Second Reading against ribbon development of the kind that has been taking place in our cities and towns; many members of the R.I.B.A. have engaged in and lent themselves to ribbon development. As a matter of fact, numerous members of the Institute are responsible for the abortions which go by the name of architecture disfiguring our cities and towns today. I said on the Second Reading that no building in this country was so degrading to the name of architecture as the headquarters of the R.I.B.A. in Portland Place. It seems in keeping with the machine age and mass production, I agree, but there are no æsthetic qualities about it whatever.

The Bill has been advanced with a view to safeguarding the profession of architecture. How are you going to do it? The House is handing over to the Royal Institute a monopoly. The 2,500 architects with equal qualifications who are members of the Incorporated Institute of Architects and Surveyors have no say in respect to examinations and to the standards that should be set up. I wonder what would have happened in this House if the Mineworkers Federation had come here and sought a charter such as we are giving this morning, to confer upon them the right to give mining certificates to their members. This House would have been up in arms and would have cast the proposal out immediately, but by this Bill we are giving the power to the Royal Institute to hand out certificates for architecture to all and sundry who subscribe to their examinations. That is not by any means safeguarding architecture. I want the House to be aware of precisely what we are doing in this regard. If the Federation of Building Industries had attempted this procedure, we should have cast it out.

We are too willing—and this criticism includes many of my colleagues on this side of the House—to grant to professional organizations charters which they have no right to expect in a democratic country. Furthermore, will the Bill make it easier for the young man or young woman possessing qualifications in architecture to get into the profession? I say that it will not. The manner in which the scholarship scheme is being administered should not in any sense inspire the House with confidence. Questions were placed on the Order Paper yesterday by myself seeking information from the Home Secretary in respect of the administration of the scholarship fund. According to the replies given by the right hon. Gentleman he has no jurisdiction in regard to the manner in which the scholarship fund is administered. But, when the Bill was going through Committee, the Committee was led to believe that the Home Secretary would watch the manner in which these funds were being administered. I think we are entitled to take exception to the administration of a fund in this way. The amount awarded for scholarships in 1935 was £156 10s., but the administration costs amounted to £308 10s., and the average age of the persons to whom the scholarships were awarded was 20.

MR. SPEAKER: The hon. Member is now referring to a matter which is not in the Bill, and which, therefore, is not in Order on the Third Reading.

MR. VIANT: I mentioned it by virtue of the fact that this is legislation by reference. The original Act embodies the scholarship scheme, and it is not possible to consider the merits of this Bill as apart from the original Act. That is my reason for mentioning the manner in which the scholarship fund has been administered and the small number of those who are benefiting from it. I bow to your Ruling, but that is the reason why I referred to the matter.

MR. SPEAKER: There is nothing about scholarships in the Bill.

MR. VIANT: I bow to your Ruling. The next point that I want to make is this. When the Bill leaves this House, the House will have no further power in regard to it. The charter will have been conferred, and the Home Secretary admitted in his replies yesterday that he has no jurisdiction over the manner in which the charter is administered by the organization upon which these powers are conferred. In my view, our educational system for the training of architects is entirely wrong. I speak as one who has been associated with the industry, from my apprenticeship days upwards, for over 40 years.

The Architects' Registration Bill passed the Third Reading in the House of Commons on Friday last by a majority of 134 votes, as follows:

AYES - 166 NOES - 32

LIEUT.-COMMANDER AGNEW: What industry?

MR. VIANT: The building industry. I know many of our young men who have gone through their apprenticeship, who attended evening classes and obtained all the technical knowledge which enabled them to obtain their City Guilds certificate. They obtained that certificate with honours in building construction, and no one could be more capable or more efficient in preparing, not theoretical plans, but working plans. Over and over again it has happened that those who have had charge of work have had to prepare their working drawings from the original drawings, because the architects were unable to prepare for them a working drawing, for the reason that they had had no practical training whatever. If architects are to be efficient, they should spend a portion of their time in being trained in the workshop, so that they may have some practical as well as theoretical experience. The educational system provided for in this Bill does not give that.

Again, the architect, like the artist, is not a manufactured article. The artist is born, and the potential architect also should be discovered in his younger days. The architect, equally with the artist, should have some æsthetic qualities. If our architecture is to be improved, it will be along those lines, and we should be seeking our students of architecture among the younger people, and not among those who have reached the age of 22 or 23, as is the case here. On broad general grounds I contend that the House is doing wrong in conferring this charter upon one professional organization while others with equal ability and an equal standard of efficiency are ignored. Furthermore, I would suggest that, the architects having succeeded in this regard, other industries, trade unions and so on would be equally justified in seeking a similar charter from this House. I do not expect that they would get it, because we know quite well the attitude that would be taken up by our opponents, but none the less the House should be aware of the wrong it is committing today, and I hope that a substantial number of Members will go into the Lobby against the Bill.

MR. LYONS: There is a good deal in what has been said by the last two speakers that I should like to endorse. You have declined, Mr. Speaker, to call the Amendments which were put down in the names of certain of my hon. Friends and myself, and therefore I conceive that it would not be right for me now to deal with the matters to which those Amendments related; but I would like to point out to the House that this is a Bill to

> "restrict the use of the name Architect to Registered Architects and to extend the time within which practising architects may apply for registration."

I hope the House will realise that, in addition to the points raised by the last speaker, the Bill restricts others in an extraordinary way and, as I see it, confines the vested interests already given to one society of architects, reaffirming to them rights which nobody else is allowed to have, and it may well be that it will deny that equality of opportunity which the House would like to see in so many other circumstances. [AN HON. MEMBER: "What about your own profession?"] There is no comparison between the two. I should not be in order in discussing the facts which enable me to say that with authoritative detail, but there is no denial of opportunity whatever in my profession. It seems to me that this Bill is very closely associated with the Act of 1931, but it fails to carry out the intention of Parliament as expressed in that Act, and makes no provision——

MR. BOSSOM: I wonder if my hon. and learned Friend would explain to the House how many of the annual examinations are held by the body to which he is referring, and how many are held by other bodies in this country?

MR. LYONS: I do not know whether I should be in order in dealing with that, because it is one of the very topics dealt with in the Amendments which you, Sir, have declined to call, but, if it were in order, I could enlarge upon it in great detail. Perhaps I might put it in this way. The examination involved by the Act of 1931, apparently, has never been put into force, and, if this kind of thing is going to continue, it will make the vested interest of which others have already spoken even more unfair than it may be at the present moment. I would ask the House to realise what the implications of the Bill are, and the hardships it will entail on many people, and to consider even now whether the exceptions provided for at the end of Clause 1 (1), such as, for example, the non-application of the Bill to a person who is a member of the Institution of Municipal and County Engineers, will make for any of the good work that was claimed to be within the ambit of the Bill by those who spoke on its behalf when it was first introduced. There are many objections to this Bill in its present form. It will do a certain amount of injustice to many people, for whom this House desires to create no injustice. It will confer on others benefits which it may well be said are merely an extension of vested interests to one section which is not prejudiced in any degree by the present position. But if this Bill is accepted as it is, I join in the hope that the powers conferred may be used wisely, and as equitably as possible.

LIEUT.-COLONEL SIR THOMAS MOORE: I find it very difficult to answer some of the speeches which have been made, because they seem to suggest that there is much more in the Bill than there really is. This Bill is introduced simply to undo a grievous harm which was committed in the 1931 Act, which is the principal Act. In that Act, towards the end of the proceedings, we were forced, for reasons of time, to insert the word "registered" in front of the word "architects". We were rather unhappy about that, because anyone who was on the register was obviously a registered architect; but in order to save time we accepted the Amendment. The general public do not realise the difference between the words "registered architect" and the word "architect." If they see that any man has a brass plate with the word "architect" on it, they assume that he has all the qualifications and knowledge of a registered architect. Therefore, we have been forced to take this opportunity of rectifying that position. In order that no disadvantage shall be caused to anyone, we also extend up to two years the period in which those who desire to register can do so.

If I were to embark on a reply to some of the statements made by the hon. Member opposite and my hon. and learned Friend the Member for East Leicester (Mr. Lyons) it would take more time than I propose to occupy; but I will say that it is totally wrong to go always on the lines that the R.I.B.A. are the criminals of the piece. It is the largest architectural body in the world. Owing to its high status and great reputation, every good architect wants to belong to it, with the result that it has more members than any other architectural organization, by a long way. To call it a villain, animated by dark purposes against the very body that it exists to protect, is totally wrong. I would point out that on the council which is a statutory body set up by the 1931 Act, the Royal Institute take only their proper and legitimate part. We have five members on it representative of the Treasury Bench, and there is also representation for the Government of Northern Ireland. Will the House believe that all these crooked transactions in regard to bursaries and scholarships are taking place when these people are on the Council? It is casting a slur on them.

MR. VIANT: Does the hon. and gallant Gentleman infer that the particulars I gave are not correct?

SIR T. MOORE: They are perfectly capable of explanation, as hon. Members know. I think I should be out of Order in going into them, because that would be going back on the debate we had in 1931. It was actually overlooked when the Act was passed that six months must elapse before any money at all was got in by the Council. We had to get an Act passed in order to enable the Architectural Council to collect sufficient reserves to enable them to carry out the very specific functions set out in the Act. The hon. Member for West Willesden (Mr. Viant) went on to attack the Board of Architectural Education. There are members representative of this very body on that board, and I think that its present president is one of the strongest supporters of this Bill, the hon. Member for East Woolwich (Mr. Hicks). I think the building industry cannot be completely and fairly represented by the hon. Member for West Willesden; otherwise we should not have the hon. Member for East Woolwich so strong in his advocacy of this Measure. We have, as hon. Members know, a desire to ensure that the general architectural and creative standards of architecture shall go up. It is only by such means as this that we shall eliminate slums and ribbon development.

All that the Architectural Council insist upon is a minimum technical standard. As regards their own development, architects may go on their own lines; but the council insist on this minimum standard. That is why there are certain bodies which are not yet recognised as being proper bodies for examination purposes. If they have not yet submitted a test examination which is accepted by this wide body of headmasters and schoolmistresses, the Co-operative Union and other organisations representative of our national life, these people have decided that such bodies are not sufficiently equipped to have their examinations recognised. As soon as they conform to the standard they will be recognised by this board. Architecturally, we have come to the end of one long period and are starting a new one. I hope that, for the whole countryside, it will mean a change for the better. We have been too long at the mercy of people with insufficient knowledge and no architectural education. We have an opportunity for young architects to take part in the reconstruction of our countryside and great cities. We believe that, by this Bill, we are enabling these architects to enter into their heritage and provide new creative work for the benefit of our people. The public themselves will be the first to benefit by the Bill. When a public authority goes to an architect in future, it will know that not only has he artistic instincts but the necessary technical education.

SIR R. TASKER: My hon. and gallant Friend the Member for Ayr Burghs (Sir T. Moore) has followed the usual practice of indulging in a little romance. Let me just point one or two misstatements he has made—no doubt innocently, but very ignorantly. I do not say that offensively. I cannot be expected to take quite the same view of architecture as my hon. and gallant Friend. He says that all the best architects belonged to the R.I.B.A. [*Interruption.*] I wrote down his words.

SIR T. MOORE: They would like to belong to it.

SIR R. TASKER: I will put it this way and say that they would like to belong to the R.I.B.A. I have here a list of some of the most eminent architects this country ever produced who were not members of that Institute—Roland Anderson, John Bentley, Geo. F. Bodley, W. Butterfield, Basil Champneys, Somers Clarke, Horace Field, Thomas Garner, Herbert Horne, T. G. Jackson, Gilbert Scott, and Norman Shaw. I could go on like this and give scores of names of architects, some of whom were elected to the Royal Academy because of their architectural qualifications.

We were retold the story of the architect with the brass plate. I know a great many architects, but I do not know any of them who puts out a brass plate. There may be such people in existence, but I would ask the House whether any Member seriously thinks that anyone would go into a man's office to ask him to spend thousands of his money because he had a brass plate outside his door. He would want to know something about the reputation and work of the architect before he entrusted him with the expenditure of his money. A reference was made to crooked transactions. The hon. gentleman the Member for West Willesden (Mr. Viant) did not suggest that there had been crooked transactions; no one has ever suggested it. Does my hon. and gallant Friend know of any?

SIR T. MOORE: The pamphlets issued by certain bodies, which, I believe, the hon. Member represents, asserted very distinctly that there were actions which would not bear investigation, and if that does not mean crooked actions I do not know what does.

SIR R. TASKER: I deny that emphatically and say that my hon. and gallant Friend's terminology is most inexact. No documents can be produced alleging crooked financial transactions. The hon. Member for West Willesden said that certain moneys were expended for scholarships and criticized administration costs, but I must not pursue that because Mr. Speaker has already indicated that such matters cannot be introduced. No one has suggested what the hon. Member for East Woolwich (Mr. Hicks) referred to when he said that nobody had dipped his fingers into the till. I am very indignant that this sort of suggestion should be thrown out, in order to create a kind of atmosphere detrimental to those who are opposing the Bill. The Bill is not so innocent as it would appear to be. It restricts the use of the name "architect" to registered architects, and extends the time within which a practising architect may apply for registration. It is an accurate and proper description to say that it is a Bill which requires those who are to legislate and vote upon it to study the principal Act as it is legislation by reference.

I do not suggest to the House that the State will be overthrown if the Bill is passed or that it will be overthrown if the Bill is rejected. I do not suggest for a moment that it will affect my practice. I know that it will not. It will not affect the practice of men who have gone through the workshop. I agree with the hon. Member opposite who said that the proper place in which to begin training as an architect is in the workshop. It is there that you learn what may be done with materials and how to use them. One can afterwards go into an office and learn draughtsmanship. No one ever became a great architect who did not know a good deal about the material which he was called upon to use in the construction of his building. One would think, in listening to those who advocate this Bill so strongly, that they are afraid of those Tapers and Tadpoles who obtain little commissions which those who have made any mark at all in the profession do not covet and do not want.

Will this Bill alter ribbon development or bad building? No, Sir, it will make no alteration. Precisely the same people who are doing bad designing today will go on doing bad designing in future. They will submit their plans to the local authority and the local authority will pass them. Members of this House who have served on local authorities and have taken part in passing building plans will support me when I say that, provided that plans are in accordance with the bylaws, the building Acts, or the regulations, approved by the Ministry of Health, the local authorities have no right to refuse such plans. All that they can do is to see that their inspectors make quite sure that some kind of resemblance to skilled operative work is employed in the erection of the property.

I believe that those who are responsible for running the R.I.B.A. must spend a lot of their time in contemplation. They pose as the Yogis of the profession. It is regrettable and deplorable that the busy practitioner has no time to spare to guide, govern and control architecture. I am not a member of the R.I.B.A. but I object very strongly to anybody belonging to any institution reviling those who follow the same practice, and saying "He is not in my institute; he is therefore a blackleg or a bad egg." The Bill will not enable a poor boy or a poor girl to get into the profession. Many hon. Members know about Polytechnic institutions and art schools. It ought not to be necessary that the parents should be compelled to spend large fees year after year in one of the special architectural schools or, alternatively, to spend a large sum of money by way of premium.

I am glad to see that my hon. Friend the Member for Norwich (Mr. H. Strauss) is present, because it affords me an opportunity of exposing the references which he once made to influence Members of this House. My hon. Friend has referred to the squares of Bloomsbury and to the nobility of the buildings, and so on. There is only one square in Bloomsbury, and that is Bloomsbury Square. The only good architectural building in Bloomsbury Square is one that has been erected in the last 20 years, which occupies the whole of the east side. There is another building of fair average merit, which is occupied by the Royal Society of Literature. All the rest of the buildings are speculative buildings of the last century of ordinary London stocks and stucco.

MR. SPEAKER: Will the hon. Member keep to the Bill?

SIR R. TASKER: I will retrace my steps from the contemplation of Bloomsbury and come back to the House of Commons. Reference has been made to the Board of Architectural Education, to whom is entrusted by the Registration Council, certain duties. The Board of Architectural Education consists of 75 persons. One would assume that the Board would carry out their duties and hold examinations, but the House may be interested to know that it has never yet held an examination. The Board has approved certain schools but I hope my hon. Friend the Member for Maidstone (Mr. Bossom) will confirm this—it has been alleged that those schools are dominated by members of the R.I.B.A. That may be a good or a bad thing, and they ought not to be condemned because they are controlled by members of the R.I.B.A. I should be the last person in the world to condemn them, but it does bring about a position of affairs that appears undesirable. The examinations ought not to be conducted on lines which really make the student learn how to pass—to please the examiners of his school, and cram up the things he is sure to be asked, the teacher becomes subordinated to the examiner. Teaching has to follow examinations and pupils form the habit of looking to examination as the true end of education.

MR. SPEAKER: There is no reference to examinations in the Bill.

SIR R. TASKER: I was attempting to drag in that reference, because one cannot become registered unless he passes an examination, and I hoped that I should be in Order. If I am not in Order I will leave that subject. I would ask the House not to give to a particular body such big powers as are provided in this Bill. The House ought to hesitate before creating a monopoly. We believe that democracy and democratic government are best; but this is autocratic government. It is a kind of Hitlerism in architecture. The Bill makes no attempt to cultivate and develop architecture but to convert it into a monopolistic trade making a business of art. It is forging a weapon to coerce everyone into the fold of the Institute. It is handing over a great profession to a small group of people. The people who should be encouraged are the artist architects, and not the men who slavishly copy things that appear in the building papers. If I thought the Bill would be of service to the building community, which is the biggest industry in the Kingdom, I would heartily support it, but because of its narrow, cramped and confined ideas, which only strengthen the hold of one particular institution on a profession and an industry, I feel bound to oppose the Bill.

MR. AMMON: I shall not detain the House long in what I have to say on this Bill, which affects the lives and the work of a great number of people. The first thing that we have to remember in discussing the Bill is that the House has already considered this question at length on at least two former occasions, and has approved legislation by the overwhelming majority of four to one; the present Bill has come unscathed through Committee. The Bill ought to commend itself to the House. There are two particular points to which I should like to refer. One is the position of the Committee and the other is the possibilities of people of humble circumstances being able to reach heights in the profession. My hon. Friend the Member for West Willesden (Mr. Viant) was unfortunate in his reference to the miners, and his statement that there was no examination with regard to them.

MR. VIANT: I said nothing of the kind. My reference to the mining industry was that no one would permit the Miners' Federation of Great Britain to give a certificate of mining to their members. That would have to be obtained through the School of Mining.

MR. AMMON: They would not have to go through the School of Mining. The position in regard to mining is somewhat similar to the present case. There is a committee which has to consider the examination for the granting of mine managers' certificates, which are given after examination on various subjects relating to the theory and practice of mining. They must have practical experience and pay a fee of two guineas. The examinations are conducted by a board of mining examiners, containing representatives of mineowners and of the Miners' Federation of Great Britain. My hon. Friend the Member for Wigan (Mr. Parkinson) is one of the members; the right hon. Member for South Ayrshire (Mr. J. Brown) is another member, and a former member of this House, Will Lawther, is a member. Therefore, from that point of view the hon. Member's analogy breaks down completely.

Let me turn to the architects' profession. On the proposed council you will have all the education authorities, the London County Council, representatives of the workers and also representatives of the Royal Arsenal Co-operative Society. In regard to what the hon. Member for Holborn (Sir R. Tasker) has said, I took upon myself, after the discussion which took place in the House, to go to a presentation of prizes by the Architects' Association in order to hear what was said. The prizes were presented by a distinguished French architect, and the man who received the first prize had come through the Liverpool Art School. Afterwards I had a talk with him, and he said that he was the son of a South Wales miner and that his father had never earned more than £3 a week, but by the self-denial of his parents and the winning of scholarships he had been able to reach that point. The majority of the people who were successful on that occasion had come from humble circumstances, through evening schools. May I quote from the speech I made on the Second Reading of the Bill? I do not think my statements can be challenged. I said:

> "A large number of those who have passed these examinations have attended evening classes or have been able to study at home, or have taken correspondence courses. I will give the figures. There were 215 successful candidates at the two Royal Institute of British Architects examinations held in 1936, and of these 128 trained themselves by attending evening classes, while the remaining 87 studied at home or took correspondence courses."—[OFFICIAL REPORT, 17th December, 1937, Col. 1558, Vol. 330.]

In the face of evidence like that, to say that a barrier is put up against those who come from humble homes is a misuse of language.

MR. BENJAMIN SMITH: Will the hon. Member tell the House the number of children of school-leaving age who have been granted scholarships in this particular association?

MR. AMMON: The answer, of course, is that this is arranged for those who come from secondary schools, but there is nothing to prevent children passing from elementary schools to secondary schools, as all these successful candidates did. In no case had they passed direct from the elementary school. In the Post Office itself even telegraph messengers have to go through a course of education. I submit that, in view of the evidence before us, it is rather wasting the time of the House to pursue any opposition to this Measure on what I may call a purely factional line, especially having regard to the importance of the Measure.

SIR REGINALD CLARRY: In common with most other hon. Members I have been the victim of lobbying and much correspondence in regard to this Bill, and it seems to me that so far as the opposition to it is concerned it is much ado about nothing, and largely emanates from personal feelings. In a word, the Bill corrects a disability of the 1931 Act, and is generally in the national interest. I have much pleasure in supporting the Third Reading.

MR. BOSSOM: We should all feel very sorry if we did not express our gratitude to the late hon. Member for Lichfield (Mr. Lovat-Fraser), who when he was quite ill accepted the responsibility of introducing this Bill as a result of the Ballot. He is no longer with us, but we are much in his debt for assuming this task. I want also to thank the Under-Secretary of State for the Home Department and the Home Office officials for their courtesy and help in putting the Measure into shape. We are by this Measure joining up with the remainder of the Empire, Canada, South Africa, Australia, New Zealand and many of the Crown Colonies who already have similar legislation. I hope that in the course of the years this Measure will cause the public to refuse to accept illiterate architecture, from which we unfortunately have suffered in the past, but which will now I trust pass away. I am not going to say any more, but I would like to thank the House for the consideration it has given to the Measure, to which I hope they will now give the Third Reading.

Question put, "That the Bill be now read the Third time."

The House divided: Ayes, 166; Noes, 32.

On May 12, the day before the third reading of the Bill, several references were made to the Architects' Registration Council; questions and answers are given below:

Mr. Viant asked the Home Secretary if he was aware that the Architects' Registration Council possessed over £3,000 ear-marked for scholarship funds in June, 1934, when application was made to Parliament for relief of the obligation, and that the passing of the Architects' Registration Act, 1934, deprived children of the opportunity to secure scholarships in architecture; and whether he would give the House details of how the sums diverted from their original purpose were expended.

Sir S. Hoare said that the Act of 1931 made no provision for the expenditure involved in setting up the registration system before any revenue from registration fees became available. To remedy this omission Parliament by the Act of 1934 authorized the postponement for two years of the requirement that half the fees should be devoted to the provision of scholarships. Consequently the money became available to enable the Council to meet its expenses and liabilities. He had no responsibility for the Council's expenditure and could not undertake to give information about its accounts.

Mr. Viant asked the Home Secretary whether he could give any explanation of the fact that, out of the scholarship fund of 1935 under the Architects Registration Act, 1931, £308 10s. was charged to administrative expenses and only £156 10s. to actual scholarships, and that in 1936 £550 was taken from the scholarship fund for administrative expenses and only £530 used for actual scholarships; and what steps he proposed to take to prevent this frustration of the intention of Parliament that at least half the total amount of the fees received in each calendar year under the Act of 1934 should be devoted to the provision of scholarships and maintenance grants.

Sir S. Hoare said that the Architects' Registration Council, which was a professional body to which Parliament, by the Act of 1931, entrusted certain powers and duties, was not answerable to him for its proceedings, but he was informed that the Council had adopted the plan of forming a reserve fund for scholarships and that the figures quoted by the hon. Member ignored the amounts placed to this reserve.

Mr. Wedgwood asked the Home Secretary whether his attention had been called to a recent resolution of the Architects' Registration Council to the effect that, in view of the several ambiguities in the Act, amending legislation was necessary; and whether he would take steps to secure the removal of these ambiguities and inequalities of the existing law.

Sir S. Hoare said that the answer to both parts of the question was in the negative.

Mr. McEntee asked the Home Secretary whether he was aware that the scholarships awarded under the Architects' Registration Act had in the main been given to persons over 17 years of age; and whether he would take steps to see that in future awards were given to assist children of school-leaving age to enter the architectural profession.

Sir S. Hoare said that the Act of 1931 provided for the appointment of a representative body as a Board of Architectural Education, and the question at what age young persons could best derive advantage from the training made available through these scholarships was one for this body, which included representatives of the teaching profession and the Universities and the schools of architecture throughout the country.

Highway Development Survey

SIR CHARLES BRESSEY'S REPORT

London's estimated traffic needs for the next 30 years are the basis for the Highway Development Plan prepared over the last three years by Sir Charles Bressey, with Sir Edwin Lutyens as consultant. The plan deals with an area of 2,000 square miles. Sir Charles recommends:—

Three concentric ring-roads, designed to deflect traffic from the centre;

A new East-West arterial road 12 miles long;

A new North-South road, largely overhead;

Tunnels in Kensington and Westminster to free new routes;

Extension of the Victoria Embankment to the Tower and Putney Bridge—eight miles in all;

A new route to Croydon airport;

Parkways through open country radiating towards provincial centres.

Two maps accompany the report, which is published by H.M. Stationery Office at 7s. 6d. The innermost of the three concentric rings is the Loop-Way round the City, which is intended to relieve the pressure on the Mansion House intersection. The next is formed by the North Circular Road, the circle implied by which is envisaged as completed by a South Circular road, the complete circle's circumference extending from Finchley in the north to Catford in the south, and from Ealing in the west to Ilford in the East. A new vehicular tunnel at Woolwich will supersede the ferry.

The third and outermost ring is a circuit of 125 miles formed by the North and South Orbital Roads, skirting Hatfield in the north, Purfleet and Dartford in the East, Reigate in the south and Egham in the west. Incorporated in this are the lower Thames tunnel and a new bridge at Egham.

Oxford Street is to be paralleled and relieved by a wide, new, east-west arterial route, 12 miles long, passing north of the city and connecting Western Avenue, Hammersmith, with the Eastern Avenue in Essex. That also is intended to deflect traffic from the centre, and a similar purpose lies behind the conception of the proposal that Wandsworth Bridge, which is now being reconstructed, should not only lead traffic to the South Circular Road, but should be provided with an improved northern approach, curving round London to Edgware Road and the Watford By-Pass in the Cricklewood District.

Battersea Bridge is incorporated in another curved route, extending from Tooting Common to Marylebone, passing in tunnel under Kensington Gardens, Kensington Road and Bayswater Road. New roads are recommended which will divert traffic from the City. The most important of these routes leads through Canning Town northwards up the Lea Valley to the North Circular and the North Orbital Roads.

Duplication of, and improvement of the approaches to, the Blackwall and Rotherhithe Tunnels are recommended. Thus a direct north-south route is opened up from Victoria Park, Hackney, via the Blackwall Tunnel to the South Circular Road, near Eltham; the Rotherhithe Tunnel forms part of a route ten miles long from Stamford Hill to the South Circular Road, near Forest Hill. Connected with the proposed extension of the Embankment on the north bank of the river, an Aldgate By-Pass is intended to lessen congestion on the eastern ringe of the City at Gardiner's Corner.

A viaduct is proposed to facilitate the north-south crossing of London: the viaduct will form part of a route connecting the Holloway District in the north with the South Circular Road, near Tulse Hill. Westward extension of the Shooters Hill By-Pass is recommended so as to create a new route paralleling New Cross Road and Blackheath Road.

Westminster and its neighbourhood are affected by proposals for a new Mayfair-Soho route—partly underground—the improvement of communications between Lambeth Bridge and South Kensington, and the creation of a parallel road for the relief of Bond Street.

A new route to Croydon aerodrome is proposed, and a new south-eastern outlet from London which would pass under the high ground near Crystal Palace.

Several new routes of Parkway type are proposed in Outer London. New legislation might be needed to keep these free of anything like ribbon building. Since the modernization of existing roads might present difficulty, these are proposed to give relief to them. Detailed suggestions are made for improving such roads as the Harrow Road, which have grown up haphazard.

In all, some 123 miles of new routes are recommended in the L.C.C. area, and 388 miles outside it, not counting parkways. Of those there would be 307 miles.

Sectional reports have been submitted from time to time by Sir Charles Bressey to the Minister of Transport, as well as plans touching individual projects and several of these have already been brought to the notice of the local authorities concerned. In some instances negotiations have been opened by the Ministry of Transport for the preservation of corridors through which new roads could pass.

AIR RAID PRECAUTIONS IN BUILDINGS

The Home Secretary is to open on Monday, June 13, at the Royal Institute of British Architects, 66 Portland Place, W.1, the first of a series of Conferences on Structural Air Raid Precautions. These conferences are being organised by the R.I.B.A. in response to the request made by the Air Raid Precautions Department to the R.I.B.A. to undertake the dissemination of technical knowledge on this subject. The A.R.P. Department is placing at the disposal of the Institute reports and research information which have been collected during recent years.

The Conference at the R.I.B.A. will begin with an inaugural meeting at 8 p.m. on June 13, at which two short general papers are to be read. This meeting will be open to members of the R.I.B.A. and its Allied and Associated Societies.

The two following days will be devoted to a course of technical lectures and discussions. Local Government Authorities in the Greater London Area are being invited each to appoint a delegate from their architectural staffs to attend the Conference, including the lectures. R.I.B.A. Allied Societies are similarly being invited each to send one member who will be prepared subsequently to act as an information officer in his area. The Course of Instruction will also be open to privately practising London members of the R.I.B.A. who apply beforehand.

The subjects for instruction and discussion in the two-day course will include: (*a*) Methods and effects of attack and precautions in general terms; (*b*) general recommendations in building practice; (*c*) provision of shelter accommodation in new and existing buildings; (*d*) consideration of special types of building.

Other conferences, with one-day courses of instruction, will be held later in Provincial centres under the ægis of the R.I.B.A. Allied Societies. The Local Authorities in each area will be invited to send delegates to these conferences.

LETTERS *FROM* READERS

R. W. BEARD

Salaried Members

SIR,—The commotion aroused by the President's Inaugural Address, followed by the publication of a report by the sub-committee appointed to draw up a statement of the Institute's policy towards official architects, may have induced in many salaried members the belief that the R.I.B.A.'s attitude towards them has altered for the better. In so far as the Council has been forced by fear of a mass secession to offer a sop to official architects, this belief is justified. Any idea, however, that a real change of heart has occurred was effectively killed by the proceedings at the General Meeting held on May 9 to consider the Committee reports for the year just ended.

First, a Mr. Jenkins had apparently been deputed to act as "Interlocutor" to the speeches by Committee Chairmen, by asking questions and commenting on the reports. He used his opportunity to repeat, almost verbatim, some of the very remarks which caused so much anger amongst official architects when made by the President six months ago.

Secondly, a suggestion was put forward that the work of the Official Architects' Committee and of the Salaried Members' Committee was overlapping, and that the latter should be made a sub-committee of the former. I wish to point out that the Salaried Members' Committee is supposed to look after the interests of *all* salaried members, not only of those officially employed; that the official Architects' Committee represents only a small body of salaried Principals, between whom and their staffs a cleavage of outlook exists, which is identical with that between private practitioners and their assistants, but which lacks the same economic *raison d'etre*, and is indeed against the realities of the conditions of public service. If there is any substance in the suggestion made, it lies in a reversal of the proposal: the Official Architects' Committee should be a sub-committee of the Salaried Members' Committee.

Thirdly, an apparently obvious attempt was made to escape anticipated criticism by means of a snap-vote. The Committee Reports had been taken at random, and much time wasted by verbose accounts of how various committees had done nothing, eulogies of the new Library Catalogue, etc. Certain members had attended in order to ask questions about the activities of the Salaried Members' Committee, which, since it deals with the affairs of a majority of the Institute members, is one of the most important Standing Committees. It became obvious that some Reports would have to be taken very rapidly as time grew short, but we assumed that the Committees would be named and questions invited. What happened was this: the President glanced at the clock, and, without warning, moved that the remaining Committee Reports be passed, without even naming them. Before he had finished putting this motion, a member of the Salaried Members' Committee rose. He was not noticed until the Motion had been passed, when he succeeded in getting the President to "notice" him, after which, as an "act of grace" (forsooth) the questions were permitted. These referred to the conspiracy between certain official offices in London to restrict assistants' movements between them in search of better pay and conditions. The Committee Chairman replied that the Committee had been unable to find any evidence of the existence of this conspiracy.

This reply will arouse astonishment amongst assistants who have had experience of the offices concerned. So far from there being no evidence of this practice existing, it is in no sense a matter of rumour, but is common knowledge among the staffs affected. The A.A.S.T.A. has a number of quite incontrovertible examples, submitted by assistants who have had direct contact with it, and I happen to know that these cases already have been submitted to the Committee. In view of the Chairman's reply to questions, it seems to me that there is good ground for investigation into the activities and personnel of the Committee.

The proceedings at this meeting provoke me to wonder when the R.I.B.A. will wake up to the realities of modern conditions in architecture. The methods employed on May 9 may be clever politics, but they settle no problems, and merely serve to feed suspicion as to the motives ruling the dominating elements in the Council.

R. W. BEARD

The Architects' Journal Library of Planned Information

INFORMATION SHEET

SUPPLEMENT

SHEETS IN THIS ISSUE

In order that readers may preserve their Information Sheets, specially designed loose-leaf binders are available similar to those here illustrated. The covers are of stiff board bound in "Rexine" with patent binding clip. Price 2s. 6d. each post free.

Sheets issued since Index :

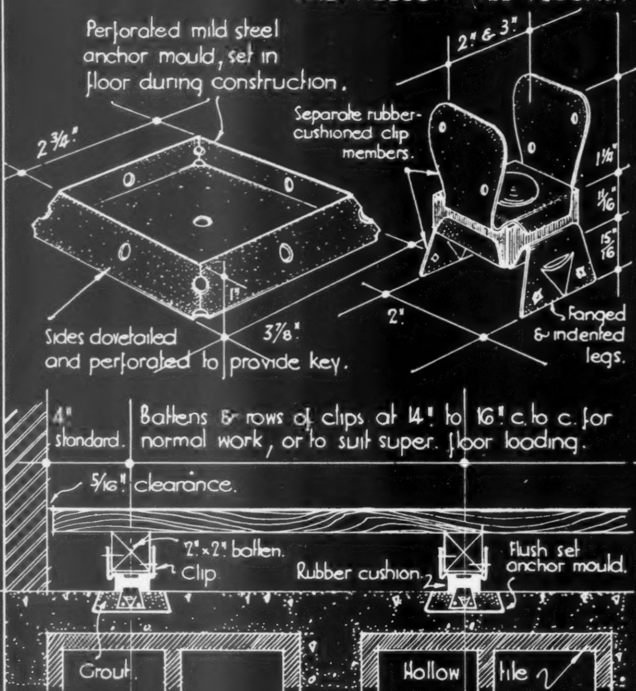

803.

THE ARCHITECTS' JOURNAL LIBRARY OF PLANNED INFORMATION

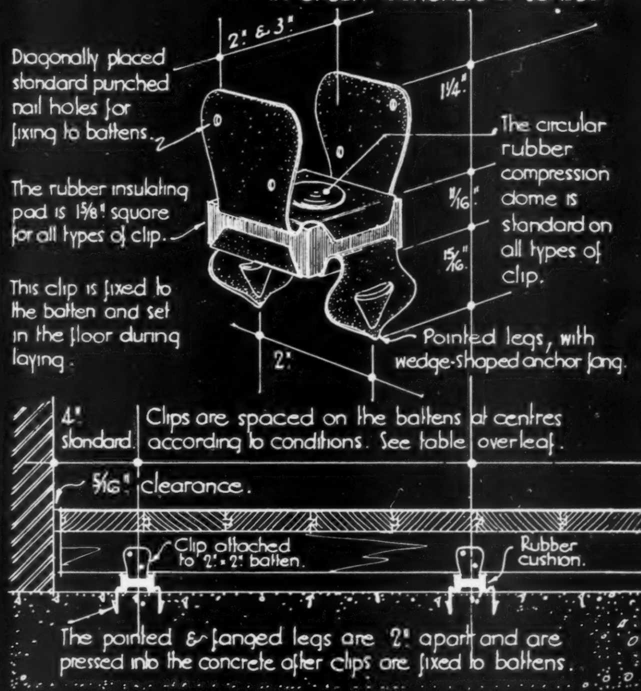
DIAGRAMS SHOWING SIZES & APPLICATION OF STANDARD ·SYLENZ· CUSHIONED INSULATING CLIPS:

All types of clip should be staggered on adjacent rows.

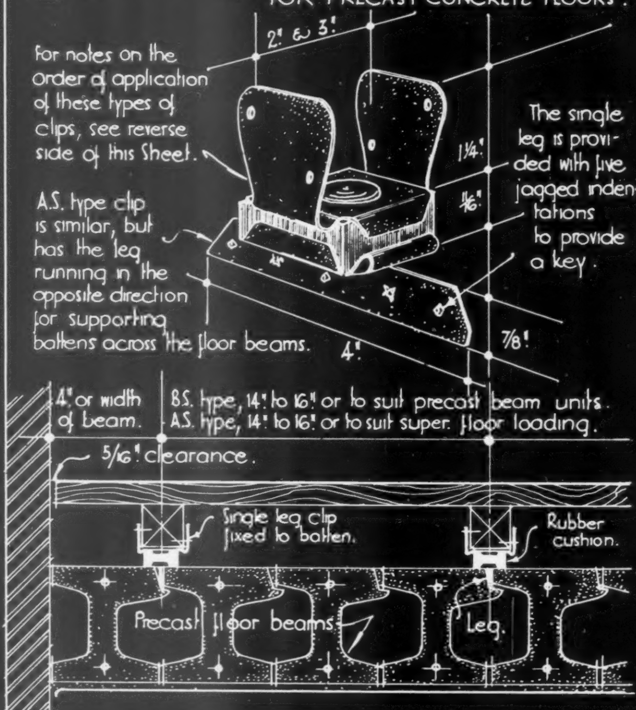
① ·B· TYPE UNIT FOR IN SITU CONCRETE AND HOLLOW TILE FLOORS:



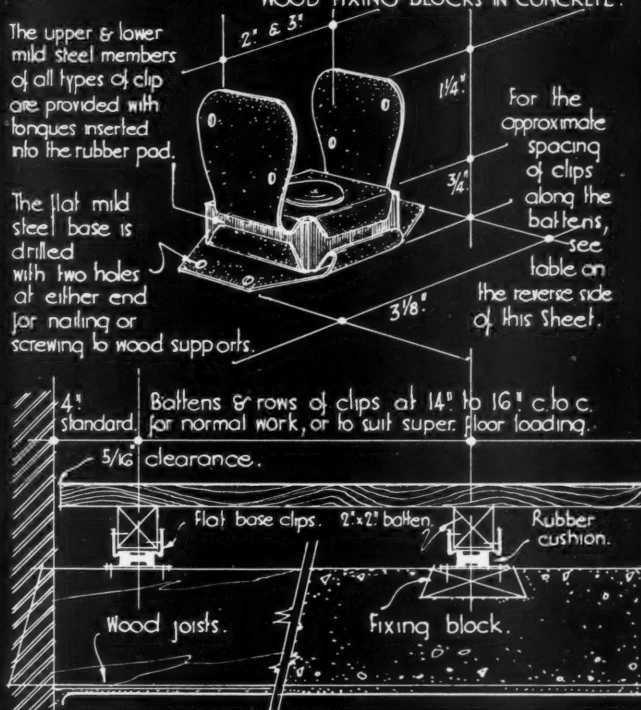
② ·A· TYPE CLIP FOR DIRECT SETTING IN GREEN CONCRETE or SCREED:



③ ·B.S: TYPE SINGLE LEG CLIP FOR PRECAST CONCRETE FLOORS:



④ ·F.F· TYPE CLIP FOR WOOD JOISTS OR FOR WOOD FIXING BLOCKS IN CONCRETE:



Information from J.C. Birch.

INFORMATION SHEET: INSULATED FLOOR-ANCHORAGE CLIPS.

SIR JOHN BURNET TAIT AND LORNE ARCHITECTS ONE MONTAGUE PLACE BEDFORD SQUARE LONDON WC1· Oscar A. Bayne

THE ARCHITECTS' JOURNAL
LIBRARY OF PLANNED INFORMATION

INFORMATION SHEET • 627 •

SOUND INSULATION

Product: Rubber Cushioned Insulating Clips and Anchor Moulds

General :

This Sheet sets out the standard types of "Sylenz" cushioned insulating clips for the sound insulation of wood floors laid over *in situ*, or precast concrete, or timber under-construction. The clips are designed to isolate the wood flooring and joists from the main structure, thus reducing the amount of sound vibration transmitted to the structure. It is important that clearances of $\frac{5}{16}$ in. be allowed between the walls and the battens or joists and the flooring.

To ensure an even bearing, it is recommended also that a clip be fixed approximately 4 ins. from the wall end of every batten, and that the clips be staggered on adjacent battens.

Types of Clip :

All four types of clip are made in two sizes to suit 2-in. and 3-in. wood joists. The standard thickness of the rubber cushion is $\frac{1}{2}$ in., but clips can be obtained with cushions 1 in. thick; the reference number of the latter type is H.C.F.

Construction :

Each clip consists of an upper and a lower mild steel member, separated by the rubber insulating pad to which they are fixed by tongues penetrating the cushion on opposite sides. The upper member has wings punched for nailing to the battens, and a round opening at the bottom through which projects the compression dome on the upper side of the rubber pad. All clips should be held firmly to the battens when nailing, so as to compress this dome.

The lower steel member is differently shaped and indented on each type of clip to suit the conditions of use. All metal parts are rust-proofed.

Insulation :

The insulating pad is resilient rubber, treated to increase its strength, stability and ageing properties. The effects on the rubber pads of the grip of the metal parts, after loading, are pre-determined and adjusted to avoid side-sway or bounce with the finished floor.

Purpose of Types :

(1) *B Type Unit :* This type is for the insulation of *in situ* concrete floors of hollow tile or solid construction. The complete unit is a one-piece, dovetailed mild steel anchor mould for setting flush in the green concrete, and a clip having fanged and indented square legs for grouting centrally into the mould.

The mould is perforated, and allows enough concrete to penetrate and prevent voids, and form a key. Moulds are supplied packed with a swab of wood-wool to prevent dirt or rubbish getting into the mould during the interval between placing and the laying of the flooring. They are placed flush with the surface and cannot be damaged during building operations.

When the flooring is to be laid, the packing is removed from the moulds and the clips are nailed to the battens at centres to correspond with the spacing of the moulds. The battens are then placed in position with the bottom edge of the square legs of the clips standing in the open moulds and the clips are grouted in with sand and cement mortar. Slight variations in the sub-floor will not affect the joist level.

When the grouting has set, the flooring is nailed to the battens in the usual way.

(2) *A Type Clip :* This type is designed for use where the floor battens can be fixed in position during construction. The clips are similar to those described above but have pointed legs for direct insertion into the green concrete or screed. They are nailed to the battens before they are laid, and pressed into the sub-floor till the flat metal base is level with the surface. The flooring can be laid when the concrete has set.

(3) *BS and AS Types :* These types are for use with precast concrete floors : type BS to carry wood joists or battens parallel with the beams, and type AS to carry them across the beams. The only difference between the types is that the single indented anchoring leg runs parallel with or at right angles to the batten.

Precast floors which require grouting up are grouted up in the usual way except that loose sand filling should be placed at intervals in the joints to provide holes wherever clips are to be fixed. This sand is later removed to receive the clips, which are first fixed to the battens.

(4) *FF Type Clip :* The FF type clip is suitable both as an insulator for fixing to wood floor joists, and for direct nailing to wood or composition fixing blocks set in concrete or screed. The lower steel member has a flat base with four punched holes for nails or screws. When used on wood sub-floors the clips are always fixed so that the battens run across the joists.

Spacing :

The following table sets out the approximate spacing of the clips along the battens, and between the rows of battens, for floors used for various purposes. The figures are based on the average superimposed load to be applied to the floor.

The use of anchor moulds will not affect the spans given. The number of clips and moulds per yard super will vary slightly according to the size of the room.

SUGGESTED STAGGERED SPACING OF "SYLENZ" CLIPS

Type of building	Spacing of clips on battens C. to C.	Centres of battens	Approx. No. of clips per super yard	Basis of calculation. Room size
Flats, Hotel bedrooms, etc....	3' 0" with battens at ... 2' 8" with battens at ...	14" 16"	3·125	30' × 20'
Churches, Schools, Hospital * wards.	2' 8" with battens at ... 2' 6" with battens at ...	14" 15"	3·375 3·250	30' × 20'
Lecture and Assembly halls, * Restaurants, etc.	2' 2" with battens at ... 2' 0" with battens at ...	14" 15"	4·050	30' × 20'
Warehouses, Works, Ballrooms.	Spacings will be recommended by the makers according to loads and conditions.			

* *For these types of buildings the battens should be not less than $2\frac{1}{2}" \times 2"$*

Prices :

A scale of approximate comparative costs per yard super, based on a room size of 30 ft. × 20 ft. (including the additional clip fixed 4 ins. from the wall end of every joist) is given in the table below.

Type of building	STANDARD TYPES COST PER YARD SUPER.			
	A type clip	B type unit comprising clip and anchor mould	FF types	AS or BS type single leg clip
Flats, Hotel bedrooms, etc.	1s. 9½d.	2s. 2½d.	1s. 10¼d.	1s. 11¾d.
Churches, Schools, Hospital wards...	1s. 10½d.	2s. 3¾d.	1s. 11¼d.	2s. 0¾d.
Lecture and Assembly halls, etc. ...	2s. 3½d.	2s. 10d.	2s. 4¼d.	2s. 6¼d.

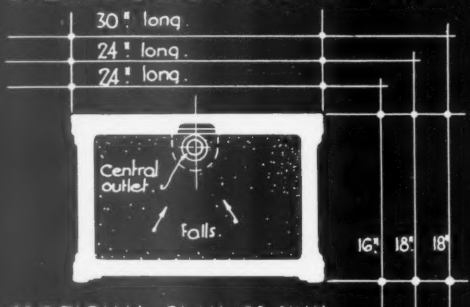
A type clip ... ... £28 10s. per 1,000
B type unit, comprising clip and anchor mould ... ... £35 10s. ,,
F.F. type clip ... ... £29 10s. per 1,000
A.S. or B.S. types, single leg clips ... £31 10s. ,,
Special prices are quoted for large quantities.

Manufacturers : Messrs. J. C. Birch
Address : Buildings Section, School Hill Works, Bolton, Lancs.
Telephone : Bolton 1767 (2 lines)
Night Calls : Bolton 3199
Telegrams and Cables : "Sylenz, Bolton"

758.

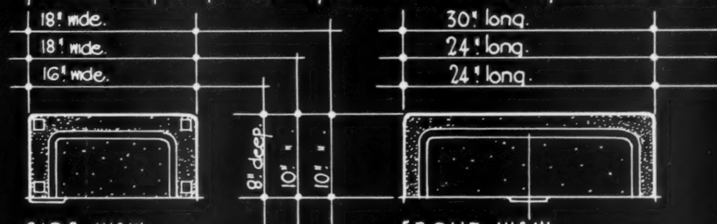
THE ARCHITECTS' JOURNAL LIBRARY OF PLANNED INFORMATION

DIAGRAMS GIVING SIZES OF THE •BRISTAN• STANDARDISED WHITE GLAZE SINK:



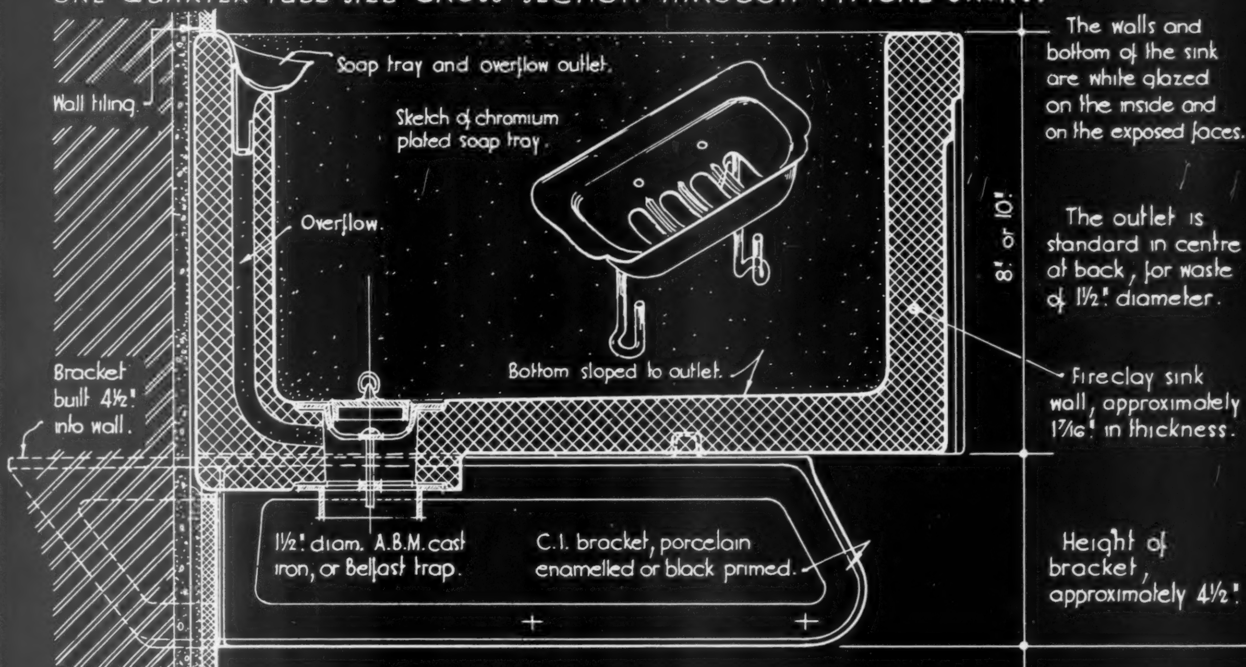
SECTIONAL PLAN OF SINK

Sinks are made of fireclay in three standard sizes, complete with soap tray & 2 C.I. porcelain enamelled or painted brackets.

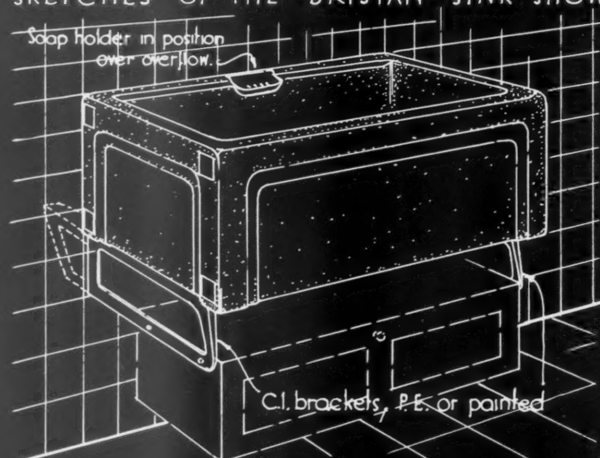


SIDE VIEW. FRONT VIEW.

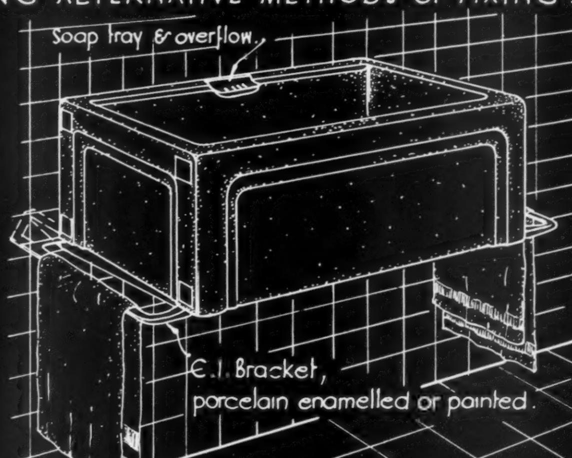
ONE QUARTER FULL SIZE CROSS SECTION THROUGH TYPICAL SINK.:



SKETCHES OF THE •BRISTAN• SINK SHOWING ALTERNATIVE METHODS OF FIXING:



BRACKETS FIXED VERTICALLY MAY SUPPORT A CABINET.



BRACKETS FIXED HORIZONTALLY TO ACT AS TOWEL RAILS.

Information from Associated Builders' Merchants Ltd.

INFORMATION SHEET: BRACKET SUPPORTED FIRECLAY SINKS.

SIR JOHN BURNET TAIT AND LORNE ARCHITECTS ONE MONTAGUE PLACE BEDFORD SQUARE LONDON WC1 • Grace G. Bayne

THE ARCHITECTS' JOURNAL
LIBRARY OF PLANNED INFORMATION

INFORMATION SHEET

• 628 •

FIRECLAY SINKS

Product : A.B.M. White Glazed " Bristan " Sink

Description :

A standardized fireclay sink made in three sizes : 24 ins. by 16 ins. by 8 ins., 24 ins. by 18 ins. by 10 ins., and 30 ins. by 18 ins. by 10 ins. overall dimensions.

The sink is designed so that it may be fitted in an exposed position, supported on brackets, with free air space to permit easy and quick cleaning.

The outlet to the waste is in the bottom of the sink at the centre at the back. The bottom falls slightly to the outlet, which may be fitted with either the 1½ ins. diam. A.B.M. cast iron trap or a Belfast trap.

In the centre of the back wall of the sink is the overflow outlet fitted with a chromium-plated grating which forms a soap holder.

Bracket Supports :

The sink is supported on a pair of cantilevered cast iron brackets.

These brackets if built-in horizontally form towel rails, and if fixed vertically may be used to give support for a cupboard screw fixed to the brackets as indicated.

The brackets are approximately 20½ ins. long overall and have a flange along the top, provided with a small stud which fits into the hole in the sink to give proper stability.

The brackets are intended for building into the wall about 4½ ins., leaving a cantilevered projection of 16 ins.

Draining Boards :

The sink is designed so that any of the standardised A.B.M. draining boards may be fitted into position over its side walls. Information Sheet No. 555 deals in detail with A.B.M. draining boards and their fitting and fixing.

Finish :

The sinks are finished in white glazed porcelain enamel internally and to both ends and front externally.

The brackets may be obtained with porcelain enamel finish, or black primed ready for painting.

Previous Sheets :

Sheets previously published dealing with A.B.M. products are Nos. 540, 555, 558, 562, 566, 570, 574, 579, 591, 597, 601, 609, 615 and 621.

Standardised Design :

The Associated Builders' Merchants is a non-trading organization devoted to the standardization of the design of building materials and equipment. Materials and equipment made by a number of manufacturers are stamped with the following symbol indicating that they conform to the standard of design and quality laid down.

Issued by : The Associated Builders' Merchants, Ltd.

Address : Peters Hill, Upper Thames Street, E.C.4

SILENCE

FOREWORD

BY LORD HORDER

It is a privilege to write a short Foreword to this special issue of THE ARCHITECTS' JOURNAL and I naturally showed no hesitation in accepting the Editor's invitation to do so.

The rapid development of machinery—for production, for transport, for the spread of knowledge and for amusement—and the urbanisation that has been the unplanned accompaniment of the industrial revolution, have brought a number of unhealthy and unlovely things in their wake.

Amongst these is Noise. We all suffer, though some of us are more aware of the fact than others, whether because we are more sensitive, or because the nature of our work makes us more susceptible to what is going on around us.

If we are going to control the machine, rather than let it control us, we must do something about all this din and clatter; not to abolish Noise, for that cannot be done, but to eliminate Noise that is needless, Noise that merely distracts and exasperates and gives us no return for the nuisance that we suffer.

There are only two ways in which this can be done. We can invent gadgets to douse the Noise that we make or we can prevent Noise at its source. The latter is by far the better method, but it demands foresight and wise planning.

Whichever method be adopted all sections of the community can unite to achieve something. The contribution that is possible from those who design our dwelling houses, our workrooms and our public buildings is one of the most helpful.

Hence the great value of this number of THE ARCHITECTS' JOURNAL, which first of all states, eloquently and convincingly, the case against Noise, and then proceeds to summarise the experts' answer to the question: What can be done?

But the final answer still rests with the public. Does it want to be saved from Noise? Does it dislike Noise sufficiently to take a little trouble, and perhaps pay a little, to be freed from it? If it does, then this effort of THE ARCHITECTS' JOURNAL will not have been made in vain.

CONTENTS

** Contributors marked thus are officials of the Physics Department of the National Physical Laboratory.*
The JOURNAL wishes to acknowledge the very great assistance given by Dr. Constable and other officials of the Laboratory in the preparation of the technical sections of this issue.

Nine till Six

THE ATTACK ON SILENCE

ONE MAY SAY that civilization connotes the establishing of such an order of law and government that people may live in a state of reasonable health, happiness and cultural activity in organized communities. The measure of civilization is then the degree to which these things are obstructed by other factors in the communal life.

In a civilization such as our own, where progress is directed almost exclusively along mechanical lines, we find that each successive amelioration is accompanied by a corresponding, though usually lesser, destruction of existing amenities. Thus the age of steam, which broadened the basis of material prosperity, despoiled both town and rural scene in its advance, and surrounded man's affairs in an ungodly halo of smoke. The discovery of electric power forwarded the possibility of pure air, and covered the landscape in a network of overhead cables.

The internal combustion engine made possible a mobility never before enjoyed by the human race. Yet that same mobility is destroying the reasoned relationship of town and country, and killing off the population like ants underfoot.

Each of these milestones to material progress, together with the telephone, typewriter, radio, gramophone, the steel-frame, the aeroplane, brought with them accessions of noise.

Noise is the absence of silence, which is essential to health, happiness and cultural activity. Yet an age which holds cleanliness to be of rather higher social importance than godliness, and in which efficiency is a by-word, is on the whole not offended by the noisy, as opposed to the noisome, citizen.

There is an attitude to the absence of silence which proclaims: 'noise will always be with us, we should learn to enjoy it.' The first part of this belief is untrue; the second, by a wise provision of nature, impossible. There will always be Philistines among us who will delight in noise. But they must not rule us; we may remember that Herbert Spencer plugged his ears with wool, and wrote: 'you might gauge a man's intellectual capacity by the degree of his intolerance of unnecessary noises.' There was Carlyle, who found that the sound of a cockcrow, that most devastating of farmyard noises, could cause him to live on tenterhooks, waiting for its repetition, and built himself a sound-proof room to work in. And Schopenhauer, who chafed unbearably at the crack of the carters' whips, and held that 'noise is the true murderer of thought.'

These no doubt were hyper-sensitive. Yet it remains true that Silence is the greatest renovator of exhausted city nerves. Today the Attack on Silence has spread from the city to the countryside and where there is no refuge from noise there can be no real health.

SILENCE IS GOOD FOR YOU

NOISE **"(a word of doubtful origin; O.Fr. *nogse* or *nose*; Prov. *nausa*, which points to Lat. *nausea*, sickness, as the origin; others take Lat. *noxia*, harm, as the source), an excessive, offensive, persistent or startling sound. By the common law of England freedom from noise is essential to the full enjoyment of a dwelling-house, and acts which affect that enjoyment may be actionable as nuisances. But it has been laid down that a nuisance by noise, supposing malice to be out of the question, is emphatically a question of degree. The noise must be exceptionable and unreasonable. The ringing of bells, building operations, vibration of machinery, fireworks, bands, a circus, merry-go-rounds, collecting disorderly crowds, dancing, singing, etc., have been held under certain circumstances to constitute nuisances so as to interfere with quiet and comfort, and have been restrained by injunction. Noise occasioned by the frequent repetition of street cries is frequently the subject of local bylaws, which impose penalties for infringement. . . ."**

Encyclopædia Britannica and Lloyds' Encyclopedic Dictionary.

SOUND **"(Fr. *sonner*, from Lat. *sono*, from *sonus*, a sound. Sp. *sonar*; Ital. *suonare*). Subjectively the sense impression of the organ of hearing, and objectively the vibratory motion which produces the sensation sound."**

By John Barton

SILENCE is the absence of noise or sound.

To live permanently without sound would, of course, be physiologically, and intellectually, undesirable, but to live without noise should surely be a final aim of social development.

The city of today is a noisier place than the city of 200 years ago, which, in its turn, was noisier than a township of the 1500's. But noise has not shown a steady increase, exactly parallel with mechanical progress. The London of Hogarth's "Southwark Fair" one can imagine being far noisier, at times and in patches, than modern London. While Gladstone's son records that the city din was greater in the 1880's, from iron-clad wheels on cobbled streets, than thirty years later when better forms of surfacing and rubber tyres for private and hackney carriages created a vast improvement, even before Dunlop's pneumatic tyre was invented.

But over any sufficiently long period of time, it appears that the volume and duration of noise has always increased; as industry and commerce became mechanized, transport became

faster and more widespread, buildings became larger, communities more numerous.

While it is true that all mechanical noise, at least, represents the wastage of energy, it seems that this wastage is seldom great enough to warrant attention from the manufacturer or consumer, except under the definite compulsion of a necessity to reduce noise.

Where there is complete freedom from this compulsion, either directly from the State, or indirectly from the consumer—as, for example, in current aircraft design—noise tends to increase in exact proportion to the increase of mechanical efficiency. Under this condition of complete freedom, which is rare, the tendency to greater and still greater noise is alarming.

Noise can be studied from the purely material aspect—as a blanket covering the modern city, to be weighed and measured, or from the psychological view, in its effect on the human being.

(For example, the irritation caused by a pneumatic drill is out of all proportion to the physical intensity of its noise, being due rather to the intermittence. Thus it is possible that the noise would be less worrying were it even louder, but continuous.)

Apart from material damage due to vibration, it is, finally, only this psychological aspect of noise that matters. So before enquiring into the sources of noise, let us therefore consider more closely its effect on the individual.

A good introductory example is the experiment of Dr. Laird, of Hamilton, N.Y.

Dr. Laird recently made a definite attempt to measure scientifically the effect of noise on human efficiency. Four typists were chosen, two male and two female. By taking calorific tests of samples of exhaled air, the preliminary discovery was made that the increase, on an average, of working metabolism over resting metabolism, was 52 per cent.

This was raised to *71 per cent.* in conditions of average maximum office noise.

In typing a standard letter, the time taken was 155 seconds. Under noisy conditions the same letter took *162 seconds*—the typists working at maximum speed in each case, and the number of mistakes (strangely, it would seem) being approximately the same. Removing a letter and inserting fresh paper took three seconds—plus *half a second* under noisy conditions.

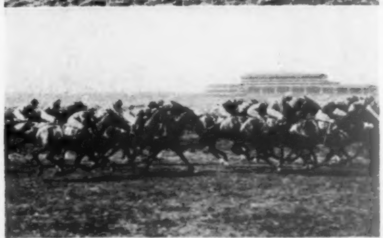
Working over a period of time, the typists, under quiet conditions, were able to produce an increase of speed, or " warming-up," almost indefinitely. (That is to say, higher speed at the end of the first half-hour, still higher at the end of the second, etc.) Under noisy conditions there was *no increase of speed*, though, as the metabolic figures show, there was a consistently higher output of energy.

From Dr. Laird's tests, which were carried out with scientific thoroughness, it may be deduced that noise acts as an invisible brake on the activities, to combat which extra energy is used, but without entirely overcoming this braking action.

Noise produces neurosis. According to eminent nerve specialists in this country and America, noise is a root cause of modern neurosis, and mental and physical breakdown, which we seem, unfortunately, prepared to accept as endemic in contemporary life. Sir James Purves-Stewart writes:

> Cases of neurosis, functional nervous disorder, or so-called " nerves," are aggravated by the effects of noise, which is one of the primary fear-producing stimuli (the presence of which), renders the neurotic individual incapable of coping with his anxiety-neurosis.

Writing of the state before final exhaustion is reached, Dr. Purves-Stewart explains: " This process of suppression involves a diversion of nervous energy, which is sometimes greater than the individual can afford—to remain in good health. Personal and industrial efficiency is inevitably impaired . . ."





So much for the psychological aspect of noise. One might call it the litmus test of the reaction of noise on the mind. And since it appears very definitely to turn the blue litmus red, let us now consider the specific sources of noise; their particular reactions; and the possibilities of abatement.

The sources of noise can be divided into three, quite arbitrary, groups. As social problems in order of importance, we should set them down:

Transport noise (road, rail, air).

Industrial noise (factories, offices, mechanical equipment in the home).

Natural noise (pedestrian, vocal, the sea, the trees, music). To deal with these noises in a general way, comparing here Niagara Falls' *105* phons with a street crowd's ***110***, there the lion's *102*-phons roar with a tramcar's ***106***, would probably be amusing. But presenting sources of noise in the light of definite consideration of their abatement, which is the purpose of this article, it will be found more practical to review them in their appropriate groups.

Let us then take the least of these groups:

Natural noise, the first in age, in ubiquity, the least disturbing.

It ranges from thunder, at *85* phons, to woodland noise, *42*, grassland, *35*, and a quiet whisper, *15* phons. *10* phons of sound is usually considered the threshold of intelligibility. Where noise falls below this, the ensuing silence is described as "uncanny."

Natural noise can thus be very loud. But apart from the fact that one tends instinctively to condone natural noise, in its louder forms it is seldom frequent or continuous. Sea breakers, thunder and gales of wind are three of the few cases where natural noise has any great effect on the nervous system.

Nevertheless, much natural noise is obtrusive, consequently irritating, and above all often unnecessary.

The most universal is that of footsteps, deriving from one of two causes: the impact of hard surface on hard surface (e.g. leather, and steel nails, on pavements), and vibration (e.g. footsteps on wood-framed floors overhead).

In the first, rubber reduces footstep noise. In the second case, architects should be obliged to design all but the most transient of structures in rigid materials. (Complaints of lack of "springiness" in, for example, hollow-tile floors, could be met if necessary by super-imposed wood-frame floors, but to any impartial judge cork or rubber surfacing is a complete substitute, except for dancing.)

In annoyance-value, the next natural noise is probably street cries.

In spite of the late Mr. G. K. Chesterton and other romantics, street cries and street music could be abolished to the detriment of the very few, the relief of the sick, of night workers, and any number of quite intelligent people. At present, though old Metropolitan Police Acts are still in force to cope with this evil, setting them in motion by a private individual is sometimes expensive, always dilatory, and usually ineffective.

A bane peculiar to the English-speaking countries, and constituting a fruitful source of noise, is the abundant cat and dog life in our cities. No one would appear to have measured a cat's meaouw, but a dog's bark is *85* phons. What should be done?

A preliminary skirmish would be to raise licences to ten shillings, and impose, say, a five-shilling licence on cats. This would encourage people to reflect whether they really wanted their dog, or their cat (or their two dogs and their two cats). Dogs or cats found wandering without a current (coloured) licence-ticket would be seized, held for one week, and then destroyed.








Of other noise that must be called natural, in the sense that it cannot be cured by the manufacturer, is music, fireworks, loud talking and shouting, and roller-skating. The last should obviously be prohibited altogether from the streets, while fireworks should be reserved strictly to their appropriate festivals.

The question of music in modern life raises an interesting point; and it applies to good music and bad, to Brahms and Buddy Rogers. The main point is: what effects are produced in using music as a background to living—for eating (restaurant dance-band, home radio), for conversation (radio or radiogram), for working, for driving (radio in the kitchen, on the dashboard)? In all cases it may be said with absolute assurance, that the attention being divided, the mind is either irritated or "carried away"—with the possible exception of "automatic" work in factories—and in consequence the activity in hand accomplished less well than it might have been. No true restaurateur would therefore inflict an orchestra on his patrons.

So far as loud talking and shouting are concerned, these seem to be subject to the inevitability of gradualness. They can only be educated out. The occasions when one need shout are remarkably few, yet some people shout more than they talk. They habitually shout on the telephone. They could be ostracised, as one ostracises other manifestations of obtrusive self-assertion.

And that is the worst we can do for *Natural noise*. It is not very bad. But it would make a good test-case—as the opening shot in a real anti-noise campaign, if the authorities could be persuaded first to legislate against all avoidable natural noises.

We would then be free to deal with the second of our groups, *Industrial noise.*

Humbert Wolfe once described a scene where—

> . . . the little feet of rain
> gliding from blade to blade were almost heard.

It gives one perhaps as good an idea as any of the scale of industrial noise, to realize that in an average boiler factory (*110–115* phons), not only would the little feet of rain be unheard but an adult lion roaring to capacity (*105* phons), would be equally inaudible.

Within the scope of Industrial noise should be included factory, office and building construction noise, and all noise resulting from mechanical equipment (telephone, typewriter, pneumatic drill, clock-ticks and alarums, doorbells), that could, by re-design in the factory, be largely eliminated.

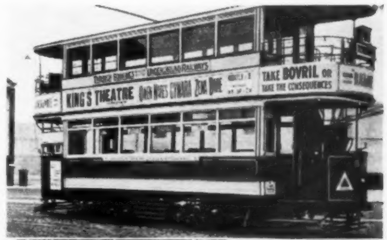
Let us consider factory noise.

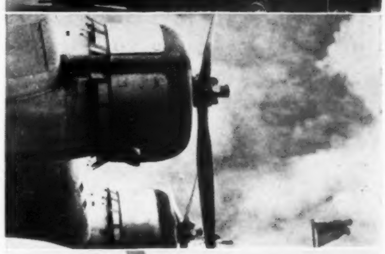
The loudest factory noise is that of hammering on steel plates (*128* phons). This approaches the level of physically painful sound (*145* phons). There is, too, the riveter (*116* phons), which is of course also used in building construction. Comparing favourably with the boiler factory, the average noise-level in a machine shop is *87* phons.

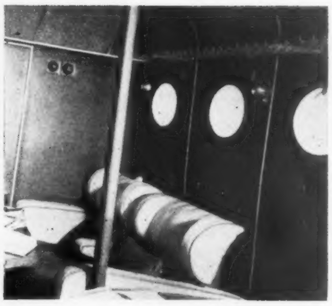
What is the effect of this noise on the workman? To quote Dr. Purves-Stewart:

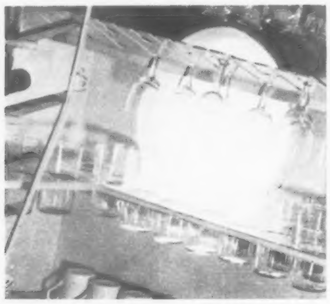
> Workmen who are habitually exposed to loud noises in the course of their employment tend, sooner or later, to become deaf. Such, for example, are boiler-makers (especially those working inside the boiler), also other metal-workers like blacksmiths, iron-turners, file-makers, and plate-makers; also spinners and weavers and, incidentally, machine-gunners and artillerymen. Noise-deafness of this sort is due to damage inflicted on the auditory nervous mechanism, especially of the inner ear, by the continued excessive stimulation of loud noises.

A less common variety of deafness is that produced by a single "deafening" explosion, as of a big gun. This can be permanent, where the drum or membrane of the ear is ruptured. Of actual gun-fire, that on board ship is by far the most harmful, additional vibration being transmitted through the body of the









vessel itself. A partial remedy, against explosions of this nature, adopted by sailors, is to keep the mouth open, thus equalizing pressure on both ear-drums, while at the same time plugging the ears with wax.

An interesting observation from Dr. Ritchie Rodger, is that in the early stages of deafness, the maximum deterioration of hearing occurs at the pitch of the deafness-producing noise. Thus the boiler-maker, who is subject to high-pitched sounds, loses his hearing earliest for such sounds. The beetler, whose occupation consists in finishing off cotton cloth by the repeated impact of heavy logs or "beetles," which make a deep, thundering noise, loses his hearing earliest for low-pitched sounds.

Dealing with riveting, Sir Thomas Oliver writes:

> . . . as many men are working close together the clang is almost continuous. The percentage of men who have followed the occupation for 15–20 years without becoming deaf is small. Men who have thus lost their hearing are badly fitted for other occupations. The deafness causes the men to become introspective, and in the case of illness tends to delay recovery . . .

Finally, an otologist, Dr. Dan Mackenzie, should be quoted, lest it should seem that this deafness may in itself give relief:

> It is rare for deaf persons to live in a pool of silence or even in a world of reduced sounds. On the contrary, in most cases of acquired deafness the patient really lives amidst noise, since coincidentally with his inability to hear external sounds he is annoyed by spontaneous noises in his head—so-called tinnitus or ringing in the ears. Such subjective noise is often continuous and incessant.
>
> More usually the sufferer grows used to his tinnitus, just as the factory-worker learns to ignore the noise of machinery.

What can be done to combat factory noise?

In the first place the factories themselves should be isolated within industrial zones—satellite townships connected by a minimum line of communications with the residential city.

Secondly, research should be conducted in methods of reducing the noise of processes. Modern sources of power (e.g. electricity), modern materials and methods (e.g. plastics), tend to assist this aim.

In some processes it may be assumed that considerable noise will always be present. Here, workmen should be provided with effective noise masks on a similar principle to the gas-masks worn in various industries.

> Any efforts made in industrial works to reduce the amount of noise, writes Professor Henry J. Spooner, would lead to increased production and an improvement in the general condition of the workers, particularly in their nervous systems. Some engineers know by experience and introspection how much we are affected by noise, and how a period spent in the midst of working machines and mechanical operations—causing strident and deafening sounds of a wide range, and shocks to the auditory nerves—produces a feeling of sensory fatigue.

It is interesting to remember that in the "silent" days, film-making was an industry of considerable noise, none of it, one was assured, being reducible except at an uneconomic cost.

With "talkies" came a change of heart. There is no reason to suppose that restrictive legislation could not effect a similar change in other workshops and factories.

To turn from the modern *factory* to the modern *office* does not, from the noise angle, constitute a particularly great change. Mechanization of business routine has converted the average office (*75* phons), into something approaching a superior form of workshop. A large typists' office (*85–90* phons), is actually noisier than a machine shop (*87* phons).

All types of office have been affected, and the following extract from a Bank Officers' Guild report indicates to some extent where the fault lies:

> Many banks have been mechanized in a haphazard way. Adding and accountancy machines have been dumped into offices not designed for them. . . . Complaints are numerous. Girls and machines have been accommodated in small rooms where the noise becomes nerve-racking. Nervous disorders have increased.

Apart from the re-design of offices, for segregation and absorption of sound, mechanical equipment itself should be silenced. Partially silenced typewriters have been on the market for some years. They should be compulsory where there are two or more persons in an office. Computators should be silenced.

That the appalling noise of the telephone bell has not been replaced by a low "tock-tock" or a small flashing light, is surprising in view of the Post Office's generally progressive attitude. It can only be set down to the universal lack of noise-consciousness.

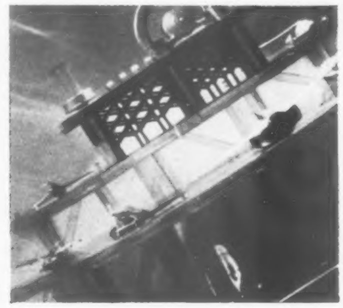
In building and road construction, apart from the riveter (*116* phons), the pneumatic drill (*105* phons), is the worst offender, with the steam pile-driver (*102* phons), steam shovel and rock drill (*97·5*), and simple hammering (*91·5*), as good runners-up.

The pneumatic drill is the instrument calling forth most protest from the general public. Let us consider it.

As far back as 1932, a demonstration was given of pneumatic road-drills fitted with silencers. The comparatively small amount of noise emitted was remarkable. It was not made compulsory by law, and one has yet to come across a normal building job on which it is being used. Building contractors not being philanthropists, it seems that they will not voluntarily submit to the extra initial cost or hire, nor the fractional loss of power resulting from its use.

This is typical of the general attitude of contractors to noise.

Within the group that we have called industrial noise, there still remains mechanical equipment used in the home: the door-bell, the tick, chime and alarum of a clock, the vacuum cleaner, the lawn mower.



The doorbell (knockers, of course, being forbidden) should be designed to give a low melodious note, and function on the intermittent principle of the telephone bell. Any clock for which a fair price is paid should be absolutely silent in action.

There is no reason why the vacuum cleaner and lawn mower should not be made almost completely silent. And in view of the public nuisance caused by the latter during summer months, it should, for this instrument at least, be legally necessary.

With major abuses out of the way there would be found much scope for minor " mopping-up " of unnecessary noises. Dustbins and dustbin lids should be fitted with rubber rims, the whole of our sanitary systems and methods of door and window construction need revising, from the standpoint of noise-reduction.

We have now dealt with two of our three groups. With *Natural noise*, the greatest common source being footsteps (20–40 db.), and *Industrial noise*, where processes may give more than 100 decibels.

Our third and greatest group, the *pièce de résistance* of any anti-noise thesis, is—*Transport noise*.

Transport is conducted by land, sea and air. Beyond saying that, still, many luxury liners are noisy, it is not worth while to write other than technically on sea-going noise. The shipping companies are fully aware of the bad " box-office " of noise and vibration, and they are doing their best to reduce it.

There remains land transport and air transport. Let us start on the ground.

Land transport is by road and rail. Of the two systems rail traffic makes most noise per unit, road traffic—by its vastly greater volume—gives the larger total of noise.

Road traffic noise ranges from the horse-cart on an asphalt road (*76* phons), to a saloon car at speed (inside, ***90*** phons), and an omnibus (inside, *81–89* phons). If we include the loudest motor-car horn (*115–125* phons) we approach physically painful sound (*145* phons), and make Niagara Falls (noisiest position, *105* phons) seem pretty quiet.

Generally speaking, however, road traffic is heard as a symphony rather than a solo.

Moderate traffic gives a fluctuating noise-level of *60–75* phons, heavy traffic a continuous noise-level of *85* phons or more. Some examples of both types are: Regent's Park (*67* phons), Fleet Street (Law Courts) (*77* phons), Trafalgar Square (*87* phons), Victoria Street (*88* phons)—with the religious quiet surrounding St. Paul's (*89* phons).

One might add that the roar of a Bengal tiger, which occurs, of course, only from time to time, is the imperceptible amount of *16·5* phons above St. Paul's traffic noise (*90·5* phons).

The greatest problem in noise-abatement of road transport is the internal combustion engine; by far the largest proportion of vehicles—private car, lorry, omnibus—using this source of power.

Motor-vehicle noise falls under the two heads of fact and opinion. The noise arising from ramshackle vehicles and badly packed loads is fairly easy to deal with because it is largely a question of fact. That emanating from inadequate silencers or —from the noise standpoint—crudely designed engines, is more difficult, for as a writer in " The Listener " has said, it is affected by the word—so beloved by the draftsman, but loathed by the police—the word " reasonable."

The petrol motor, by nature, is not ideally adapted to silent action, but with the use of multi-cylinder engines, " floating " engine-blocks and more adequately designed exhaust silencers—in addition to diesel-engine development—all noise from this source could be brought down to the Rolls-Royce level.

Let us again quote the writer in " The Listener " :

> In the first place, he says, " recording instruments must be invented that will measure the volume of noise . . . and which are so accurate that a Court of Law will accept them as evidence." Then " the law should make the manufacturer, or repairer (of the engine), liable if he cannot disprove that the car or cycle turned out by him, and not tampered with subsequently or deteriorated by age . . . (is, in fact, noisy)."

A far easier problem is to deal with the motor horn (maximum, *117* phons). Being inessential to the functioning of the vehicle it could be abolished altogether, and replaced by a soft, battery-operated gong. (Mobile police could then use the present hooter — a far more satisfactory arrangement).

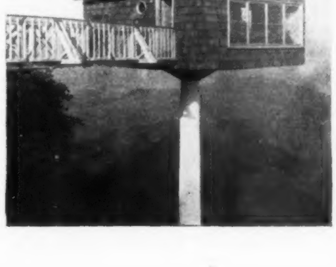
The point to realize is that a motor horn should sound like a request, not a command. For this reason the present " musical " horn is to be commended.

Against racing the engine in order to " warm-up," and sounding the horn when stationary, there are already regulations, though knowledge of them does not seem to be widespread.

One final point is the question of the car door. In setting out on any journey the ratio of doors to door-slams appears to be—4-door car (6 slams), 2-door car (3–4 slams). Could not the Society of Motor Manufacturers, by the use of sliding doors or rubber absorbers, cure this in their next year's models? It would require far less ingenuity than inventing the annual radiator design.

After the petrol engine, the next noise-bugbear of the roads is the tramcar. As it is now happily passing into obsolescence we need not deal with it. Instead, we may reflect on the extreme quietness of its successor, the trolleybus, which in this respect is almost ideal.

Though one may inveigh against the horse-drawn vehicle on other grounds, as a noise-factor it is not considerable (asphalt road, *76* phons). This ***76*** phons represents almost entirely the noise of the horse, for where the float or carriage is well-sprung,



[…]IC NOISE MEASUREMENTS IN LONDON
[…]icrophone Suspended Above Pavement.

Location	Average Noise Level
	Phons
In front of St. Paul's Cathedral	89
Mansion House	88
Victoria Street	88
Trafalgar Square	88
Fleet Street (Law Courts)	77
Temple Gardens	68
Regent's Park	67

TABLE GIVING VARIOUS NOISE LEVELS

Source	Observer's Position	Average Noise Level
		Phons
Aeroplane	10 ft. from airscrew	135 to 145
"	In cabin	105 to 125
Pneumatic drill	10 ft. away ..	105 to 115
Ship's siren	115 ft. away ..	113
Niagara Falls	Noisiest position ..	105
Motor horn	20 ft. away ..	109 to 117
Tram (30 m.p.h.) ..	6 ft. away ..	106
Tube train (30 m.p.h.) ..	In carriage ..	99 to 106
…am train (60 m.p.h.) ..	In carriage ..	89
… m.p.h.) ..	Inside ..	79 to 89
	Inside	90

LOUDNESS LEVELS OF COM[…]

	Phons above Threshold	
	115	Noisy aeroplane cabin.
In the aeroplane	105	Pneumatic road drill.
(Very noisy)	95	In the Tube train (London).
	85	Very busy traffic (London).
	75	In steam train (window open).
In the train	65	
(Noisy)	60	Ordinary conversation (3 ft.).
	55	In quiet saloon car (30 m.p.h.).
In the street	45	Suburban street.
(Average)	35	Quiet garden (suburbs).
In the home	30	
(Quiet)	15	Quiet whisper (5 ft.). Rustle of leaves in light breeze.
In the country (Very quiet)	0	Threshold of hearing.

MAXIMUM NOISE LEVELS FROM SPECIFIC SOURCES

	Phons
Hammering on steel plate (almost painful)	113
Motor horn	102
	101
	83
	81

oiled, and mounted on pneumatic tyres, the additional noise from this source is practically non-existent.

In order to reduce horse-noise, experiments are being conducted with rubber-composition horse-shoes, which should prove effective. At the same time, milk churns, milk-bottle carriers and dust-collecting equipment would be more adequately silenced, particularly in view of the early morning hours when they are used.

The general rubber-surfacing of all urban roads would be a great silencer of the horse-vehicle, together, of course, with most other traffic. The problem, in this connection, of "creeping" of rubber blocks has too long been considered insurmountable.

Of other road traffic noises, bicycle bells could be forbidden in favour of a less irritable sound, handcarts could be compulsorily pneumatic-tyred, and steam tractors could be blown up (under their own superabundant power).

From road transport to *rail transport*, is to turn from noise of the greatest volume and universality, to that of greater concentration and individual sound.

The main forms of rail transport are, steam train (in carriage, 89 *phons*), electric tube-train (in carriage, 99–106 *phons*), and diesel electric train (no figures available, probably under 89 *phons*). Other forms, the overhead mono-rail train (in Germany and Glasgow), and the rubber-tyred railcar tried out in France, do not appear to have a future.

Rail transport noise is derived from three factors, the engine, the couplings, and the friction of wheel-flange on rail—"rail roar." In the case of tube railways, this combined noise is reinforced by reflection from the sides of the tube, a factor which also operates in steam railway stations, tunnels and cuttings.

Of the three sources of engine-power, diesels should grow silent by development, steam engines by abolition; which leaves us to deal with the electric engine.

Noise-reduction in the electric engine can be—and in the case of Underground trains, is being—reduced by the use of greatly increased horse-power, and such mechanical refinements as helical gears.

Apart from the noise at rail-joints, which is being reduced by the spliced joint and long welded rail, "rail roar" is caused by the infinite number of dents and scratches—perhaps only a few thousandths of an inch deep—in the rails and wheel-flanges themselves. Noise from this source is quietened proportionately to the elimination of this friction.

For reducing the reflection of noise, tubes, tunnels, cuttings and stations should be surfaced as completely as possible.

From *road* and *rail* transport we have taken, in recent years, increasingly to the *air*. If one is to believe the newspaper writers, the future of almost everything lies in the air. So what is the position of air transport with regard to noise? Pretty bad.

Though it is many years since Alcock and Brown first flew the largest stretch of unbroken water, and many more since

Bleriot and the Wright brothers first circled over the heads of their amazed backers, flying is still looked upon as something of a miracle. There is still a feeling that we should be thankful if we can get up, and stay up, without coming down except when we want to. Consequently, a little matter of noise (10 ft. from airscrew, 145 *phons*), is not taken very seriously.

Nevertheless, if we are to have the skies black with warplanes (or even black with air liners), something will have to be done about it. It is unfortunate, from the noise point of view, that our military strategists are working along lines of speed tactics (bomb *him* before he bombs *you*), rather than on a policy of creeping on the enemy unawares.

The main sources of airplane noise, which are roughly of equal importance, are the airscrew and the engine. While very little trouble has been spent on the matter, it has nevertheless been discovered that for the reduction of airscrew noise, reducing the tip speed of the propeller blades is vital. By the use of geared engines and alternative designs of airscrew, tip speeds have been reduced by 25 and more per cent., when the noise becomes not only less in actual volume, but lower and less irritating in tone.

Engine silencing, in so far as it is peculiar to the aero-engine, awaits the design of silencers of weight and bulk not prohibitive in their effect on performance. It is, too, a matter of some difficulty to design so as not to increase materially the risk of fire in the event of a crash—owing to the high temperatures reached by internal parts.

Success on these lines could be attained within a reasonable time for light aeroplanes; but for military machines and liners, the general tendency is to increase power without consideration for the consequent increase of noise.

For the air passenger, some progress in noise reduction has been made. The placing of engines in the wings, away from the body of the plane, and the sound-proofing of cabin walls, has made air travel tolerably quiet. As liners become greater in size, sound-proofing could be made still more effective.

In general, legislation could be useful in forcing aircraft to considerable heights above ground when in transit, in prohibiting aerial advertising (an extensive source of low-flying), and in encouraging by vigorous means such developments as glide-landings (engines switched off well above ground), at aerodromes.

And that concludes our three groups.

To sum up, a recent writer has said: " The most serious aspect of the noise problem is the appalling economic loss to the nation due to impairment of working capacity in city and industrial life. More particularly must this be so with men of affairs, principals and executives, whose capacity for clear thinking, hard work, and energetic action is without doubt perceptibly weakened by the incessant if unconscious strain upon their nervous systems caused by the din and babel of noise from outside. In the aggregate, the economic loss due to this kind of wastage must be staggering in amount. . . . But the loss due to ill-health and premature death cannot possibly be estimated."

The Retreat

London Paris Berlin 5000 B.C.

As the ice withdrew and the sun flickered between the clouds, man found himself faced by another enemy. Under the warming rays, forests spread down to the water's edge. Forest and bog covered the country. Around the hut-stilts, eddies lapped, dappled with yellow light, biologically experimental birds fought between the trees, and across the hills came the cry of an owl hunting the swamps. Man gulped his stringy oysters, broke his tame dog's back when it barked, and went to sleep.

London Paris Berlin 500 A.D.

The country was rich with life. Geese flew overhead and herds of swine ran grunting through the beech woods. Men were few. To Nordic man, with his frame aching for exertion, noise was life, silence the death that came to a lone traveller on the uplands. He feasted in the high hall, splintering marrow-bones with his tankard, shouting the songs of joy and war and freedom. But the village was quiet. Sheep bleated their content, the cattle lowed only when wolves were sighted in January. Deserted by field-workers, the village heard the clink of the smith's hammer, the sporadic shouts of fighting children.

London Paris Berlin 1500 A.D.

Freed from the domination of the barons, cities and townships flourished. Under the guilds an ordered bustle of trade and commerce proceeded in narrow, echoing alleyways, on grass-grown fair-grounds. Flat-capped London burghers, striking a bargain, heard the wains creak through the town gate, carters urging their straining horses, and beyond the walls troops clanked by, crying out and armed cap-à-pied, the caked mud of Flanders on their corselets. On the steps of the wealthy, mendicant poor whined for alms. And over all in the monastery at Westminster, ponderously swung the deep-toned belfry chimes at matins and evensong.

From Silence

In her cobbled streets and close-built stucco houses, neo-classical England bestirred industry and its handmaiden, invention, to turn to account raw materials from the colonies. Watt reported of his engine: "The velocity, violence, magnitude, and horrible noise . . . give universal satisfaction to all beholders." Applied to wind and water-driven mills, the new power gave work to Walpole's "mobility," copy-holders, dispossessed of the quiet countryside by enclosure. Wooden-clogged they tramped from new-built terrace cottages to the mills. Through the echoing streets passed gig, phaeton and running chairmen. The orange-seller and town-crier competed with their calls, while the Englishman's dog howled at Signor Stradivari's violin.

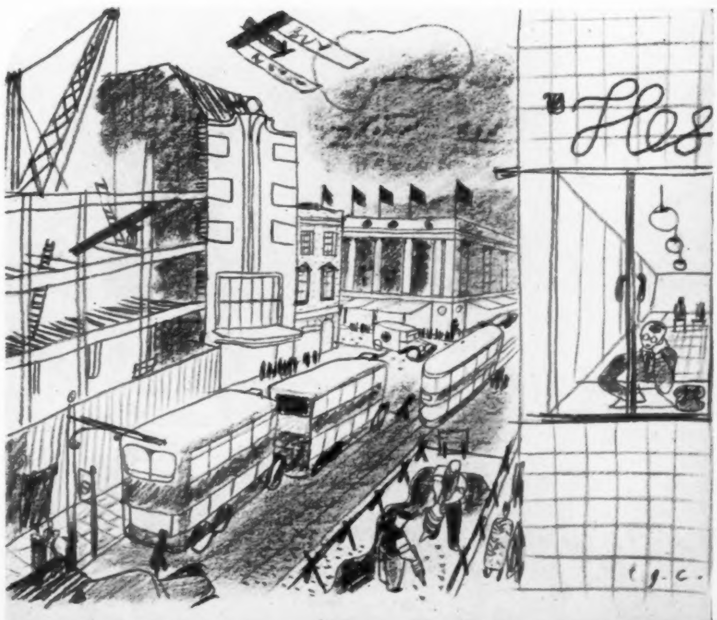
London Australia New York
1750 A.D.

Under the great queen, who preferred Windsor, London, the industrial Midlands and North grew apace. Trevithick's steam carriage, the Stockton and Darlington railway, had been launched. Through the streets of the capital rattled the iron-tyred coach and Shillibeer's bus, the hobby-horse, the hansom, brougham and sulky. Though renaissant-gothic spires maintained a six-day silence—in deference to the factory siren's one—on Sunday mornings, Dickens' draper's assistant would gallop his horse from the stables to Hyde Park, where assembled and exceedingly large families of Britons would listen to the martial blare; in summer, crowding the Margate paddle-steamers from Southwark Bridge. At night the charley's rattle and the gin palaces maintained their noise till dawn.

London Sydney New York
1850 A.D.

Covered with a fine lace of roads, Britain is a city with segregated areas of agricultural and park-land. On the most isolated hamlet, without care, by aeroplane, radio, telephone and film, noise from all the world may descend. In London, Birmingham, Glasgow, close-packed blocks like sounding boards reflect the cumulated roar of traffic, building process and swarming crowd. In factory, office, home, the machine is seen and heard. Like opposing yet conjoining waves, the din of work meets the din of play. The evening's music echoes the rush of wheels, the bell, gong and siren of industrial day. Streaming from the town, noise reaches the farthest corner of the countryside. Too civilized to kill the dog that barks, man does not sleep.

LONSYDNY
'38



PROBABILITIES

THOSE who first urge any reform must risk being considered cranks. In the case of noise this risk has been already taken and surmounted. After several years of warning by medical opinion the public has begun to consider noise anti-social.

The next step is to try to foresee the stages and means by which a tolerable degree of silence can come to be enjoyed by everyone. There are clearly two ways of doing this : the buildings in which most people spend most of their time can be made noise-proof; or the noises against which they are proofed can be reduced. The larger part of this issue deals with the first method. Here the problems of reducing noise itself can at least be mentioned.

It is only about thirty years since the country could be described as a lake of reasonable silence interspersed with islands of excessive noise. Now the conditions are exactly reversed; the islands grow fewer and are islands of reasonable silence, the lake is of largely unnecessary noise.

The greatest cause of the present ubiquity of excessive noise is the internal combustion engine, the second cause is other forms of locomotion, and the third is machinery and mechanical equipment. All of these are being examined under pressure from public opinion, and that little improvement has taken place must be attributed almost wholly to the lack of a standard way of measuring noise which can be universally understood and applied.

The perfection of one of the types of objective noise-meter now in use may be expected to fill this need within the next year. One of the first applications of tests by this instrument will certainly be upon new motor vehicles. The results of imposing this test will be to cure far more than isolated sources of noise. The public, given a standard by which to judge one source, will apply it widely; and motor manufacturers and motorists, themselves penalized, are not likely to tolerate trams, steam wagons and iron-shod horses and carts.

From this initial probability public opinion will rapidly realize that standards of silence are intimately bound up with zoning under town planning schemes.

This idea has already been put into practice in embryo form on housing estates. Its wider application will probably be by providing

AND POSSIBILITIES

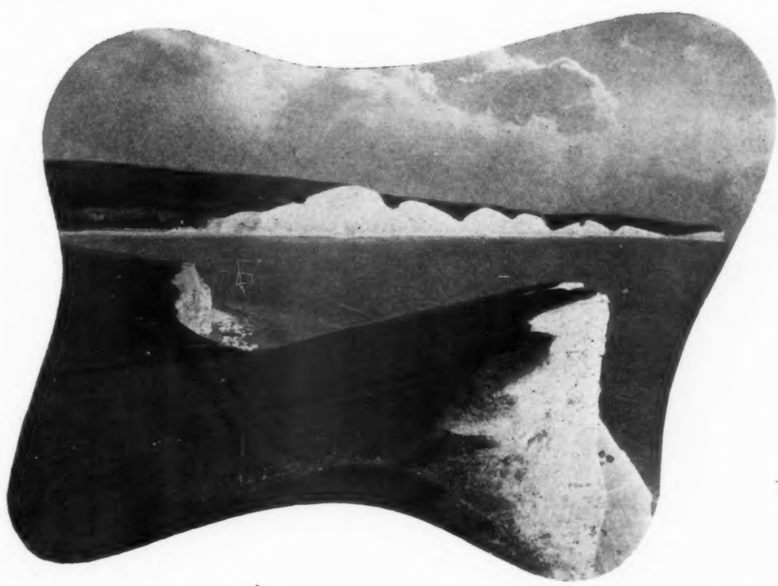
new estates with narrow width access roads only, on which no motor vehicle would be allowed to move other than slowly and on top.

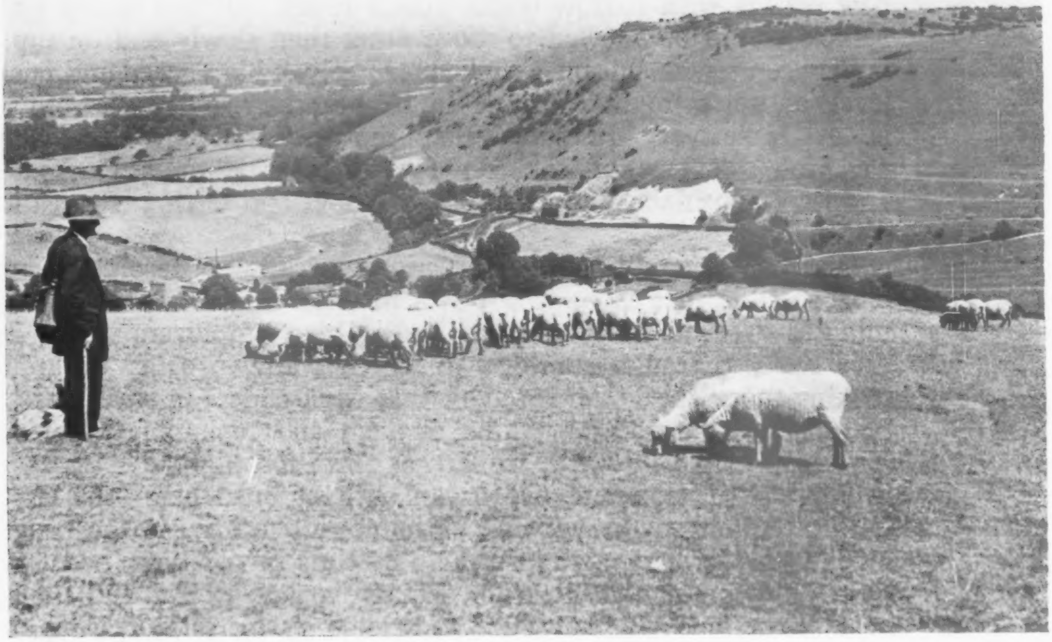
Between towns, but on Trunk Roads only, a high speed and fairly high level of noise might continue to be necessary. Apart from this, it is at least very probable that the country will be zoned for, say, four degrees of silence: Heavy Industry and Docks; Light Industry, Business, Shopping; Residential and Civic; Recreation and Agriculture.

Under such zoning, with the various noise levels resolutely enforced, it is possible that those who travel to work might have to start fifteen minutes or even thirty minutes earlier, that employers would have to give really thorough attention to whether any machine or group was making more noise than it might, that week-enders in small cars would be unable to twist and whine through any remaining rural villages. To most people the price would not seem too high.

The last development which can be mentioned here—the last which it is profitable to discuss in a machine-ridden age—is the progress of invention. Hitherto, labour-saving or time-saving have been, perhaps rightly, the perpetual aims of constructive inventors; and the amount of equipment in factory, office and home is always increasing and will certainly continue to do so. But one may expect—once noise is considered as serious a menace as tubercular infection—to find a change in the aims of invention. Not only will much of it be devoted to the single end of reducing noise in existing machines, but the rest will have not a single but a double test of success.

The test will not only be whether the invention works more efficiently than former means of doing the same thing, but also whether, being more efficient, it does not raise the existing noise level in the places where it will be used. Once we have got to that stage, the menace of noise will be past.





20 and 65 phons

Sources of noise. An aerial photograph of Hyde Park Corner (London's heaviest traffic centre) with Mayfair beyond. Intensive development, narrow streets, and heavy traffic present serious obstacles to effective noise insulation.

SILENCE

2. GENERAL DEFENCE

THE POSITION TODAY

[BY K. M. CONSTABLE]

THE control of sources of noise which affect the occupants of buildings is a matter of monetary importance. The architect cannot prevent noise which arises outside a building from disturbing the occupants except by making the building more or less sound-proof, which is usually a costly proceeding. There are, however, various bodies within whose province it lies to prohibit or mitigate certain classes of noise; much has already been done by these bodies, whose activities will be briefly described below, but more could be achieved if the public were sufficiently insistent. Legislation, for instance, however desirable, is seldom carried out before the public demand it. Architects can reinforce the public demand for less noise very effectively by continually urging the authorities concerned to exert their powers, or to acquire new powers, to abate noises which affect proposed buildings.

Such noises are conveniently divided into (1) those which are more or less permanent in a certain locality, and (2) those which arise almost anywhere.

(1) *Local Noises.*

Of these, factories, aerodromes, garages, electricity stations, and even church bells are frequent causes of complaint, and, being usually permanent, are worth tackling by concerted and, if necessary, continued action. Housebreaking and building are other noisy operations, although as a rule only temporary (which makes the disturbance seem greater). These are worthy of special mention as they are sources of noise not entirely outside the control of the architect and builder. The noise of riveting or bolting steel frames can be avoided by using electric welding as was done in the Bank of England building. It has also been suggested that the noise of cutting holes and chases may be reduced by the use of electric drills and a special grinding wheel respectively instead of the usual hammer and chisel. Demolitions, including of course road repairs, by means of pneumatic drills are a constant source of complaint. Pneumatic drills can be considerably quietened by the inclusion of suitable silencers on the drills, although there is some evidence that the quieter drills take somewhat longer to do a given job.

(2) *General Noises.*

Of these, traffic noise probably concerns the architect and his client most, on account of the situation of so many important buildings on busy thoroughfares. The noise level in city streets is so high that not only in hotels, hospitals and flats, but in business premises of all kinds steps are being taken to prevent the entry of this noise by the provision of sound-insulating windows, etc. In city streets, trams, particularly at curves and crossings, are the worst offenders, and are well seconded by steam lorries and other heavy commercial vehicles. Elsewhere, along main roads, sports cars, motor cycles and antiquated delivery vans make themselves objectionable, and even ordinary private cars can be very disturbing, particularly at night when cornering or ascending steep hills.

Other noises which cause general complaint are wireless loud-speakers and gramophones, street hawkers and street musicians, barking dogs and other noisy animals, and not least, low-flying aeroplanes engaged in such pursuits as joy-riding or advertising.

What Is Being Done

The Law.

It may, of course, not be necessary or advisable to resort to legal proceedings to abate a noise. It is only fair to factory owners, electricity undertakings and others to say that in many cases they have at the request of local residents voluntarily and at considerable expense taken steps to reduce the noise emerging from their premises.

Top, riveted steel frame. A source of intense temporary noise.

Centre, a battery of road drills fitted with silencers. The muffled drills, while still very audible, are a great improvement on the earlier types.

Left, heavy industry. A field in which no one has yet wondered whether every noise is equally necessary.

If such requests do not produce a satisfactory response, legal action may be taken, the nature of which will depend on the individual case.

Noise comes within the reach of the law in two ways. It may be dealt with (1) at Common Law if in any particular case it can be proved to be a nuisance, or (2) it may offend against a statute (including byelaws made by local authorities in the exercise of their statutory powers).

(1) *The Law of Nuisance.*

An actionable nuisance by noise has been defined in the Court as one which interferes with the reasonable and healthful enjoyment of one's premises, and it is no defence in common law to say that the best known means have been taken to reduce the noise complained of, or that the cause of the nuisance is the exercise of a business or trade in a reasonable manner. Injunctions have been granted in numerous cases restraining the noise, or, in the case of noisy building operations, restricting them to certain hours. The penalty for breach of an injunction is imprisonment or in the case of corporations, sequestration of property, and damages may be awarded as well as, or instead of, an injunction. (In suitable cases an action may be brought in the County Court, but it is then essential to claim damages as well as an injunction, since the county court, unlike the high court, has no jurisdiction to grant an injunction unless damages are claimed also.) An injunction is thus a powerful weapon, but unfortunately nuisance actions take time and money to conduct and are therefore only a suitable remedy for noises which are likely to be permanent. Several interested residents may then act as plaintiffs, sharing the cost between them. In other cases, not only the cost of proceedings, but the difficulty of catching offenders, and the reluctance to prosecute or give evidence renders this remedy less effective. It may, of course, happen that a noise affects so many people that it constitutes a public nuisance. The perpetrator is then guilty of a misdemeanour for which an indictment will lie at Common Law, but most noise nuisances will probably come under the heading of private nuisances, when the remedy in Common Law is a civil action.

(2) *Statutes and Byelaws.*

These provide a remedy against many noises which cannot conveniently be dealt with at Common Law. The most important statutory regulations (apart from those dealing with road traffic, which will be dealt with under that section) are the Public Health and Local Government Acts and the Byelaws of Local Authorities made thereunder. Any byelaw made by a local authority must be confirmed by the Home Secretary and in some cases by the Minister of Health; also a byelaw cannot be made for the suppression of a nuisance where an existing enactment in force already deals with that nuisance. Byelaws can be made by County Councils and Borough Councils under the Local Government Act (1933), Section 249, dealing, *inter alia*, with noisy animals and birds, noisy instruments and noise from loud-speakers. To assist local authorities the Home Office has prepared model byelaws which have been widely adopted, dealing with these noises and other nuisances. These byelaws prohibit noisy hawking, and the use of steam organs so as to cause annoyance; and require street musicians to remove, on request, to a distance of 100 yards from a house, office, church or hospital. The model byelaw on wireless loud-speakers, gramophones, etc., is so important that it deserves to be quoted verbatim :—

No person shall—

(*a*) In any street or public place or in connection with any shop, business premises or other place which adjoins any street or public place and to which the public are admitted, or

(*b*) Upon any other premises—

by operating any wireless loudspeaker, gramophone, amplifier or similar instrument make any noise which shall be so loud and so continuous or repeated as to cause a nuisance to occupants or inmates of any premises in the neighbourhood.

Provided that no proceedings shall be taken against any person for any offence against this byelaw in respect of premises in paragraph (b) unless the nuisance be continued after the expiration of a fortnight from the date of the service on such person of a notice alleging a nuisance, signed by not less than three householders residing within the hearing of the instrument as aforesaid.

Anyone aggrieved by a noise which might possibly contravene local byelaws may complain to the police: offenders against byelaws are prosecuted in the Courts of Summary Jurisdiction, who may impose a penalty not exceeding £5.

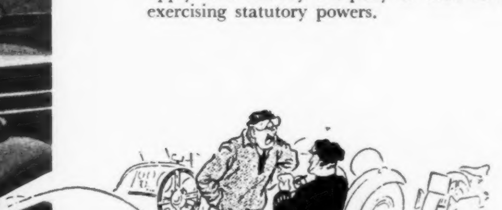
An important new remedy against noise has been put into the hands of local authorities by Local Acts passed during the last few years. A number of local authorities including the L.C.C. have obtained by local act provisions applying to noise nuisances the procedure of the Public Health Act, 1936, for the abatement of sanitary nuisances. The provision usually allowed is as follows :—

Noise Nuisance under the Public Health Act, 1936.

(1) A noise nuisance shall be liable to be dealt with as a statutory nuisance under the Public Health Act, 1936. Provided that no complaint shall be made to a justice under the said Act unless it is signed by not less than three householders or occupiers of premises within hearing of the noise nuisance complained of.

(2) A noise nuisance shall be deemed to exist where any person makes or continues to be made or continued any excessive or unreasonable or unnecessary noise and where such noise (*a*) is injurious or dangerous to health, and (*b*) is capable of being prevented or mitigated having due regard to all the circumstances of the case. Provided that if the noise is occasioned in the course of any trade, business or occupation it shall be a good defence that the best practicable means within the meaning of the said Act of preventing or mitigating it have been adopted.

(3) Nothing contained in this section shall apply to a railway company or their servants exercising statutory powers.



Testing motor-car running noise at the National Physical Laboratory. Right, " Defective silencer, my foot! There isn't one! "
(By permission of the Proprietors of " Punch ")

(4) Nothing in this section shall affect the power of the Corporation to make byelaws under Section 249 of the Local Government Act, 1933.

A statutory nuisance may be dealt with by a Court of Summary Jurisdiction, failing compliance with an abatement notice issued by the local authority. If the nuisance is proved to exist, the Public Health Act, 1936, enacts that the court shall make a "nuisance order" requiring the defendant to abate the nuisance and a fine not exceeding £5 may also be imposed. Any person failing to comply with a nuisance order is liable to a fine of £5 and to a further fine of £2 for each day on which the offence continues after conviction therefor. The local authority may then abate the nuisance and recover the expenses incurred. Proceedings may be taken in the high court by a local authority against a person committing a nuisance if it is deemed that summary proceedings would afford an inadequate remedy.

To sum up the legal position, it will be noted that a noise may be a nuisance at Common Law without being a noise nuisance under the Public Health Acts, since to be a nuisance at Common Law a noise need not be injurious to health, but to come within the scope of the above provision it must be. Further, the defence conferred under paragraph 2 of the above provision is not a good defence at Common Law. Common Law thus has a wider scope than existing statutory regulations, and if the aggrieved party is prepared to take the trouble to bring an action at Common Law, he may obtain more effective remedies, in the shape of injunctions and damages, than can be afforded by Courts of Summary Jurisdiction.

The Ministry of Health.

The Public Health Act, 1936, Section 61, authorises the making of byelaws for regulating the materials to be used in the construction of buildings and it is possible for such byelaws to deal with materials from the point of view of the transmission of noise. The local authority may, if required by the Minister of Health, be obliged to make such byelaws.

The existence of this provision does not appear to be very widely known, but it is a very important weapon in the hands of local authorities and the Ministry of Health. It is desirable that model specifications for this purpose should be drawn up as has been done in several European countries, and that at some future date byelaws based on such specifications should be widely adopted. A class of building in which the problem of the transmission of noise is particularly acute is flats erected for working-class tenants. While, as far as is known, no regulations have as yet been made on the subject of sound transmission in these buildings, a report on their construction has been issued by the Ministry of Health, which contains recommendations on the standards of sound-insulation which should be afforded by walls and floors, together with a survey of the most practicable known means for attaining these standards. The recommendations are based on the results of an intensive programme of research which is being carried out by the National Physical Laboratory and the Building Research Station.

Traffic Noise.

Many bodies have taken steps to deal with traffic noise in some way or other. These include :—

The Ministry of Transport, which is concerned with legislation about road traffic.

Manufacturers, both individually and in co-operation as manufacturers' and engineering associations. These have made great progress in reducing the noise made by individual types of vehicles.

Public conveyance systems, notably the L.P.T.B., have done much by modernizing their fleets of vehicles, substituting trolley buses for trams and by treating their underground railway system.

Legislation on road traffic deals :—

1. With noise made by the vehicle or its load.

2. With noise emitted by warning devices.

Both of these are dealt with in the Motor Vehicles (Construction and Use) Regulations, 1937.

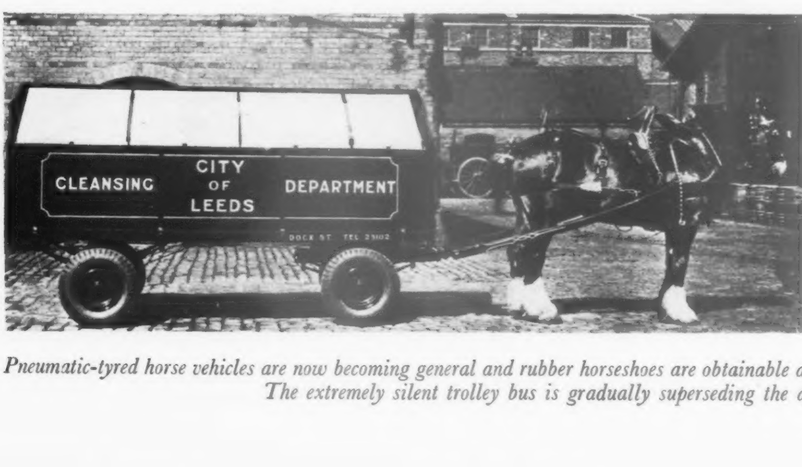
Some of the legislation incorporated in these regulations must be regarded as undergoing a trial stage. In common with other legislation it is not always strictly enforced, one reason for this being the difficulty of proving that a given noise is "excessive." It is obviously desirable to be able to substitute noise measurements for necessarily vague allegations. An important step in this direction was the institution, in 1934, of a Departmental Committee of the Ministry of Transport on "Noise in the Operation of Mechanically Propelled Vehicles." The Committee have published four reports containing recommendations, which, while they have not yet been embodied in legislation, have, in so far as they concern new vehicles, been accepted by manufacturers.

(1) *Vehicle Noise.*

A method of testing vehicle noise has been proposed by the Ministry of Transport Departmental Committee and a limit of 90 phons has been recommended for new vehicles and a limit of 95 phons for all vehicles on the road. Noise-testing stations have been set up by the Ministry of Transport to assist manufacturers to maintain this standard of 90 phons for new vehicles, which they have voluntarily accepted. A simplified noise meter has been designed for this purpose by the N.P.L. which will be generally available. This noise meter will also be of assistance should recommendations of the above type be adopted as regulations to be enforced on the road.

(2) *Warning Devices.*

It was felt that a single loudness limit which would be applicable to all warning devices was required. Obviously a



Pneumatic-tyred horse vehicles are now becoming general and rubber horseshoes are obtainable although not yet used on any appreciable scale. The extremely silent trolley bus is gradually superseding the appalling tram.

horn sufficiently loud to attract the attention of the driver of a heavy goods vehicle, for instance, would be too loud to be agreeable to the residents in a quiet street. As a compromise between conflicting interests a noise level of 100 phons measured at a distance of 20 ft. has been recommended.

Aircraft Noise—Legal Position.

The annoyance caused by aircraft passing over any particular neighbourhood is as a rule too intermittent to constitute an actionable nuisance, although nuisance actions have succeeded in obtaining injunctions restricting pleasure flights over certain property. Provided aircraft fly high enough for safety they do not appear to contravene any regulation, and furthermore the Air Navigation Act (1920) provides that no action shall lie in respect of trespass or nuisance by reason of the flight of aircraft over any property at a height above the ground, which, having regard to weather and all other circumstances, is reasonable. The legal position then depends on what a court will consider "reasonable."

The Air Ministry.

A great deal of discomfort is caused by low flying, against which there is no convenient legal remedy. Numerous complaints have been made to the Air Ministry and representations have been made by the Noise Abatement League. In reply to the latter the Air Ministry prepared a memorandum, the main points in which were :—

1. At the present stage of development, individual machines are bound to emit a certain amount of noise, caused by the engine exhaust, the airscrew, and by the rush of the machine through the air. Much research is being carried out on the reduction of aeroplane noise and useful results have been achieved, but there remain difficulties, particularly in the design of silencers sufficiently light in weight to be suitable for aircraft.

2. Complaints of *unnecessary* low flying of civil aircraft as a rule concern :—

(*a*) Low flying of air-liners in certain conditions of weather on the Continental services.

(*b*) Noise in the neighbourhood of airports.

(*c*) "Joy-riding."

[The Memorandum deals only with civil aircraft. Military aircraft does not, except in certain selected areas (whose grievances are ventilated in the Press from time to time) appear to be a general cause of complaint.]

On the first point the attention of the company concerned (usually a foreign line) is drawn by the Air Ministry, whose wishes regarding low flying are impressed on the pilots. On the second point, a certain degree of noise at an important airport is unavoidable. Complaints from persons who have come to live near an established airport are difficult to understand, but even in these cases complaints of *unnecessary* disturbance are heard with sympathy. On the third point, "joy-riding" is often from temporary aerodromes, or even, in the case of clubs, is only occasional, but in cases where avoidable annoyance is caused, representations, which are always effective, are made to the operators.

Special action has been taken by the Air Ministry to prevent noise in the vicinity of churches in the form of a Notice to Airmen (52/1934) to avoid low flying over churches and historic buildings.

The proposal has been put forward that powers might be taken by the Air Ministry to impose definite regulations on the avoidance of noise, and although viewed with sympathy has had to be rejected as impracticable. Co-operative action with aircraft companies and pilots will be continued, together with intensive technical researches.

Advertising by Aeroplane.

The desirability of prohibiting advertisement by means of aeroplanes has recently been debated in the House of Commons. It has been proposed that the Advertisements Regulation Acts might be strengthened so as to deal with advertising by aeroplane.

Noise in other Countries.

Noise is now assuming not merely national but international importance. The League of Nations Housing Commission, which held its first meeting in June, 1936, have instituted a programme of studies on Urban and Rural Housing, and deputations from several European countries have tried to pool their information on the prevention of noise in buildings. Model building regulations in different countries were compared.

In America a Noise Abatement Commission held in 1930 made a number of recommendations, notably that at least eight hours of the night should be free from distressing noises.

In a number of European countries and in America societies similar in object to the Noise Abatement League have been formed.

Note.—The noise problem is so many-sided that no one person can be expected to provide authoritative information on every aspect thereof. Although the author has taken every care to ensure that the information contained in this article is as accurate as possible, readers may need to remember the customary warning "Errors and Omissions Excepted."

Summary

The general opinion about noise appears to be that, like smoke, smells and other nuisances, it detracts from the amenities of life ; but while most people are willing to grumble about noise, it is not always easy to induce them to take steps to reduce it. One reason for this is perhaps that noise, like a lot of other nuisances, does not kill : it does not produce a toll of deaths comparable, for instance, with that of the roads. Also there is no evidence that, except in a few very noisy occupations, noise produces deafness or actual ill-health in normally healthy persons, and furthermore, experiments on the output of workers under noisy conditions

Constructive town planning, however imperfect, would prevent housing being squeezed between railway goods yards and docks where noise is unavoidable.

have not yielded very striking results. On the other hand, as Lord Horder has pointed out, these facts do not dispose of the whole of human experience of reaction to noise. The irritation, nervous strain, perhaps loss of sleep, caused by noise is not easily measurable by laboratory or other experiments, but these things are none the less important. To take the example of another nuisance, the harmful effect of fogs on human beings cannot easily be estimated or measured, although it must be considerable. In time objective experimental evidence of the harmful effect of noise may be forthcoming, but meanwhile a sufficiently good argument for noise abatement is that quiet is an amenity just as fresh air, sunlight, access to open spaces and so on are amenities, to which all are entitled.

Looking into the future, it may be predicted that the value set on the amenities of life, including quiet, will go up. One reason for expecting this is that if the present trend in the birth rate continues, the population in this country will, in the future, contain an increasingly large proportion of elderly people, who usually dislike noise. This does not imply that we shall become in the future a set of neurasthenics or cranks. As Dr. Kaye has pointed out, the most that need be asked of a particular locality is that its background of noise, whether by day or by night, shall be suited to the environment and the reasonable requirements of the majority of its occupants. The means of bringing about this desirable state include propaganda and education to reduce noise made by the individual; town-planning and zoning of noisy and residential areas to deal with noise made by the community; legislation; and research to increase our defences against noise to develop quieter machinery.

One cannot venture on detailed predictions. No doubt, however, new districts will be planned with regard to quiet conditions. Better enforcement of existing legislation would probably be more useful than fresh legislation, though in the case of noise by aircraft some regulation seems desirable; but unfortunately we may have to await more settled times for any advance in this direction. Research is proceeding apace and no doubt will continue to do so, the only difficulty being in the application of research results to practice. Industry is making increasing use of noise level measurements in developing quieter products. Noise level guarantees and noise specifications in contracts are becoming increasingly used in America, and will become more usual in this country; but a great deal depends on the development and use of a simple and efficient noise meter. Such an instrument should also be robust, portable and, not least, cheap, if its use is not to be confined as at present to the specialist.

SILENCE

GENERAL DEFENCE

PRESENT METHODS OF SOUND MEASUREMENT

[*BY A. H. DAVIS*]

Physics Department, National Physical Laboratory.

Introduction

THIS article explains that the chief measurable physical characteristics of sound are its pitch and mechanical intensity, and indicates why pure tones of various pitches are used in acoustical tests of the insulation afforded by partitions, windows, and other building members which have to exclude a variety of noises. The article deals also with the extent to which the "equivalent loudness" of sound can be measured when measurement of the pitch and mechanical intensity of sound are insufficient. A description is given of the special steps ("decibels" and "phons") adopted in measuring the intensity and loudness of sound, in order to cover in a reasonable number of steps the enormous range of intensity met in everyday life.

Sound has its origin in vibration. The sound spreads out from the source through the agency of waves in the air, just as ripples travel outward from a periodically disturbed water surface. The amplitude of the motion of the vibrating source, and the consequent degree of condensation in the accompanying sound waves, determine the intensity of the sound. The frequency of the vibration determines the pitch of the sound, pitch rising as the frequency is raised. For a tone pitched at middle C on the piano the frequency is 256 vibrations per second. Doubling the frequency raises the pitch by an octave, and Table I shows the frequencies corresponding to notes of various pitches in the musical scale.

TABLE I
FREQUENCIES OF SOUNDS IN THE MUSICAL SCALE

Notation	Frequency Vibrations per second
C_2	16
C_1	32
C	64
c	128
c^{i}	256
c^{ii}	512
c^{iii}	1,024
c^{iv}	2,048
c^{v}	4,096
c^{vi}	8,192
c^{vii}	16,384

We all know, however, that sounds of very different character may be emitted by different musical instruments tuned to the same note. These differences in "quality" are associated with differences in the manner in which the pressures in the sound waves rise and fall. The simple pendular motion of the prong of a tuning fork in free vibration gives rise to smooth undulations of pressure which are characteristic of pure tones—that is, with tones which consist of a single fundamental without overtones. A complex tone like that of a reed organ pipe involves much more complicated fluctuations of pressure, and the quality of the tone can in fact be reproduced by sounding together a number of pure tones of different pitches in the same musical scale. For this reason pure tones are much used in acoustical measurements. They are the only sounds which are unchanged in character when they are transmitted from one system to another, and when the behaviour of a system to a series of pure tones is known, its behaviour to any specified complex tone can be predicted.

Measuring Pressures in Sound Waves

In measuring pure tones in the air it is usual to measure the oscillatory pressures which occur in the sound. For the purpose various kinds of electrical microphones are employed, in association with amplifiers and recording instruments. Where the sounds occur in solids they may be measured by devices which may be described as contact microphones, since they are actuated when they are placed into contact with the vibrating surface.

Complex sounds may be analysed by finding the strength and frequency of the components of the sound—i.e. of the pure tones which, sounded together, would give the same complex result. To this end the microphone amplifier is fitted with selective circuits, in the same way as a radio-receiver is fitted with tuning circuits which make it possible to sweep through the range of wave lengths and thus to ascertain which radio stations are operating. In the acoustical case one sweeps through the range of pitch, and determines which sounds are present, and to what extent. Sometimes, however, analysis into different components is not attempted. One ascertains merely how the sound is distributed in the various octaves of the musical scale. This indicates whether it is high-pitched components, low-pitched, or both which have to be dealt with.

Decibels

The range of pressure to which the ear can accommodate itself at medium frequencies, in the range from the threshold of hearing to the onset of tickling and pain in the ear, is over one millionfold. Since the energy in sound waves is proportional to the square of the pressure variations, the range of the ear as regards energy is a million millionfold—a truly enormous figure. With such a range to be dealt with it is convenient to adopt a special scale (in fact, a logarithmic scale) which covers such enormous numbers in a reasonable number of steps. For this purpose a decibel is used. It is not necessary to discuss fully what a decibel is. It suffices to say that it is a definite fractional step (26 per cent.) in sound energy, and it is approximately the smallest change of intensity which the human ear can detect. Three such increments correspond to a twofold change, ten to a tenfold change. The million millionfold range of the ear is covered in 120 such steps (Table II).

Phons

Acoustical powers and pressures are mechanical data, obtainable from instrumental measurements of the sound, and they express intensity of sound in physical terms. It should be understood, however, that sounds which have the same intensity (power or pressures) are not usually equally loud if they are of different pitch. Intensity is a matter of pressures, frequency, etc.; loudness is a question of the effect which these pressures have upon the human ear.

The principle of the method adopted for measuring loudness is somewhat reminiscent of the ordinary manner of expressing loudness. In ordinary life we say, for example, that a certain noise was so appreciable that you could only just "converse in comfort without raising the voice," or that the noise was so loud that "one could not make oneself heard." In such cases the unknown noise is compared with a noise which is familiar to us. The process adopted for scientific measurement of loudness consists in adopting a standard noise, and varying its strength on a known scale of energy units until it is judged to be as loud as the unknown noise—i.e. until the observer is equally aware of the unknown and known noises. The method is analogous to estimating the brightness of a light by comparing it with a number of standard candles.

The "noise" which has been adopted as the standard with which all other noises are to be compared is a pure tone of frequency 1,000 cycles per second. The procedure is to listen with both ears alternately to the test noise and to the standard tone, the standard being adjusted until it is judged to be as loud as the noise. The intensity of the standard is then measured (by microphone), and is expressed as so many decibels above a specific zero ([1]) which is very near the threshold of audibility of the 1,000-cycle tone. If, when the noise and standard tone are equally loud, the standard has an intensity of n decibels above this "threshold," the noise is said to have an "equivalent loudness" of n phons.

TABLE II

DECIBELS (A METHOD OF EXPRESSING AMPLIFICATION RATIOS)

Amplification of Energy in Sound-wave	Amplification of Pressure in Sound-wave	Intensity Change in Decibels
1,000,000,000,000-fold	1,000,000-fold	120
100,000,000	10,000	80
10,000	100	40
100	10	20
10	3·2	10
4	2	6
2	1·4	3
1·26	1·1	1

A Scale of Phons

The range of the ear is about 130 phons. On the scale the difference between one twin crying alone and two crying together is only three phons or so. This helps us to realize that, in order to get an appreciable mitigation of interference due to noise, much larger reductions than three phons are usually necessary.

For most sounds (except those very high or very low in pitch or loudness), a reduction of 10 phons corresponds to the loudness change caused by moving a source (in unrestricted space) to just over three times the distance from the hearer, and is often subjectively assessed as a "halving" of the loudness, though fewer phons corresponding to "halving" when the loudness is slight. Some landmarks on the scale of phons are indicated in Table III.

Subjective Noise Meters

The standard measurement of equivalent loudness involves free-air listening to the noise and to a standard tone of 1,000 cycles per second, and listening to them alternately. These and other considerations make the standard technique suitable only for the laboratory. In commercial practice more convenient techniques are employed, various subjective noise meters being obtainable for the purpose. All of them apply a comparison tone of variable strength to the ear in some convenient manner. In several, a standard tone is produced in a telephone earpiece, by means of suitable circuits, and is controlled in strength until the observer judges the tone to be as loud as the noise. The reading on the control dial or attenuator then indicates the loudness of the noise.

It is possible to use a tuning fork as a portable noise meter. The fork is struck in a standard manner and note taken of the time which elapses before the loudness of the fork, when placed as closely to the ear as possible, falls to the loudness of the observed noise. The total interval which elapses before the fork is masked by the noise is also

[1] The fixed zero of the 1,000-cycle note corresponds to an acoustical pressure in free air of 0·0002 dyne per square centimetre.

TABLE IV

taken for check purposes. A fork actually used by the writer some years ago had an equivalent loudness when first struck of about 100 phons. The measured rate of decay was practically constant and about 1½ phons per second. A number of noise levels are indicated in Table IV.

Usually in the use of subjective noise meters the noise and the standard tone are heard together. Unfortunately this technique does not always give the same results as the standard technique in which alternate listening to the noise and standard is employed. The difficulty can probably be avoided by arranging in some way to listen alternately to the noise and to the reference tone.

Objective Noise Meters

Although measurements of the loudness of sound are essentially aural in nature, it is very desirable to have a physical instrument giving on a meter, without suspicion of personal error or bias, readings in accord with the average of aural judgment.

Instruments of the microphone and indicator type have been constructed for this purpose, their sensitivity to notes of different pitches being adjusted to simulate that of the ear for the approximate loudness concerned. This is achieved by introducing suitable electrical networks into the amplifier circuit. Such instruments, however, give results much too low for impulsive and rattling noises, unless other characteristics are incorporated. A meter, designed by the writer, has been found to be satisfactory for a variety of moderate and loud noises of steady and impulsive character, and has been in use at the National Physical Laboratory for some time. It is also adaptable for use in measuring sound pressures, and for simple analysis.

At the present time objective noise meters are perhaps least likely to give a proper indication of the equivalent loudness of sounds to the ear when the sounds concerned are impulsive, and of low pitch and low intensity*; but any meter proposed for measurement of the equivalent loudness of noise should first be subjected to appropriate tests by a standardizing laboratory.

Experimental Measurements

In studying transmission of sound from one room to another through partitions, doors, windows, or ventilating ducts, or in measuring the attenuation of sound along flanking walls or water pipes, it is usual to employ a series of pure sounds, some of high pitch, and some of medium and low pitch. The results are expressed as a sound reduction in "decibels" at each of the frequencies tested. As far as partitions are concerned, an idea of the minimum reduction in loudness (phons) afforded by a simple partition is often given roughly by the average of the reductions in intensity (in decibels) recorded at the various frequencies tested. There is thus sometimes a tendency only partially justifiable to concentrate on the average reduction afforded by partitions although full information requires that separate results be given for several frequencies.

In the case of the insulation afforded by floors against footsteps and other impacts, one is not concerned with measuring the intensity of a sound before and after its passage through the floor. For by adding a resonant floorboarding it is possible to raise the level of noise in the upper room without affecting that in the room below. This would give an increased difference in loudness between the upper and lower rooms without benefiting anybody. Also the character of the sound would be different. What is required is simply a statement of the loudness set up in the room below the floor by standard impacts overhead. The procedure therefore is often to measure the equivalent loudness of the transmitted sound in phons, employing a team of observers to make the subjective measurements. At present it is risky to use objective meters for such work, for it is precisely for low-pitched impulsive noises that simulation of the human ear is most difficult to achieve.

* Such sounds are met when floors are subjected to moderate dull blows.

TABLE III

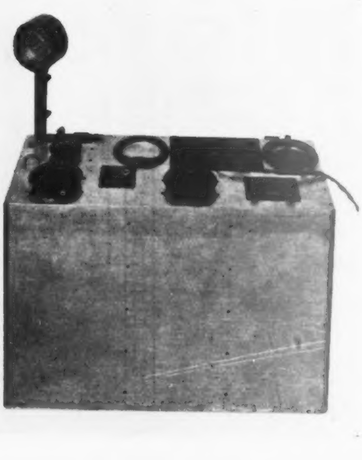
Phons	
130	Threshold of painful sounds.
110	Near unsilenced aeroplane engine.
100	Near pneumatic drill.
80	Street with moderate accelerating traffic.
60	Moderate conversation.
40	Clock ticking briskly.
20	Quiet whisper.
0	Threshold of hearing.

Summarizing the foregoing in so far as methods of measuring noise are concerned, it may be stated that the mechanical characteristics of sound are measurable with apparatus consisting of a microphone with an amplifier and indicator. Complex sounds may be analysed by such apparatus, i.e., the pitches and intensities of their component sounds may be ascertained.

It is not always possible, however, to infer the loudness of a complex sound from its analysis, so that where one desires to measure the loudness of a complex sound resort must be had to either (*a*) the subjective judgment of a group of observers, or (*b*) the indications of an objective meter, of the microphone-amplifier-indicator type, which has been adjusted to give a result in accord with the average human judgment of loudness for the sound concerned.

For the subjective measurements standard conditions of listening have been specified, but they are difficult to realize outside special laboratories. However, certain subjective meters are available commercially, which are useful for allowing an approximate assessment of the equivalent loudness of sounds to be made. The observer compares the loudness of the noise with that of a standard tone of variable strength provided by the apparatus. Preferably the noise and the reference tone should be listened to alternately.

As regards the production of objective meters for measuring equivalent loudness, considerable success has been attained for certain classes of noise. Impulsive sounds and sounds of low intensity give most trouble, and any apparatus intended for objective measurements of the equivalent loudness of sounds should first be subjected to appropriate tests by a standardizing laboratory.



Objective noise-meter designed and used by the National Physical Laboratory.

SILENCE
3
TECHNICAL DEFENCE
PLANNING AND STRUCTURE

OFFICE BLOCK BY SERGE CHERMAYEFF

ACOUSTIC treatment of buildings, however essential this may be for the enjoyment of health and privacy, costs money, and at the moment money is receiving more attention from building owners than human welfare. Until acoustic treatment becomes entirely economic we must welcome the rare opportunities that are encountered where we can apply the available knowledge. The detailed examination of these rare opportunities must form a valuable reference for the future development of acoustics.

One such opportunity was given to the writer of these notes when designing the new office buildings for Messrs. Gilbey in Camden Town. This building is a particularly happy example to examine, as it illustrates on one small site a considerable number of different means of sound elimination and insulation.

The building had to be erected on a corner block between two cobbled streets serving adjacent railway goods yards and warehouses. That in itself constituted a serious handicap to the ideal noiseless working conditions within the building. The whole design and method of construction therefore was governed by the problem of eliminating an unusual amount of noise. The sources of noise fell readily under four heads :—

I. Structure-borne sounds from outside: Transmission of vibrations of the roadway through the building proper.

II. Structure-borne sounds from inside: Noise of lift machinery and other service sounds within the building.

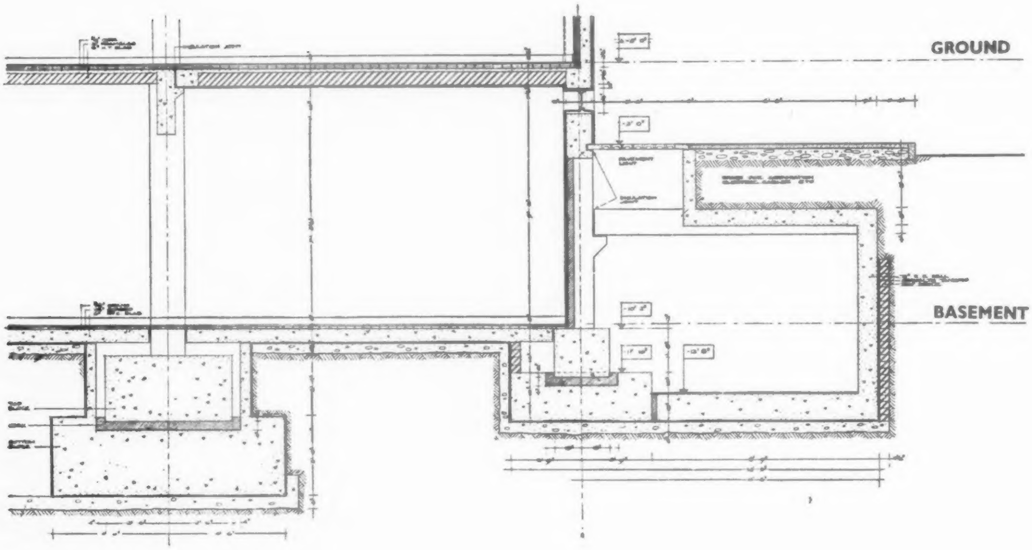
III. Air-borne sounds from outside: Street noise entering directly through windows or being reflected from neighbouring buildings through the windows.

IV. Air-borne sounds from inside: Noises within the working space created by the occupants themselves.

The preventive measures taken under these heads are as follows :—

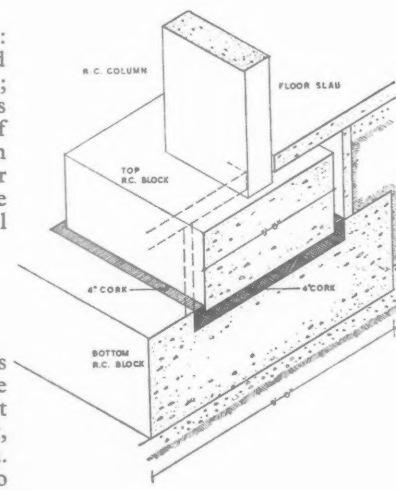
I. *Elimination of Structure-borne Sound from Outside.*

The bases of all walls and columns are carried on pads of natural cork through which the loads are transmitted to concrete blocks below. Additional protection is afforded by the depths of the foundations of which the lower faces are 8 ft. below the basement floor. The cork pads, 4 ins. thick, provided a homogeneous insulator which compressed uniformly over the whole of its area. The whole of the superstructure is erected within the basement. This superstructure is insulated at every point from the pavement by cork joints, and by a special independent basement under the pavement which provides additional protection to the foundations and superstructure by forming a continuous air cushion between them and the roadway.



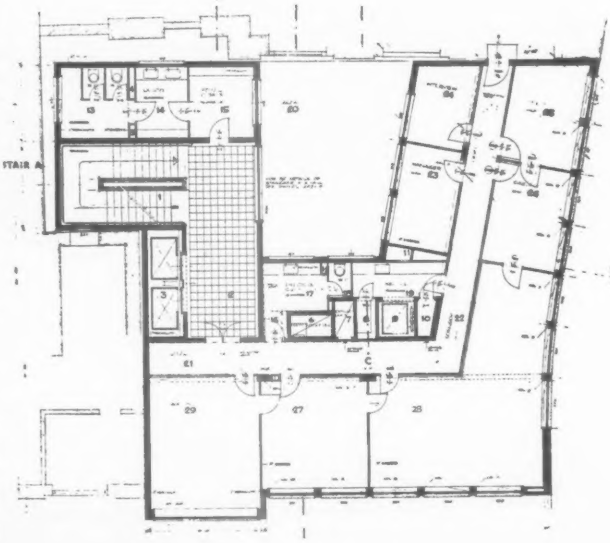
II. *Structure-borne Sound within the Building.*

The superstructure itself has been split up into three separate structural units: one unit containing the staircase, passenger lifts and main lavatories; the second unit the service lift, vertical air-conditioning ducts, and subsidiary lavatories; the third unit being reserved exclusively for working space. The isolation joints were made by inserting cork between all concrete of the one section and that of the adjacent section. In this way sound transmission through structure, or even service ducts and conduits, to the working space was largely eliminated. (A further precaution arising under the third section of *air-borne sound* was to construct the vertical and horizontal plenum ducts of reinforced concrete to form an integral part of the structure, making for greater rigidity and, therefore, silence.)



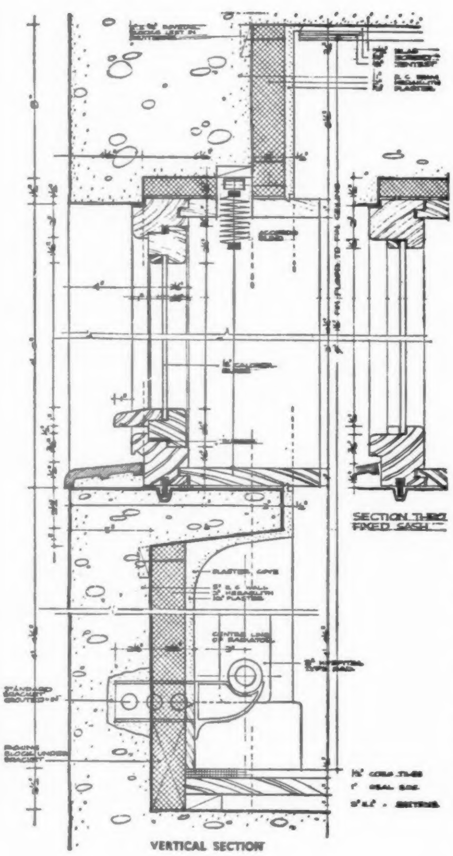
III. *Air-borne Sound from Outside.*

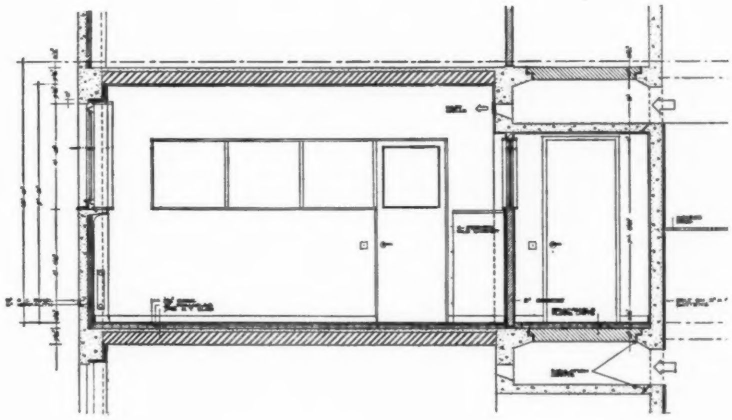
In order to eliminate the intrusion of street sounds the whole building is sealed, the windows opening only for cleaning purposes. This necessitated the air conditioning of the entire working space of the building by a plenum plant in the basement. Ideally, all the windows should have been double; cost, however, prevented this, with the exception of the sixth floor boardroom. All other windows are constructed in teak, which was used in preference to metal to make the windows more inert and rattleproof, and these were glazed with a 32-oz. glass (just under $\frac{1}{4}$ in.). The window areas themselves were reduced as far as possible without undesirable light loss. (The final cill height of 4 ft. $4\frac{1}{2}$ ins. from floor proved useful in another respect, as it allowed standard filing cabinets to be placed against any wall.) To compensate the loss of double glazing, the ceilings of all offices facing the street were treated with absorbent plaster, so as to reduce any downward reflection of noise which did penetrate. On the sixth floor, occupied by the directors' clubroom and board-room, other measures were adopted: the clubroom on the south side of the building was set back behind a 5 ft. balcony, which has proved efficacious (see photograph on next page). In the board-room to the west, where architectural and planning considerations made such a setback impracticable, there is a system of double windows: the internal window is divided into smaller sections glazed with a different weight of glass.



IV. *Air-borne Sound within the Building.*

The acoustic ceiling treatment mentioned has proved of considerable assistance in reducing noise in the larger offices containing typewriters, accounting machines, etc. In addition, the elimination of occupant-made sound was cured to the greatest possible extent at the source. The flooring

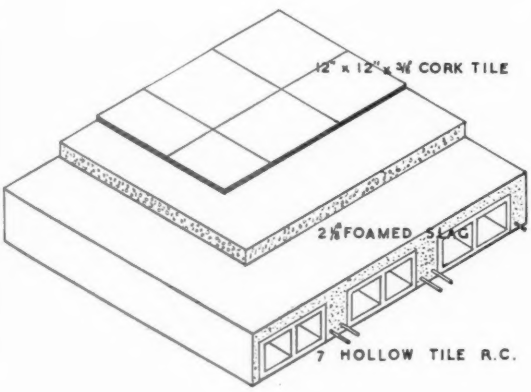


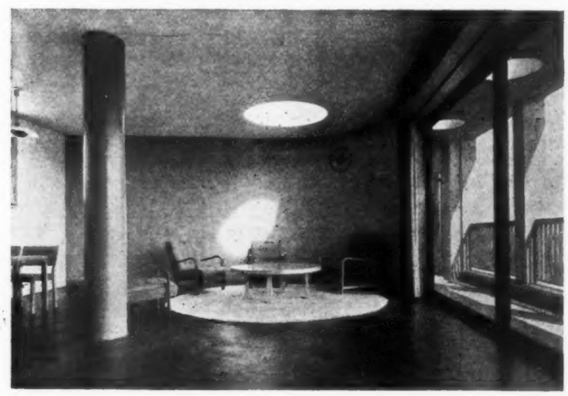


throughout the offices and corridors is of $\frac{3}{8}$-in. cork laid in bitumen on a $2\frac{1}{8}$-in. screed of foamed slag. The cork reduces to a minimum the sound of footfalls on the top surface of the slab, whereas the high insulating properties of the foamed-slag screed on top of a hollow block floor prevents their transmission to the working space on the underside of the floor slab.

Apart from these purely mechanical preventatives, the control of the planning was an additional aid. For instance, the canteen and managers' dining-rooms—silence not being an essential factor—have been placed on the ground floor, where various noise preventive measures were likely to be least effective. As already described, lavatories, services, etc., are grouped vertically without exception within sections structurally separated from the working space, so as to eliminate the transference of noise from conduits and pipes.

It will be readily appreciated that the preventive steps outlined above do not claim to be the ideal solutions in each particluar. If money and time had been no object, there is no doubt that each individual problem could have been analysed further and each measure improved on.





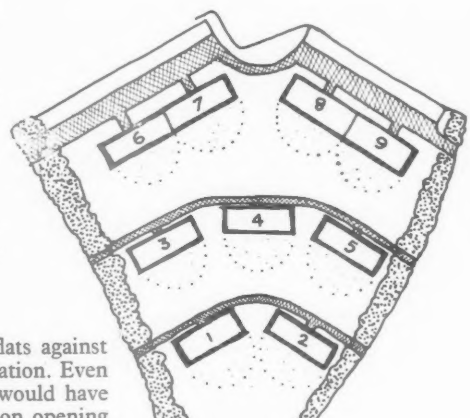
FLAT GROUP BY FREDERICK GIBBERD

THE client required an absolutely soundproof family flat to let at " middle class " rentals, that is, between £110 and £150 per annum. The site area was two and three-quarter acres and the number of four-room flats allowed by the Town Planning authorities was fifty-four. The flats were split up into nine blocks of six flats. Each individual block is three storeys high with flats on either side of a central staircase. The external walls are 13½ ins. and 9 ins. brickwork, and the reinforced-concrete hollow tile floors span from these walls to a central reinforced-concrete spine. The high land cost—over £150 per flat unit—and the comparatively low rents precluded expensive constructional systems, services, and equipment. An absolutely soundproof flat was not therefore possible. Nevertheless, in the planning and selection of equipment the question of noise was carefully studied. These notes are intended to show how the problem was tackled, and the amount of precaution against noise that may be reasonably taken in a flat without making the rent excessive.

Prevention rather than cure was the approach to the problem of sound-proofing. The sources of sound were studied rather than methods of silencing sound itself. It is obviously cheaper to select a quiet door catch than to try and stop the rattle being heard in the adjacent flat.

The sources of noise that cause the most inconvenience to tenants were classified under the following headings :—

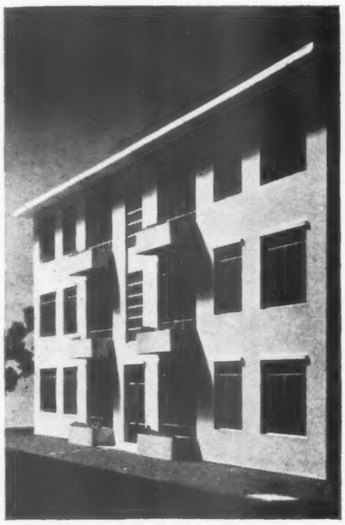
1. Street : Air-borne traffic noise.
2. Access : (a) Air-borne noise from tenants' tradesmen, dust carts, etc.
   (b) Impact noises on hall, stairs, and landings.
3. Tenant : (a) Air-borne noises from talking, wireless, etc.
   (b) Impact noises from footfalls.
4. Services and equipment : Service pipes, w.c.s, tanks, etc. Air-borne and impact noises from equipment such as door catches.



Street Noises—The Block Plan

The low building cost desired ruled out any question of sealing the flats against street noises by equipping them with double windows and artificial ventilation. Even had there been the money, it is doubtful whether artificial ventilation would have been adopted as there is no question that tenants would have insisted on opening their windows, thus upsetting the balance of the air circulation through the plant.

Trees, particularly when in leaf, form a blanket against street noises. A survey of the exact position of all the trees on the site was made and the buildings arranged between them so that they were practically all retained. The trees round the site (see



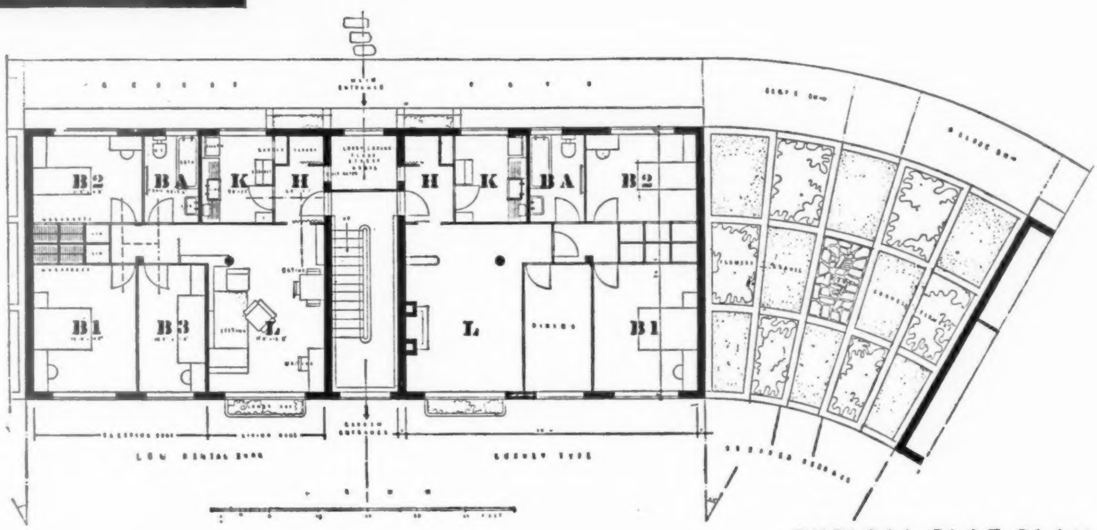
photograph) were reinforced where necessary by new shrubs and trees so that the whole of the site is or will be surrounded by a thick belt of trees screening the buildings from the roads.

The buildings were arranged to look inwards—towards the interior of the site rather than the roads—and in front of each an area of ground was laid out as a lawn or garden as a " quiet zone." The large windows to the principal rooms look on to these gardens (left). No windows look on to the roads.

Site Access—The Block Plan

Access to the individual buildings is by paths which pass behind them. Small windows only face these paths. The multiplicity of entrance and access paths thins the traffic out on the site and avoids any large volume of noise that may occur through concentration of vehicles and people on the large drive.

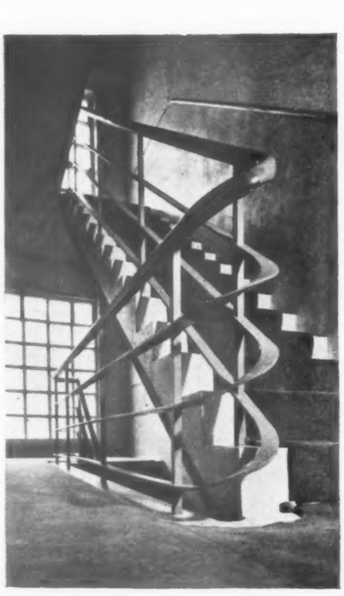
The garages, dust and coal stores are on the top boundary of the site. No cars pass in front of the principal habitable rooms and none can be seen from the gardens in front of each block. The dust cart visits the top left-hand corner of the site only, dust being conveyed from the flats to the store in that position by small trolleys.



TYPICAL FLAT PLAN

Flat Access or Staircase Hall

The Direct in Pairs—flat on either side of a central staircase—type of access used for the individual buildings is quieter than the gallery plan where some windows are bound to look immediately on to the means of access, or the corridor plan where the corridor itself often forms a sound-box.



In the individual block the central staircase is separated from the flats on either side of it by solid 9-in. brick walls. Brickwork was chosen rather than a double partition as it could be made to support the reinforced concrete flights and landings. The thickness of 9 ins. was settled through experience gained on another job. There a double partition consisting of two 2-in. breeze leaves with a 1-in. air space between them was found to be about equal to a 4½-in. brick wall. As neither were entirely satisfactory the thickness was doubled—a mass of material being an effective deterrent to air-borne noise.

Impact noises arising from footfalls on the stairs and landings were muffled by the carpet finish. Acoustic plaster to the soffites of the stairs and landings to absorb air-borne noises could not be afforded.

The entrance and garden doors are fitted with double-action shoe springs so that the door does not come into contact with the frame, thus avoiding any possibility of impact noise.

Tenant Air-borne Noise—The Plan

In the planning of individual flats against the transmission of air-borne noise laterally from one flat to another it is usual to plan quiet rooms against quiet rooms and noisy against noisy. For example, in adjacent flats the party wall should be between bedroom and bedroom, never between bedroom and living-room. In this particular case the flats are entirely separated from each other by the staircase hall and the entrance lobby or flat stores.

The plan was arranged so that the principal habitable rooms—living, dining, and bedroom 1—look on to the garden, and the hall, kitchen, bathroom, and spare bedroom on to the access path. The latter, being small compartments, isolate the main rooms from the noise of occasional callers and tradesmen.

Tenants' Impact Noise—The Section

Most complaints from flat tenants are about the transmission of noise through floors. The Building Research Station was consulted and the following notes made : " Impact noise from footfalls is the chief consideration. A solid reinforced-concrete floor—or for that matter a hollow tile floor—offers little resistance to impact noise, the sound below the slab being practically equal to that above. Treatment in the form of a suspended ceiling below the slab or an independent floor above the slab is necessary. A completely isolated ' floating ' floor was recommended, as this cuts off the impact vibrations from the main structure of the building. With regard to air-borne noise, the heavier the floor the better is the insulation. A normal slab gives insulation about equal to a $4\frac{1}{2}$-in. brick wall. As it is not a practical proposition to make exceptionally thick floor slabs, insulation must be provided by discontinuity of surface. Thus any precaution that may be taken against impact noises is likely to improve insulation against air-borne."

It was felt that the provision of a completely separate floor resting on resilient pads would be very expensive, and that in all probability some simpler and cheaper method of construction such as separating the screed from the floor slab by cork or felt would give satisfactory results.

In order to come to a decision it was decided to carry out tests on different floor types. A flat in Romney Court, Shepherd's Bush, by Mr. H. Victor Kerr, was borrowed, and on to the existing hollow-tile reinforced-concrete structural slab the following floor types were laid down :—

(1) $\frac{7}{8}$-in. screed on structural floor.

(2) $\frac{7}{8}$-in. screed on structural floor plus lino.

(3) $\frac{1}{2}$ in. of cork laid down *in situ* with 1 in. thick concrete on top, reinforced with chicken wire.

(4) Four layers of bituminous felt covered with granulated cork, both sides, with 1-in. screed reinforced with chicken wire on top.

(5) A patent soundproof floor, consisting of wood battens laid at 14-in. centres on to 2 ins. long by $\frac{7}{8}$ in. high rubber isolators. The battens are rebated to carry 12 ins. square loading slabs which stiffen the floor and prevent the battens from twisting. Tongued and grooved boarding was nailed to the battens.

(6) The Building Research Station patent soundproof floor. This consists of 2 ins. thick reinforced-concrete, supported on rubber pads, with 1-in. air gap between the screed and the structural floor. (See p. 863.)

The floors were tested by a tapping machine and the noise level of the room underneath was measured with a noise meter.

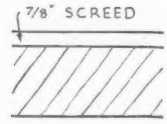
The following figures give the sound reduction in decibels over Floor No. 1 as zero :—

Floor	1	2	3	4	5	6
Rubber tappers ...	0	2	3	0	15	16
Hard tappers ...	0	2	2	8	14	16

As the air-spaced floors gave infinitely better results than the others a price was obtained from the makers of the proprietary system. The makers stated that the price laid without floor boards would be approximately 6s. 3d. per yard super. The system was adopted and the cost, including oak floor boards to the hall, living, and dining rooms and British Columbian pine to the remaining rooms worked out about £20 per flat extra over the cheapest possible finish—linoleum on $\frac{3}{4}$-in. screed. This extra is not of course only in the floating floor, but includes such structural requirements as an extra course of brickwork required by the additional floor thickness (all amounting to about £15 per block of six flats), and the cost of ordinary battens and boarding to the ground-floor flats. Further, in considering the extra cost it must be borne in mind that the oak floor finish is a valuable letting factor—particularly as the building owner was able to omit the usual clause from the lease to the effect that the tenant must close-carpet the living and dining rooms. (See photograph on next page.)

Services and Equipment

The local council required that soil and vent pipes should be outside the building. The problem of silencing vertical ducts through the building did not, therefore,



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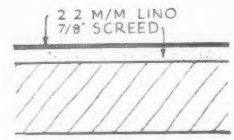

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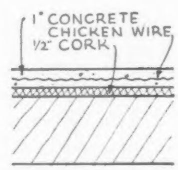

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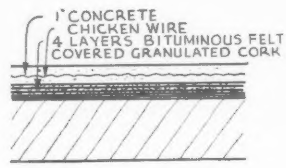

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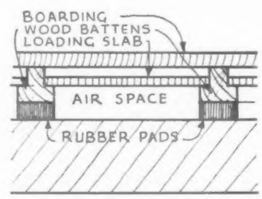

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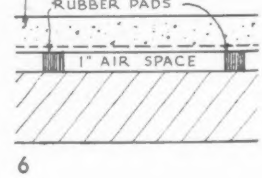


6

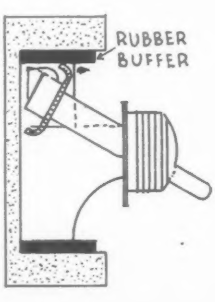
[This floor is more fully illustrated on page 863.]

arise and such questions as lining ducts with insulating board, packing them with slag wool, and sealing them off at floor levels were not gone into.

The tank room was planned over the store so that no portion of it came over the actual flats.

Several w.c.s were inspected and a " low down " model with an easily operated handle and quiet flush selected.

The sharp noises that may arise from equipment, such as door catches, can be exceptionally irritating both to the flat tenant and his neighbours. Considerable care was exercised in the selection of equipment to ensure that it would be quiet in operation.



The letter-box on the entrance door has a slip of rubber fixed along the bottom of the opening so that the flap does not strike the metal surround. A bell of sturdy construction was fixed instead of a knocker, as the latter tends to rattle. The striking arm of the bell was bent back so that it made no actual contact with the bell itself but merely acts as a buzzer.

Extra heavy bronze lever handles and stout locks were chosen for the room doors to avoid rattle. As catches such as the " ball " type give a sharp ring, cupboard doors were fitted with latches which must be pressed by the thumb to operate, preventing them from being snatched open or slammed to.

Electric light switches are of the silent " hospital " type in which the switch action strikes against small rubber pads.

TECHNICAL DEFENCE

SOUND INSULATION

WALLS • DOORS • WINDOWS • FLOORS

[BY DR. J. E. R. CONSTABLE and DR. G. H. ASTON]

(Physics Department, National Physical Laboratory)

WALLS

Introduction

FROM the point of view of sound-insulation partitions may be divided into two groups, namely, single partitions and complex partitions. The first group includes single sheets, solid panels and single walls of bricks or building blocks (plastered or unplastered). Partitions other than single partitions are termed complex

Single Partitions

Measurements have shown that the sound-reduction factor* of single partitions depends almost entirely upon their weight per square foot. The curves in Figs. 1–4, which are based on National Physical Laboratory measurements, exemplify this relationship. Such different materials as building-boards, glass and bricks all give insulations in accordance with weight curves. In Figs. 1 to 3 the results are expressed as the averages for low, medium and high-pitched sounds, namely, for frequencies of 200 and 300 ; 500, 700 and 1,000 ; 1,600 and 2,000 cycles per second. Fig. 4 gives the average for all the seven frequencies.

The curves may be regarded as representing the sound-insulation which the average single partition may be expected to have when tested under the conditions of the National Physical Laboratory measurements. Different laboratories use somewhat different test conditions, so that numerical results from different sources should not be compared.

The curves may also be used for predicting the sound-insulation of single solid partitions. They are also useful in assessing the effectiveness of any special type of partition construction, since a special construction is only of acoustical advantage if it has an insulation appreciably greater than that of an average single partition of the same weight.

Since the insulation obtainable from a single partition is fixed by the weight that can be allowed, complex partitions are sometimes employed, for example, double walls or stud partitions.

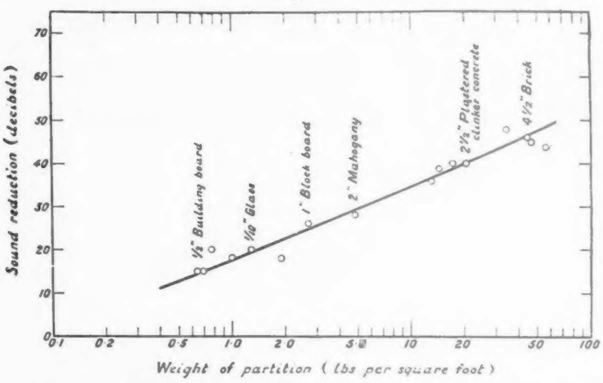
The following conclusions have been drawn from the National Physical Laboratory measurements :—

1. Single inhomogeneous partitions such as those constructed from hollow

* The sound reduction factor is the ratio which the intensity of the sound falling upon the partition bears to that transmitted. The sound reduction factor is, however, usually expressed in decibels. This figure = 10 times log (sound reduction factor).

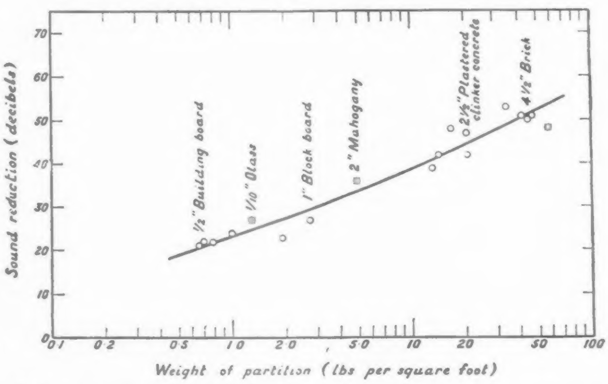
The definition of the decibel need not greatly concern the architect. He need only regard it as a convenient unit for expressing results ; differences of the order of two or three decibels between the sound reduction factors of different partitions are usually not significant.

Fig. 1.



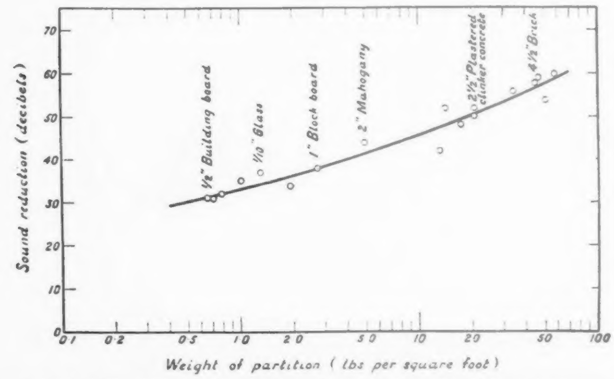
Relation between sound reduction in decibels and weight per square foot of single homogeneous partitions. Sound reduction averaged for frequencies 200 and 300 cycles per second.

Fig. 2.



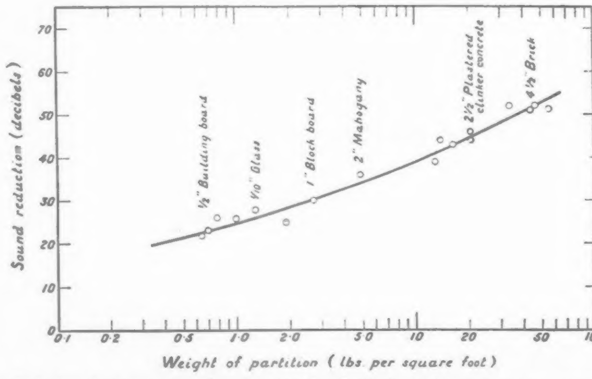
Relation between sound reduction in decibels and weight per square foot of single homogeneous partitions. Sound reduction averaged for frequencies 500, 700, and 1,000 cycles per second.

Fig. 3.



Relation between sound reduction in decibels and weight per square foot of single homogeneous partitions. Sound reduction averaged for frequencies 1,600 and 2,000 cycles per second.

Fig. 4.



Relation between sound reduction in decibels and weight per square foot of single homogeneous partitions. Sound reduction averaged for frequencies 200, 300, 500, 700, 1,000, 1,600 and 2,000 cycles per second.

TABLE I. SOUND-INSULATION OF PARTITIONS.

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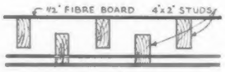
14 

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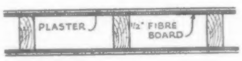
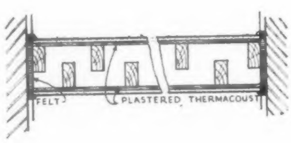
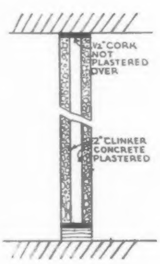
17 

19 

20 

The drawings illustrate representative complex partitions included in the table.

Construction	Weight (lbs./sq. ft.)	Thickness (inches)	Mean sound insulation for frequency range 200-2,000 cycles per second
Single homogeneous partitions—			Decibels
1. Insulating board	0·69	$\frac{1}{2}$	23 (23)
2. 21-oz. window glass	1·3	$\frac{3}{32}$	28 (26)
3. Plate glass	3·8	$\frac{1}{4}$	35 (32)
4. Mahogany	4·9	2	36 (34)
5. Cellular anhydrite blocks plastered on both faces with Pioneer plaster	16·8	$3\frac{1}{4}$	46 (43)
6. 3-in. Eonit blocks plastered on both faces ..	20·4	$3\frac{7}{8}$	46 (45)
7. $2\frac{1}{2}$-in. clinker concrete, plastered on both faces	20·7	$3\frac{1}{2}$	44 (45)
8. $4\frac{1}{2}$-in. Fletton brick, plastered on both faces (cement mortar, hard plaster)	46·0	$5\frac{1}{4}$	52 (52)
Single inhomogeneous partitions—			
9. Hollow tiles, lime plaster on both faces ..	21·0	$4\frac{1}{4}$	44 (45)
10. 4-in. hollow clay blocks, plastered on both faces	26·5	$4\frac{3}{4}$	45 (47)
11. 4-in. Cranham blocks plastered on both faces	37·0	$6\frac{1}{4}$	51 (49)
Complex partitions—			
12. A layer of $\frac{1}{2}$-in. fibre-board on each side of 4-in. by 2-in. studding at about 14-in. centres	4·3	5	41 (33)
13. Two layers of $\frac{1}{2}$-in. fibre-board on one side and one layer of $\frac{1}{2}$-in. fibre-board on the other side of 4-in. by 2-in. studding at about 14-in. centres	5·2	$5\frac{1}{2}$	44 (35)
14. Staggered 4-in. by 2-in. studding having a single layer of $\frac{1}{2}$-in. fibre-board on one side and on the other two layers of $\frac{1}{2}$-in. fibre-board separated by 2-in. by $\frac{3}{4}$-in. fillets. Each set of studs on 14-in. centres ..	7·3	7	50 (37)
15. A layer of $\frac{1}{2}$-in. fibre-board on each side of 4-in. by 2-in. studding at about 14-in. centres. One face plastered to a thickness of $\frac{3}{4}$ in.	11·6	$5\frac{3}{4}$	47 (40)
16. Lath and 3-coat hard plaster on each side of 4-in. by 2-in. studding on 12-in. centres ..	17·0	$5\frac{1}{2}$	53 (43)
17. A layer of $\frac{1}{2}$-in. fibre-board on each side of 4-in. by 2-in. studding at about 14-in. centres. Each face plastered to a thickness of $\frac{3}{4}$ in.	18·8	$6\frac{1}{2}$	52 (44)
18. Two leaves of Eonit 2-in. blocks separated by $1\frac{1}{2}$-in. air space, plastered on outer faces	18·9	6	49 (44)
19. A layer of 1-in. Thermacoust wood fibre slabs on each side of 3-in. by 2-in. staggered studding at 16-in. centres. Each leaf and its studding insulated by $\frac{1}{2}$-in. felt. Outer faces plastered to a thickness of $\frac{1}{2}$-in. ..	21·9	9	57 (45)
20. Two 2-in. clinker slabs, 2-in. air space, outer faces plastered. Each leaf of partition insulated at its edges with $\frac{1}{2}$-in. cork ..	33	6	*

* Figures are not given as results were obtained under test conditions not comparable with those under which the remainder were tested. The partition has about the same insulation as a 9-in. brick wall having three times its weight.

Figures in brackets indicate the insulation which an average single partition of same weight might be expected to have.

tiles are no better as sound-insulators than a single solid partition of the same weight per square foot.

2. A wall built in cement and hard plaster is as good a sound-insulator as a similar wall built in lime mortar and lime and sand plaster.

3. The sound reduction factor of stud partitions is usually well above that of a single solid partition of the same weight.

4. The sound-reduction factor of double partitions depends upon the air spacing between them (*see* section dealing with windows).

5. The sound-insulation of a double wall (e.g. of clinker concrete) is not usually much greater than that of a solid wall of the same weight, but can be increased effectively by insulating each leaf from the building with a layer of $\frac{1}{2}$-in. cork. The cork must not be plastered over, otherwise it completely loses its effectiveness. It can be distempered or covered with paper. A double 2-in. clinker wall constructed in this way has about the same insulation as a 9-in. brick wall having three times the weight.

6. The insulation of brick, concrete or clinker block walls is not increased by isolating the plaster from the wall by a layer of fibre-board.

Choice of Partition

In certain positions, e.g. party walls, partitions having considerable sound-insulation are required,* in others, e.g. those between rooms in the same flat or house, less insulation will suffice. An idea as to the value of any given partition may be obtained by comparing its measured sound reduction factor with that of a partition with the performance of which one is familiar, e.g. a brick wall. Alternatively, if one knows the level of the noise it is to screen and the noise which can be tolerated on its quiet side, the suitability of a given partition may for ordinary building partitions be judged by the following approximate rule. If L_1 is the loudness, in phons, of the noise to be screened and L_2 the loudness which can be allowed on the quiet side of the partition, then the average sound-reduction factor measured in decibels (the fourth column in the table) of the partition to be used should be at least numerically equal to $L_1 - L_2$.

The figures given on previous page are selected from a number of National Physical Laboratory results which were published by Constable and Aston in the "Philosophical Magazine," Vol. 23, p. 161, 1937, and also from some published in the Final Report of the Ministry of Health Departmental Committee on the Construction of Flats for the Working Classes.†

The figures given in brackets are the insulation which an average single solid partition of the same weight would be expected to have (*see* graphs in Fig. (4)).

CONCLUSIONS

Summarizing, research has shown that as far as single walls are concerned, their sound-insulation is determined almost entirely by their weight, the actual material that is used in their construction being unimportant. Hollow tiles are for this reason *less* insulating than an equally thick solid wall, not *more*, as is often thought. For the same reason the architect's dream of a material ½-in. thick which, when laid upon a wall, will render it sound-proof, is not likely to be realized. If light sound-insulating walls are required they must be multiple, for example, double-leaved walls or stud partitions. Readers may feel there is nothing new in this type of partition, but the fact is that research has shown that it can be made appreciably more insulating than if built in the traditional style; as, for example, by insulating the edges of the double partition with cork. The principles which should be adopted are now fairly clear and it remains to find reliable ways of using them in practice. Cork-insulated partitions have proved very satisfactory in practice, but it may be that time will produce an insulating material which is better for this purpose than cork. Future developments in sound-proof partitions are most likely to be either in the production of a substitute for cork in insulating the edges of double partitions or in producing a facing material for stud partitions which will be fairly heavy and fireproof so as to obtain the greatest advantage from the construction. Materials of the thermacoust type seem to be a step in this direction.

* The Departmental Committee of the Ministry of Health recommended that party walls should be at least as insulating as 8½-in. brickwork, i.e. about 55 decibels.

† (Final Report of the Ministry of Health Departmental Committee on Construction of Flats for the Working Classes, 1937. H.M. Stationery Office. Price 1s.

COMPARATIVE COST OF PARTITIONS

Below are approximate comparative costs of the partitions listed on page 857.

[Compiled by Davis and Belfield]

			s. d.
No. 5.	3-in. Cellular Anhydrite blocks set in cement mortar (1 : 3), and two coats Sirapite both sides ... ... , ...	per yard super	9 6
No. 6.	3-in. Eonit blocks set in cement mortar (1 : 3) and two coats Sirapite both sides	per yard super	9 11
No. 7.	2½-in. Breeze blocks set in cement mortar (1 : 3) and two coats Sirapite both sides	per yard super	7 0
No. 8.	4½-in. Fletton brickwork in cement mortar (1 : 3) and two coats Sirapite both sides	per yard super	9 7
No. 9.	3-in. Hollow tile set in cement mortar (1 : 3) and two coats lime plaster both sides	per yard super	9 0
No. 10.	4-in. Hollow blocks set in cement mortar (1 : 3) and two coats Sirapite both sides	per yard super	10 0
No. 11.	4-in. Cranham blocks set in cement mortar (1 : 3) and three coats lime plaster both sides	per yard super	10 5
No. 12.	4 in. × 2-in. studs at 14 in. centres and ½-in. Insulwood both sides ...	per yard super	8 2
No. 13.	4-in. × 2-in. studs at 14-in. centres, two layers of ½-in. Insulwood one side and one layer the other	per yard super	11 1
No. 14.	Two rows of 4-in. × 2-in. studs, staggered, each at 14-in. centres, one layer of ½-in. Insulwood both sides and 2-in. × ¾-in. deal fillets and a further layer of ½-in. Insulwood one side	per yard super	14 5
No. 15.	4-in. × 2-in. studs at 14-in. centres, ½-in. Insulwood one side, ½-in. Insulwood and three coats Sirapite the other	per yard super	9 9
No. 16.	4-in. × 2-in. studs at 12-in. centres, wood laths and three coats Sirapite both sides	per yard super	8 8
No. 17.	4-in. × 2-in. studs at 14-in. centres, one layer of ½-in. Insulwood and two coats Sirapite both sides	per yard super	12 5
No. 18.	Two thicknesses of 2-in. Eonit blocks set in cement mortar (1 : 3) with a 1½-in. air space between, two coats Sirapite both sides	per yard super	13 11
No. 19.	Two rows of 3-in. × 2-in. studs staggered each row at 16-in. centres, 1-in. Thermacoust wood fibre slabs and two coats Sirapite both sides	per yard super	12 0
No. 20.	Two thicknesses of 2-in. breeze blocks set in cement mortar (1 : 3) with a 2-in. air space between and two coats Sirapite both sides	per yard super	9 5

DOORS

SOUND-INSULATING DOORS

There are three types of sound-insulating door constructions, namely, single solid doors, single composite doors, and pairs of doors ; these will be dealt with in that order.

1. *Single Solid Doors*

The relation between sound-insulation and weight per square foot, which was explained in the section dealing with walls, holds also in the case of doors. It follows that a solid door, to be a good insulator, must be heavy. There is a limit, of course, to the permissible weight of a door and ordinarily a door weighing 2 cwts. would be regarded as very heavy. It may be mentioned in this connection, however, that in one of the sound-proof rooms in the Acoustics Laboratory of the National Physical Laboratory, doors of solid steel each weighing several tons have been installed.

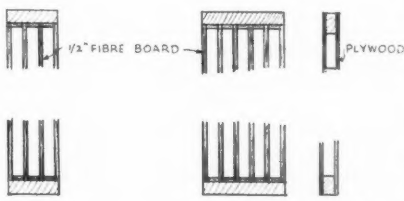
The following table gives the approximate insulation in decibels to be expected from solid doors of uniform thickness and of various weights.

Weight (lbs. per sq. ft.)	Approximate sound-reduction factor in decibels averaged for frequencies of 200-2,000 cycles per second
1	25 decibels
2	30 ,,
5	35 ,,
10	40 ,,
20	45 ,,

A panelled door, in which light wood panels are fitted into a comparatively heavy frame is likely to have an insulation less than that of an equally heavy solid door of uniform thickness, since the sound will be transmitted almost entirely by the panels. Kreuger has observed this experimentally. An average door of this type has a mean insulation of rather less than 30 decibels. An improvement of about 5 decibels can be obtained by making the door of solid wood, of the same thickness as the framing. This insulation is still 15 decibels less than that of a 4½ ins. brick wall, and such a door would accordingly form a weak point if used in anything but light walls. The only way of avoiding a weak point, if a solid door is desired, is to make the door as weighty as the wall in which it is built. An average size door would then weigh anything up to a ton !

2. *Composite Doors*

Prof. Kreuger's laboratory in Sweden has probably investigated composite doors more carefully than any other laboratory, and the following remarks are based upon his results. Probably the most familiar composition door is that consisting of a frame faced with plywood on either side. This type of door does not appear to have sound-insulating properties any greater than those of an equally heavy solid door. The desiderata for a sound-insulating composite door seem to be fairly heavy outer surfaces with a minimum of mechanical linkage between. Rigid outer faces, such as block board fixed rigidly to the door frame, appear to provide too great a linkage, and no advantage results from such a construction, unless unduly thick doors (8 or 9 ins. thick) are used. Fibre board, which is more flexible, can,



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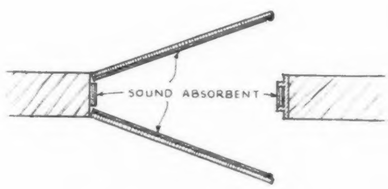

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according to Kreuger, provide an effectively insulating door. Four layers spaced about ½ in. from each other form a quite light door providing an insulation of over 40 decibels. Five layers provide over 45 decibels (i.e. better than 3-ins. plastered clinker concrete) (*see* 1 and 2).

Sheet iron, which combines fair weight with flexibility can be successfully used for sound-insulating doors. Two doors using sheet iron which might be classed as "sound-proof" have been described by Kreuger. They consisted of two iron sheets with either a light absorbent filling or layers of fibre board between. Each of the doors had an insulation of about 45 decibels and weighed about 5 lbs. and 7 lbs. per square foot, respectively. To obtain this insulation with a solid door would have required a weight of about 20-25 lbs. per square foot.

For comparison it may be mentioned that Kreuger measured the insulation of a door panelled with ⅞ in. plywood as about 28 decibels, and a normal flush door of plywood on framing (*see* 3) gave an insulation of about 29 decibels. These doors weighed about 3½ lb. per square foot.

An effective composite door tends to be rather thicker than average and probably this type of door will find application only where a specially quiet room is desired. In residential buildings or offices where what might be described as "ordinary quiet" is desired, probably a solid heavy door is more acceptable. If this is not sufficient by itself a pair of doors with an ante-room between can be arranged.

3. *Pairs of Doors*

By installing more than one door, the use of special door designs can be avoided and often more satisfactory insulation can be obtained. Two doors is usual, but more have been used in special situations. The system has the advantage that the effect of leakage due to defective closure of the doors is less (since two or more doors have to be passed) than when one door is used. The doors can be reasonably solid and of as heavy a construction as possible ; the space between them should be rendered sound-absorbent (*see* 4) by suitable treatment of the walls and ceiling with an acoustic felt or even with one of the wallboards. There should also be an advantage in covering the inner surfaces of the doors with an absorbent material.

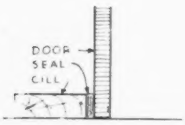
Importance of Good Closure

Whichever type of sound-proof door construction is adopted, provision must be made for ensuring a good closure which is as nearly as possible airtight. A really tight closure is probably not possible in the case of domestic buildings or general offices. In these buildings possibly the best that can be arranged is to fit a wedge-action latch and provide a felt or rubber sealing on the rebates at the sides and top of the door frame. An air-tight closure at the bottom of the door requires a cill with a square rebate (*see* 5 and 6). An alternative, which is probably not as effective, is a hardwood ramp, the bottom of the door being bevelled to fit it. A felt layer on the bottom of the door, besides helping good closure, converts gaps into what are, in effect, absorbent-lined ducts, and hence mitigates their harmfulness. (Fig. 16.)

A further alternative which is probably the most which can be achieved in ordinary buildings is to provide one of the automatic draught-excluding devices at the bottom of doors.

CONCLUSIONS

It thus appears that the production of a light sound-proof door of reasonable thickness is very unlikely and that the architect will have to continue using doors of the type at present on the market. Future developments will most likely be in the manufacture of cheap and easily fitted devices for



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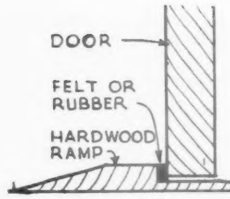

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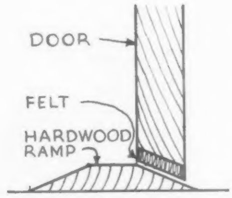

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rendering a door sound-tight. Particularly may be mentioned the need for wedge-action latches which do not give a prison-like appearance to the door. It may be that such latches will be constructed as a development of the well-finished latches now sold for domestic refrigerators.

TABLE 2. SOUND INSULATION OF GLASS OF VARIOUS WEIGHTS

Weight of glass	Thickness	Average sound-reduction factor for frequency range (cycles per second)			
		200-300	500-1,000	1,600-2,000	200-2,000
Oz. per sq. ft.	Inches				
12	$\frac{1}{16}$	16	22	32	23
25	$\frac{1}{8}$	21	26	36	28
50	$\frac{1}{4}$	26	31	39	32
100	$\frac{1}{2}$	31	35	44	36

WINDOWS

Single Windows

Similarly to other partitions, a single window has a sound-insulation which is determined by the weight of glazing only. The heavier the glass the greater the insulation. There is no evidence that a heavy frame has any advantage. The weight of the frame does not appear to influence the insulation to an important extent and, indeed, it seems quite safe for all practical purposes to infer the insulation to be expected from a sealed window from the sound reduction/weight curves given in page 856, using the weight of the glass only for this purpose. The sound reduction to be expected from some weights of glass is given above. Some of these figures are the result of measurement; others have been inferred from the figures on page 856.

As explained earlier, for approximation purposes there is some justification in using the average sound-reduction factor given in the last column on page 857 as the noise-reduction factor in phons.

If sound-insulation is important and double windows are not permissible, $\frac{1}{4}$ in. or heavier glass should be used.

Effect of Closure

Considerable loss in sound-insulating efficiency is to be expected if the windows do not close tightly. The loss is naturally more important for windows which would otherwise have a high sound-reduction factor; for example, those glazed with $\frac{1}{4}$-in. glass. The closure should be as nearly airtight as is possible. For this purpose a lining of sponge rubber, felt, or possibly soft leather should be provided on the rebates and the latches should have a wedge action (*see* 8). For

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the same reason it is important to make an airtight seal between the window and the wall. Properly prepared mastic is useful for this purpose.

Double Windows

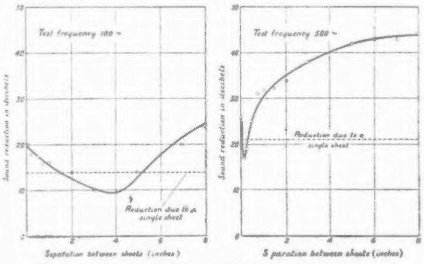
Just as in the case of partitions, the greatest insulation can normally be obtained by using a complex structure, in this case, a double window.

Double glazing in the same frame has been used in this connection. Kreuger and Sager* have shown, however, that such a window is no better as an insulator than if it had been glazed with glass having the same weight as the combined weight of the two panes. To be effective as a sound-insulator, therefore, the glazing should be in two frames. This has the additional advantage that sound conduction by air leaks is minimized, there being two frames for the sound to pass.

* Kreuger and Sager. Ingeniörs Vetenskaps Akad. Handlingar. No. 132. (1934.)

1. *Effect of Separation between the Components of a Double Window*

Theory and experiment show that as the separation is increased from zero the sound-insulation at any given frequency at first decreases, passes through a minimum, and then increases again. The table below gives the result of measurements made upon a window glazed with 21-oz. glass.† The minimum is most noticeable at low frequencies, since the separation at which the minimum occurs decreases as the frequency increases and is only



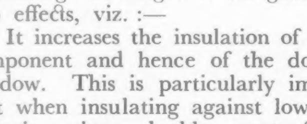
The influence of the spacing of the components upon the noise insulating value of a double window of 21 oz glass, showing a position of minimum insulation.

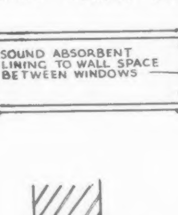
about $\frac{1}{20}$ in. at 1,000 cycles per second with 21-oz. glass.

2. *Effect of Weight of Glazing*

The phenomena described above are bound up with the weight of the glass. Increasing the weight of the glass has two effects, viz.:—

1. It increases the insulation of each component and hence of the double window. This is particularly important when insulating against low frequencies, since double constructions





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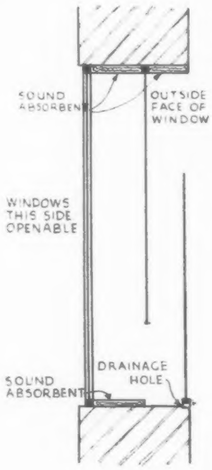
tend to be defective at these frequencies.

2. It decreases the separation for which at any given frequency the minimum insulation occurs. For example, in the case of a window glazed with 21-oz. glass, the minimum insulation against 100 cycle sound occurs

† J. E. R. Constable, Philosophical Magazine, xvii, p. 321, 1934.

with a separation of about 4 ins. If $\frac{1}{4}$ in. glass were used this minimum would occur at a spacing of about $1\frac{1}{2}$ ins.

The window should be proportioned so that the minimum insulation occurs at a frequency below the lowest note



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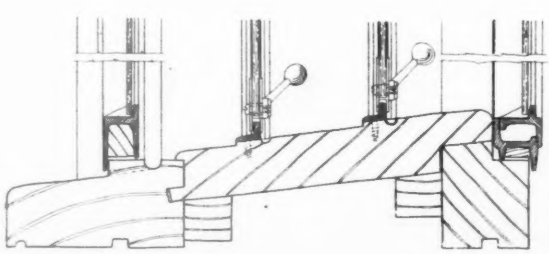
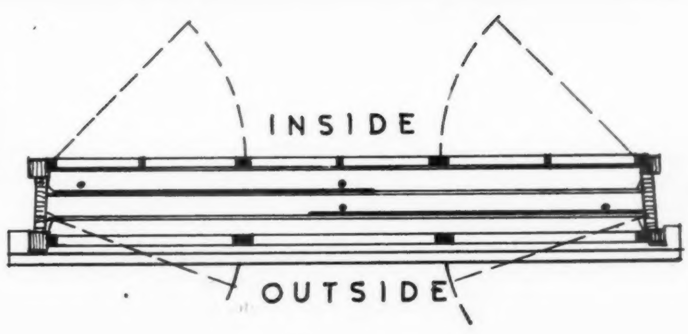
against which insulation is required. In other words, the minimum should occur at a frequency outside the frequency range of the noise to be screened. For glazing with 21-oz. glass this means that if the window is to be insulated at frequencies of 100 cycles upwards (this should be a useful window in normal cases) the separation should exceed 4 ins. (*see* table on p. 860). Since, as shown in the figure, the insulation increases with spacing after the insulation minimum has been passed, the spacing should be as great as possible. If a small spacing is necessary, heavy glass should be used. It has sometimes been recommended that the glazing in the two components

On the right and below are details of a new double window by Crittalls. The window has two steel casements and two single sliding sheets of plate, the sides being splayed to increase the efficiency of the baffle. The lower window, in which felt slips are covered with perforated American cloth, is slightly more efficient but more difficult to keep of good appearance.





should have unequal weights or that they should be subdivided with glazing bars in different ways. No experimental confirmation has been obtained for this.

3. *Use of Sound absorbent*

Usually the interior surfaces of a double window, which consist of glass and probably plastered brickwork, are acoustically non-absorbent, i.e. they are very good sound-reflectors. It has been shown* that by fitting a sound-absorbent lining on the wall, cill and lintol, a considerable increase in sound-insulation can be obtained. Increases of up to about 10 db. have been observed (*See* 9, p. 860).

Ventilating Sound-proof Windows

Some progress has been made in the design of windows which, while affording moderate sound-insulation, also provide a degree of ventilation. Messrs. Crittall have designed a window, which has recently been tested at the National Physical Laboratory. The window consists of a combination of vertically- and horizontally-hung sashes. When sound-insulation, together with ventilation, is required, the top horizontally-hung sash in the outer window and the bottom sash in the inner window are opened. In this condition the window provides an insulation about equal to that of a tightly-closed single window with 21-oz. glazing or an ordinarily closed single window with heavy glazing. Naturally, when the flaps are closed, a considerably higher insulation is obtained.

A development of this design has been constructed by Messrs. Crittall, and is shown on the previous page. No test results appear to be available for this window, but good results are claimed for it.

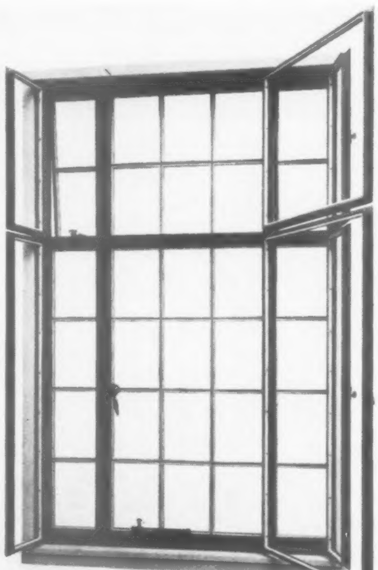
The Fisk window, *see* 10, is also claimed to combine sound-insulation with ventilation. No test results appear to be available as yet for this window either.

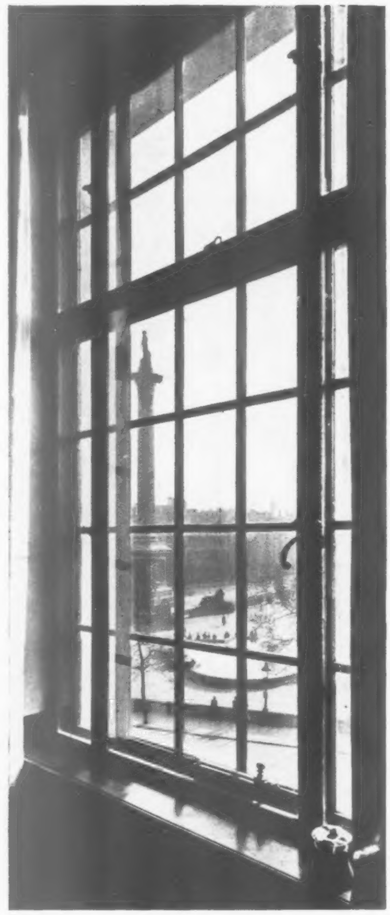
Other types of soundproof ventilating windows have been designed. These often rely upon providing ventilation through a sound-absorbent lined duct built in adjacent to the window. A forced draught is sometimes provided by a small quiet-running fan. No test results appear to be available for these designs.

CONCLUSIONS

There can be very little doubt that the future lies with air-conditioning and double windows, at least in the case of big buildings in towns. The design of large hotels, such as the recently constructed Queen's Hotel, Leeds, or the Berkeley Hotel, Piccadilly, point this way, and it is very probable that in buildings of this type, in which the provision of quiet bedrooms is a valuable asset, this construction will become standard. Other buildings in which quiet is merely an amenity and not an investment (comparable to h. and c. in every bedroom) upon which a return may be expected, may not be able to afford the extra cost of double windows as at present supplied. One may, however, look forward to the time when an increased demand for quiet rooms will have led to increased production and hence decreased cost of double windows. If in addition, as recent experiments have indicated, a double window could be designed to retain some of its insulating properties when opened, a window particularly suitable for this country should result in that it would provide sound-insulation without coming into conflict with the Englishman's inborn dislike of fresh air delivered by pipes.

*J. E. R. Constable, Proceedings Physical Society, Vol. 48, p. 690, 1936.





Two types of double window manufactured by Messrs. Hope's.

FLOORS

BY DR. J. E. R. CONSTABLE AND A. E. KNOWLER

(*Physics Department, National Physical Laboratory*)

A FLOOR which is effective for insulating against sound of air-borne origin is not necessarily successful for insulating against impact sounds such as those due to footsteps. On the other hand it appears to be a fairly general rule that floors which are effective insulators against impact sounds are also effective against sound of air-borne origin. In practice it is found that a floor of solid concrete or of hollow tiles built up with concrete transmits footsteps noise too readily. Measurements show that a wood joist floor is still noisier. It appears in fact that no ordinary structural floor is sufficiently insulating against impact sounds and where, as in flats, such noises would be regarded as troublesome, some treatment is required on the floor to improve its insulation.

The following general methods of obtaining improvement are available :—

1. Simple floor coverings.
2. Floating floors.
3. False ceilings.
4. Fillings.

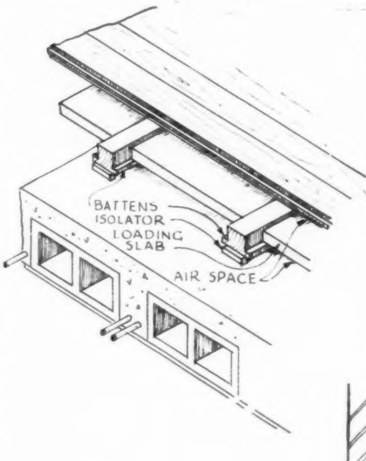
These may be used alone or in combination, and their effects appear to be approximately additive. In compiling the data below, the following sources of information have been used :—

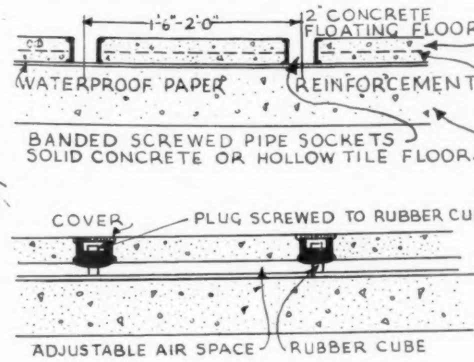
R. Berg and J. Holtsmark, Byggekunst, No. 7, 1934.

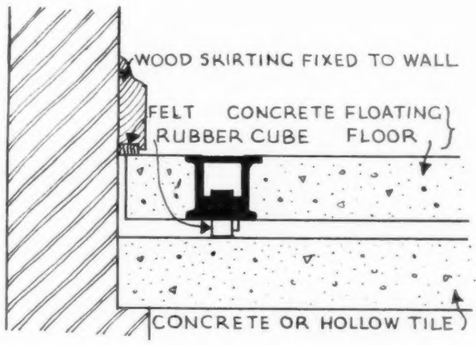
Kreuger and Sager, Ingeniors Vetenskaps Akad. Handlingar, No. 132, 1934.

Final Report of the Ministry of Health Departmental Committee on Construction of Flats for the Working Classes (1937).

Figures for the insulating effect of the treatments referred to (i.e. the reduction of impact noise heard below the floor) are given in terms of the accepted unit of noise—the phon. The definition of







Details of the Building Research Station's floating concrete floor, referred to below, and, above, the Cullum proprietary floor.

this is given in another article in this issue. For interpreting the results it may be useful to recall that a reduction in loudness of 10 phons is appreciated by the human ear as an approximate halving of the noise. Changes of the order of two or three phons are of small significance. It was felt by the Ministry of Health Departmental Committee on the Construction of Flats for the Working Classes that improvements in floor insulation are not appreciated unless they are definitely greater than five phons. The committee was of the opinion that an improvement of 15–20 phons was necessary to render a bare concrete floor suitable for flats. A greater improvement would presumably be necessary in the case of wood joist floors.

1. *Simple Floor Coverings.*

Simple floor coverings such as linoleum or solid rubber are not particularly effective, an improvement of round about five phons only being obtainable by their use. While it is possible that very thick pile carpets may have considerable value, ordinary Axminster carpet (about $\frac{1}{8}$ in. thick) on underfelt ($\frac{1}{8}$ in. thick) effects an improvement of between 5 and 10 phons which, though useful when added to the effect of some other treatment, is not sufficient by itself. Floor coverings incorporating sponge rubber provide greater insulation.

2. *Floating Floors.*

A floating floor construction is an effective insulator and has the advantage that a hard-wearing surface is provided. These floors consist of an upper layer of concrete or wood resting on an insulating material which is supported on the structural floor. It appears that the insulating material used needs to have a "springy" nature. Examples are rubber, steel wool and certain thick insulating blanket such as Cabots quilt or glass silk blanket. Rubber is used in the form of small pads of about an inch in thickness and distributed so that the loading on them is of the order of 20 lbs. per square inch upwards. The other materials are sometimes laid to cover the structural floor though some of them can be used cut up into pads or strips.

Besides improving the insulation of the structural floor, floating floors have the added advantage that they diminish the transmission of impact sounds to the structure of the building. They also have the practical advantage that pipes can be laid below them.

(*a*) *Wood Floating Floors.*—Wood floating floors are usually built of floor boards on battens and are often stood upon an insulating blanket (*see* 11). Laid on rubber, felt, or an insulating blanket, such floors can afford improvements in insulations of 15 to 20 phons. One proprietary floor (the Cullum) which is of this type, uses rubber insulating blocks and is loaded with tiles to increase its inertia (*see* drawing above). Insulated wood raft floors can also be used, with success, on wood joist floors.

(*b*) *Concrete Floating Floors.*—A concrete floating floor has several practical advantages, and is preferred in some cases to a wooden floor. It is probably unsuitable for use with a wood joist floor. When used in conjunction with an insulating blanket, the latter is laid on the structural floor and the concrete poured directly on to it (*see* 12). Care should be taken that adjoining strips of blanket overlap, to avoid the concrete penetrating to the structural floor below. Insulations of up to about 25 phons have been measured for such construction. Instead of a blanket, steel-wool, cocoa-fibre and also cork granules, in each case covered with bitumenized paper have been used successfully. It is, of course, essential to avoid rigid contacts between the floating and structural floors.

A concrete floor floating on rubber has been found very effective, insulation of up to 20 phons being readily obtainable. The Building Research Station have designed a special method for constructing such floors. Paper is laid over the structural floor and banded screwed pipe sockets are distributed over it. The concrete which is to form the floating floor is poured on up to the depth of the pipe sockets. When the concrete has hardened, rubber pads are dropped into the sockets and steel plugs screwed in as shown above. In a limited number of sockets wooden blocks are dropped and the plugs above them are screwed in so that the floating floor is gradually lifted. When it has been raised rather more than to the required height the plugs above the rubber pads are screwed down into contact with the rubber, the plugs above the wooden blocks are removed, the blocks are replaced by rubber pads and their plugs screwed down again. It should be mentioned that, as stated in the report of the Ministry of Health Committee referred to above, a patent has been applied for this construction with the object of preventing it from being exploited by one firm at an uncontrolled price. The Department of Scientific and Industrial Research propose to allow contractors to use the method at a nominal royalty. Application for permission to construct floors according to this method should be made to the Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, S.W.1.

It has been shown that the separation between the floating and structural floors is of some importance. It should not be less than 1 in., otherwise air coupling effects reduce the insulation.

It is, of course, necessary to preserve the floor levels either by carrying the floating floor treatment over the whole of the floor of a building or else by raising the level of the untreated floors.

Particular attention should be paid to the skirtings when installing floating floors. Ordinary skirtings would short circuit the insulation of the floor. A successful treatment is a strip of felt between the floating floor and the bottom edge of the skirting board.

3. *False Ceilings.*

Suspended ceilings can be used with all types of floor. Suspended ceilings should be insulated from the main floor, for example, by inserting felt between the ceiling battens and the clips. Certain proprietary clips are available which can be used for this purpose. In general, suspended ceilings give improvements of the order of 10 phons which, by itself, is scarcely sufficient to quieten a solid floor. They are therefore best used to supplement other treatments (13).

Independent ceilings are fairly successful treatments, improvements of the order of 15 phons being obtainable. In the case of solid floors, the ceiling can be supported on corbels let into the side walls (17). In the case of a wood joist floor, the ceiling can be on independent joists, laid between the joists of the main floor (16).

These treatments have the disadvantage that the height of the room is reduced considerably. But there are occasions, for instance, when the upper floor level of an existing floor cannot be altered, when this type of treatment is necessary.

4. *Fillings.*

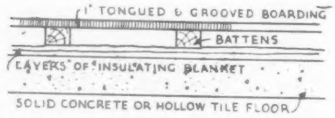
There appears to be no evidence that fillings between the battens of a floating wood floor have an appreciable advantage. Puggings in wood joist floors have some advantage but mainly, apparently, on account of the increase in weight they produce. Light fillings, for example, peat or cork dust, have very little value, while heavy fillings of shingle (up to about 40 lbs. per square foot) effect a considerable improvement. Even so, the resulting floor appears to be no better than an equally heavy solid floor (15).

General.

The evidence points to untreated solid concrete and hollow tile floors being equally noisy, but 10 to 15 phons quieter than a traditional wood joist floor. Where good insulation is a consideration, therefore, there would appear to be an advantage in using solid or hollow tile floors and applying suitable treatment to them.

CONCLUSIONS

The general tendency in sound-insulating floor construction appears to be towards laying an insulated floating floor over the structural floor, since by this means not only is the transmission to the structural floor of sound due to footsteps minimized but also (a feature of considerable general importance) the transmission to the walls of the building and hence to more distant rooms is reduced. The latter feature is not obtainable from a suspended ceiling which insulates the room below only. In fact, a suspended ceiling probably finds its chief use either when used in conjunction with a floating floor to obtain a high degree of insulation or when the level of the floor to be insulated must not be altered. Floating floors also have practical advantages in that service pipes can often be run below them. At present it is probably not possible to speak with confidence regarding the conditions for which each method of insulating floating floors is most suitable, nor is there much information available as to which material will prove to have the greatest useful life. However, "Time ripens all things: no man is born wise" and doubtless the information will come in due course.



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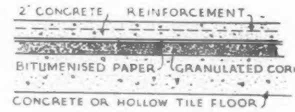

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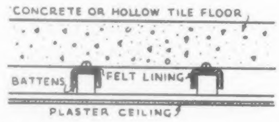

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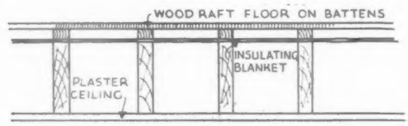

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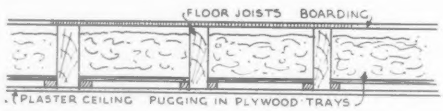

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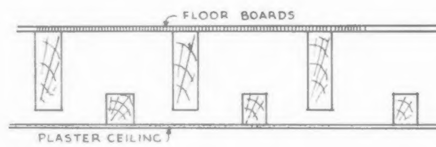

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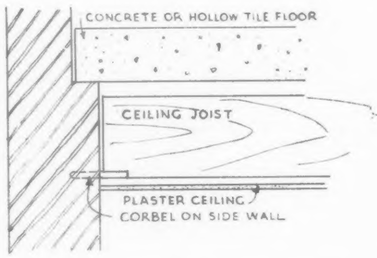


17

Examples of various types of sound-insulating floors.

COMPARATIVE COST OF FLOORS

By Davis and Belfield

	£	s.	d.
No. 11. 1-in. Deal tongued and grooved boarding, 2-in. × 2-in. deal battens, two layers of eelgrass insulating blanket and 6-in. concrete (4 : 2 : 1) reinforced with No. 8 B.R.C. fabric ... per yard super	1	0	6
No. 12. Omitted.			
No. 13. 6-in. Concrete (4 : 2 : 1) reinforced with No. 8 B.R.C. fabric, ceiling clips built in with felt linings, 2-in. × 2-in. ceiling battens, expanded metal lathing and two coats hard plaster ... per yard super	0	19	0
No. 14. 1-in. Deal tongued and grooved boarding, 2-in. × 2-in. deal battens, two thicknesses of eelgrass insulating blanket, 9-in. × 2-in. fir joists, expanded metal lathing and two coats hard plaster ... per yard super	0	17	5
No. 15. 1-in. Deal tongued and grooved boarding, 9-in. × 2-in. fir joists, 4-in. pugging, 6 mm. plywood trays with ½-in. × ½-in. fillets, expanded metal lathing and two coats hard plaster ... per yard super	1	0	7
No. 16. 1-in. Deal tongued and grooved boarding, 9-in. × 2-in. fir floor joists, 3-in. × 2-in. fir ceiling battens staggered, expanded metal lathing and two coats hard plaster per yard super	0	13	11
No. 17. 6-in. Concrete floor (4 : 2 : 1) reinforced with No. 8 B.R.C., 9-in. × 2-in. fir ceiling joists, expanded metal lathing and two coats hard plaster ... per yard super	0	18	6

TECHNICAL DEFENCE

NOISE RESEARCH

AT THE NATIONAL PHYSICAL LABORATORY

[BY A. H. DAVIS]

(Physics Department, National Physical Laboratory)

MANY technical aspects of noise reduction are today receiving attention which could not have been given to them twenty-five years ago, before the development of thermionic valve amplifiers and associated devices for the measurement and analysis of sound. Various industrial and service laboratories deal with noise in relation with their own particular requirements, and the National Physical Laboratory, which has special laboratories for the work, helps with noise problems on land, on sea, and in the air, and undertakes the standardization of all kinds of instruments used in acoustical work. It pays particular attention to building acoustics.

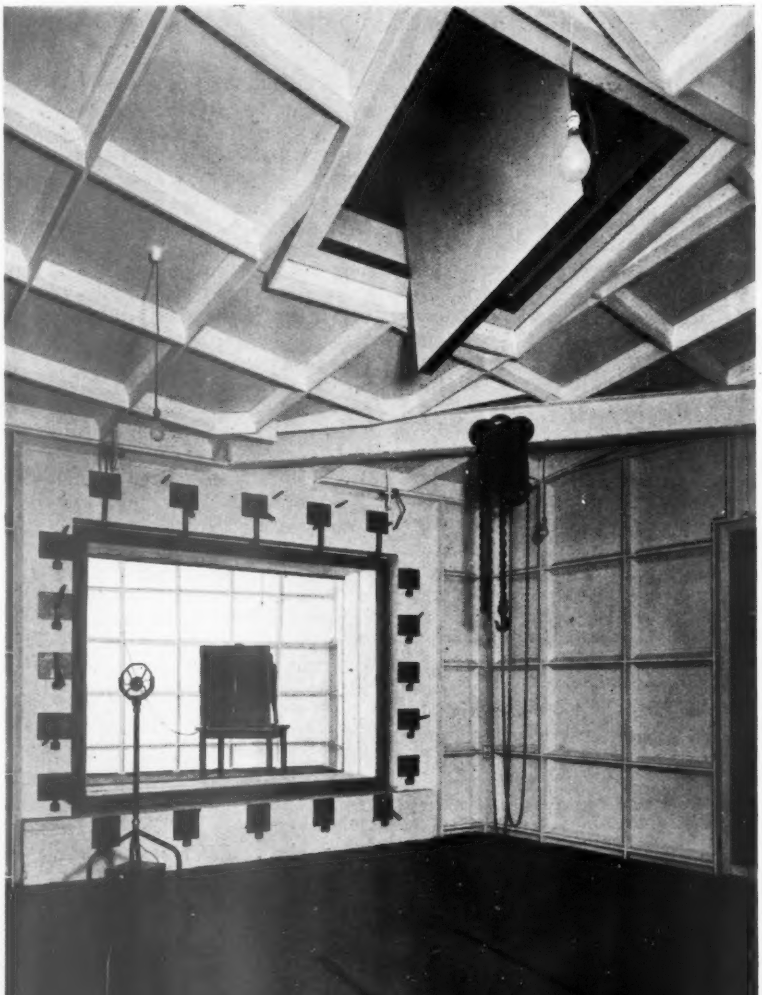


Fig. 1. *Transmission room in the Acoustics Laboratory, N.P.L.*
(By permission of the Controller, H.M. Stationery Office)

Noise Measurement and Standardization

Much depends in acoustics upon standardized measurements, and Fig. 2 shows a chamber (one side removed) in which the laboratory conducts the calibration of microphones, sound meters and analysers in terms of the actual pressures set up in the air by the sound. The cabinet is lined freely with absorbent material (cotton waste) in order that reflection from the boundaries shall be minimized. A door is seen on the left, a source of sound is visible in the end wall, and a narrow window on the right can be used for a scale observed from the outside.

Measurements are made of the sounds emitted by loudspeakers, machines, such as vacuum cleaners, etc., in connection with the particular problems which such articles present. Where necessary measurements are made not only of the overall intensity of sounds, but also of their constitution—that is, of the pitch and intensity of their components. This often helps in tracing constituent noises to their sources, or in devising means of excluding or suppressing them.

Investigations have been made of aircraft noise and of train noise, and the laboratory frequently undertakes work in connection with the suppression of noise from aeroplane testing beds, works and factories, transformer sub-stations, noisy offices, and the like. A programme of work is in progress for the Institution of Automobile Engineers, on the silencing of motor-cycles.

An important feature of noise is its loudness. The various meters manufactured for the measurement of the equivalent loudness of noise can be tested, and much attention has been given to subjective and objective methods of measurement. Objective meters, of course, if they are successful, are free from suspicion of personal bias, and suitable for employment in the control of noise by regulations which limit the loudness permissible. The laboratory has devised a meter of the objective class which has proved very satisfactory for moderate and loud sounds of a wide variety. (*See* p. 848.)

With the instrument a large programme of work was recently undertaken, for a committee of the Ministry of Transport, on the noise of mechanically propelled vehicles and on the sounds of motor horns and other warning devices. After the experiments the committee, in its reports, recommended that after a certain date no vehicle should be offered for sale or use on the public highway unless the objectively measured loudness fell below certain limits, usually 90 phons at a point distant 18 ft.

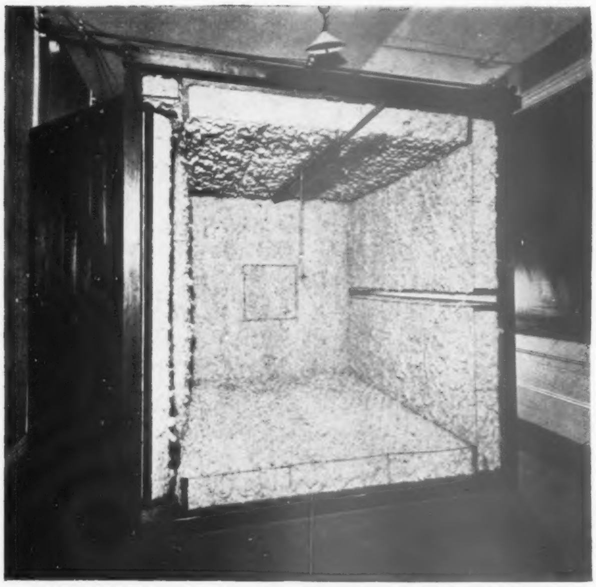
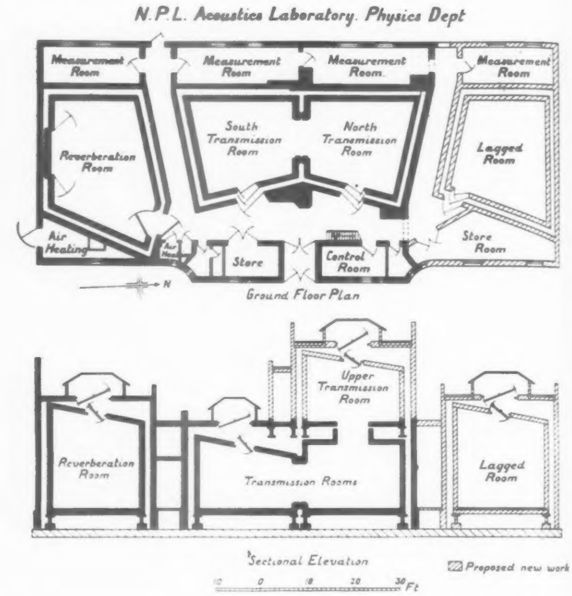


Fig. 2



By permission of the Controller, H.M. Stationery Office.

Fig 3.

laterally from the vehicle as it passes on the open road at full throttle at a speed of 30 m.p.h. Limits to the loudness of motor horns and vehicles on the road were also proposed.

Building Acoustics

Considerable attention has been paid to the problem of mitigating noise in buildings. The problem resolves itself into a few main divisions. Primary importance attaches to finding partitions, doors, ventilating ducts, etc., which are proof against air-borne sounds, and floors which insulate the rooms below from the noise of heavy footfalls or blows overhead. For, unless transmission direct through the floor or partition can be prevented, no success can be achieved. It is also necessary to study the general transmission of sound via the structure of the building, and the problem of isolating noise due to taps, cisterns, pumps, and other equipment.

Research into these various aspects is undertaken at the National Physical Laboratory in a building situated in a very quiet site, and specially planned to prevent the entrance of extraneous sound, and to avoid transmission by any paths other than those under study.

Acoustics Laboratory

Fig. 3 shows a plan and section of the new acoustics laboratory of which part has been in use since 1933, and which is already being extended, somewhat on the lines indicated by the dotted sections, to meet the increasing demands for acoustical research.

The completed portion of the building comprises two rooms for studying the transmission of sound through partitions, walls, etc., and a "reverberation" room for studying the absorbing power of materials used to control reverberation, suppress echo, or absorb noise in auditoria or other rooms.

The part under construction will provide facilities for testing floors, and a large room heavily lined with absorbent for use in fundamental acoustical measurements and calibrations.

Partitions

Much of the present work on partitions, and all the work done in the early years, was conducted with specimens about 5 ft. by 4 ft. in size placed in the double wall separating two small sound-proof rooms. The rooms are heavily lined with sound-absorbent, and in one a beam of sound is directed obliquely on to the test partition.

A photograph of the transmission rooms in the new Acoustics Laboratory is shown in Fig. 1. In these, partitions and similar structures are tested. The partitions are built in the aperture between two rooms, the north and south transmission rooms. Sounds of various pitches in the range 100-4,000 cycles per second are produced in the north room, and the transmission to the south room is measured before and after the test partition is erected in the aperture. Measurements are also made in the sending-room. The differences give the insulating value of the partition. The rooms are of irregular shape, so as to minimize transverse resonances of the air (bathroom resonances) which might give anomalous effects for tones of certain pitch, as well as to promote general uniformity of the sound within the room. A framework of wood has been installed upon the walls so that absorbents may be applied to them when it is desired to "deaden" the room. Elaborate precautions have necessarily been taken to ensure that the sound measured is that which has passed through the partition and that it is not sound which has arrived by other paths. To this end transmission through doors is minimized by fitting each room with three solid 2-in. wooden doors. There are no windows, and the 2½-in. steel shutters to the skylight are closed when experiments are in progress. Each room is double, and consists of an outer shell of 9-in. masonry, and an inner shell 14 ins. thick completely independent of the outer, and resting only on insulating piers on separate foundations. The insulation between the inner rooms and the piers is of 2½-in. cork, and provision has been made for hydraulic lifting of the 200-ton inner rooms so that the cork may be replaced if it deteriorates. The inner shell of the north room is completely separate from that of the south room, so that vibration and sound set up in the structure of one is not directly communicated to the structure of the other. The half-gap of the aperture between the two inner shells is sealed with rubber. All these conditions ensure that the sound measurement in the second room due to a noise in the first has actually come through the partition.

Floors

For testing the insulation afforded by floors against impact sounds, the floor is laid over an aperture of the floor of a room, such as that shown in the floor of the upper transmission room now under construction. Pending the completion of this accommodation temporary arrangements have been made for dealing with floor specimens about 8 ft. by 5 ft. in size. A succession of blows is applied to the test floor by means of a machine, in which hammer heads fall under gravity and deliver a succession of blows to the floor under test. The loudness of the noise produced below the test floor is measured.

The energy of the blows is that of the heavy footsteps of a man, for if heavy footsteps and blows can be dealt with, lighter footsteps would present no difficulties. The hammers are fitted with hard faces and soft (rubber) ones, since the two types do not give the same results. For example, the effect of a carpet on the floor is to muffle effectively the sound of a falling coin or the patter of leather heeled shoes, though it would have but little effect in preventing the transmission of dull heavy thuds due to rubber-heeled footsteps of a heavy man.

Many types of floor finish have been tested as part of the laboratory's research programme, and numbers of constructions have been tested for firms, not only in order to evaluate the effectiveness of their standard products, but sometimes as a step in devising the best method of using their products.

Research on floors is also being conducted by the laboratory at the Building Research Station, where temporary facilities have been provided, specimens of larger size (10 ft. by 15 ft.) being employed.

General Transmission in Buildings

The laboratory tests on walls and floors are frequently supplemented by tests in actual buildings, where practicable points connecting favourable floors and walls are thrashed out, and study is made of the general transmission of sound through the structure of the building, or via its flanking walls, ventilating ducts or water pipes to rooms very remote from the source of the noise. The study of the structure is important in these days of steel framing and monolithic structure, and it is useless to arrange insulating walls and floors if they are short-circuited by injudicious ducts or pipes.

Sound Absorption and General Acoustics of Auditoria

When everything has been done to prevent the entrance of sound to a room, further improvement may sometimes be effected by making the room adequately absorbent. To this end furniture, carpets and hangings may be introduced, or special absorbents installed. Such absorbents are also of value in controlling the reverberation of sound in auditoriums, for if too little absorbent is present speech appears blurred, whilst if there is too much the room seems "dead" and loudness inadequate.

The measurement of the sound absorption coefficients received early attention at the laboratory. Occasionally small disc-like samples, about 6 ins. in diameter, are studied under conditions in which the sound falls perpendicularly upon the discs. The results are of limited value, but usually give an indication of whether the material tested is likely to be useful as an absorbent or not. Normally, however, large samples of material—say 10 ft. square—are tested under reverberant conditions in a large room (Fig. 4) over a frequency range of 250-4,000 cycles per second and 125-8,000 cycles in some cases. The test material is placed on a large area on one of the walls which can be covered with steel doors. Alternatively, the material can be laid upon the floor. When the doors are shut, sound reverberates in the room for 10-15 seconds after the source has ceased. When the doors are open the absorbent material is exposed; the reverberation is shortened by an amount which depends upon the absorbing power of the test material, and from which the absorbing power of the material can be calculated.

For some years there has been a steady demand by industry for absorption measurements of this kind. The materials used are varied, and include fireproof felts, asbestos, eelgrass, slag-wool, or glass silk, applied in panels behind a screen of canvas, repp, oilcloth, or even perforated metal, tiles of fibrous boards, often partially perforated or slotted to increase the absorbing power; and various acoustic plasters and blocks which have considerable porosity.

The laboratory also carries out work in connection with the provision of good acoustical conditions in auditoria. If necessary it uses sectional models for the work. In this connection apparatus has been developed for photographing the progress of sound pulse or ripples in model sections of auditoria, and is used in elucidating acoustical defects.

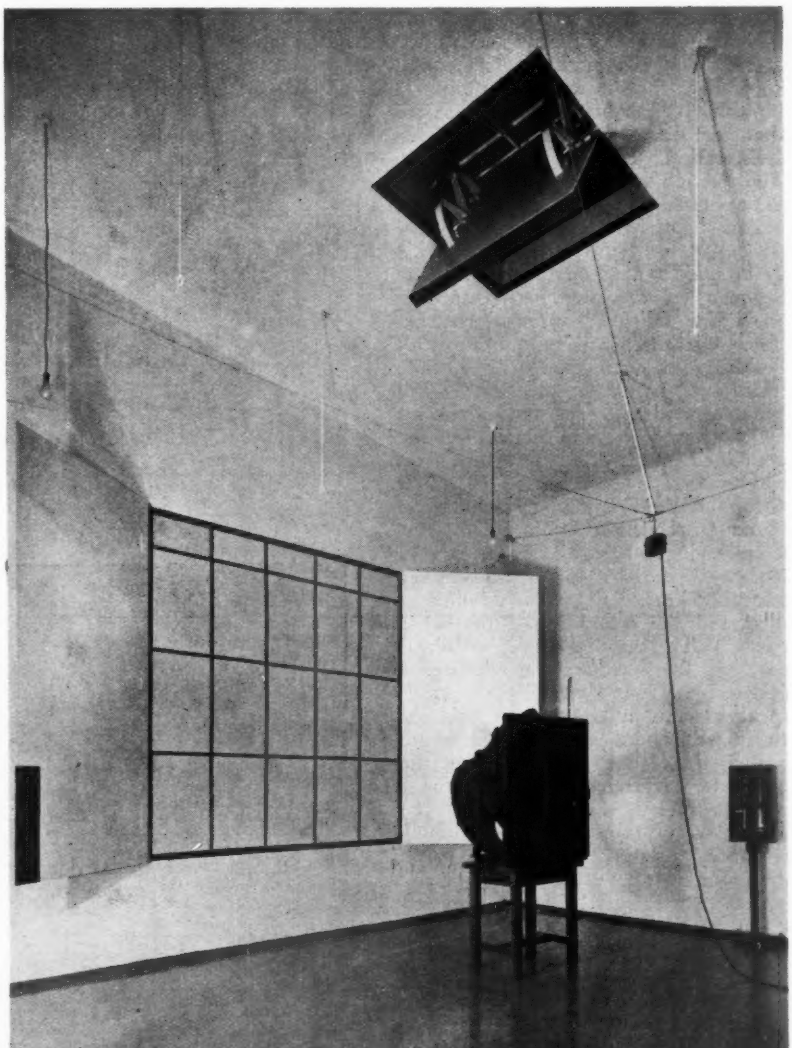


Fig. 4 *A sample of material undergoing test in the Acoustics Laboratory.*

(By permission of the Controller, H.M. Stationery Office.)

TECHNICAL DEFENCE

SOUND CONDUCTION

BY INDIRECT PATHS

[BY DR. J. E. R. CONSTABLE]

(Physics Dept., National Physical Laboratory)

SO far only the transmission of sound by direct paths has been considered; for example through an intervening partition, a door, or a window. Another problem which is engaging the attention of investigators at the National Physical Laboratory and the Building Research Station and elsewhere is that of sound transmission by indirect paths. Examples of such paths are flanking walls and floors. The problem has become particularly apparent now that large blocks of flats have become popular. In such buildings it is often noticed that hammering at one point is clearly heard in a large number of rooms. It has been variously stated that steel frames or reinforced concrete construction are responsible for this. The position is, however, that although some measurements have been made on this point by various workers there is not yet sufficient evidence available to enable a distinction to be made between the sound transmitting properties of different types of construction. Measurements in a number of buildings of each type will first be necessary. In this article all that will be attempted is to set out the results which have been obtained by the combined efforts of workers in several countries.

Probably the first measurements upon sound transmission by indirect paths were made by Berg and Holtsmark in Norway* who, leaving a loudspeaker sounding in one room in a building, measured the sound in all the other rooms. The results they obtained showed that while the difference between the sound levels in the loudspeaker room and the room adjacent to it was about 35 db., (the sound reduction to be expected from the particular partition used), the difference of intensities between others of the same row of rooms, was very much less (only 3–4 db.). This showed that the sound does not reach a distant room by a process of being transmitted through the intervening partitions (otherwise it would have dropped 35 db. in intensity as each room was passed). Berg and Holtsmark accepted this as evidence that the sound reached distant rooms by another path, viz. by the structure of the building. Sound is, of course, in these circumstances, audible in the structure when an ear is pressed against it. From these measurements they deduced that this structure-borne sound decayed in intensity by about ½ decibel per foot in the particular building they studied (18-in. brick walls; 4-in. R.C. floors).

A. Gastell† in Germany has noticed that impacts delivered to the structure in one part of a building are heard at considerable distances away and has measured the attenuation of the vibration in the structure of buildings of various types. He concludes that reinforced concrete and steel-framed buildings transmit such sounds more readily than do buildings of brick. He has also tested a steel framed building in which, as shown in Fig. 1, by wrapping the steel girders with 5 mm. cork, contact with the brick panels had been prevented. He found the attenuation of impact sounds was considerably improved by this treatment and was, in fact, about as great as in a brick building.

* R. Berg and J. Holtsmark, Det Kongelige Norske Videnskabers Selskab Forhandlingar, No. 22, vol. vi, 1933.

† A. Gastell, Akustische Zeitschrift, vol. i, p. 24, 1936.

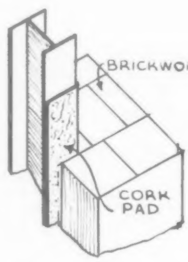


Fig. 1

Below: Novadommauerwerk, a method of dry building in which the horizantal courses of wood-wool and cement prevent structure-borne sounds.

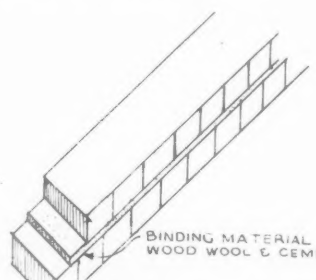


Fig. 2

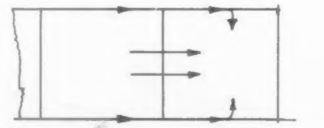


Fig. 3

It is fair to comment that these measurements should be regarded with caution since they were apparently made upon only one building of each type only. If they are correct, however, they indicate a definite disadvantage in reinforced concrete and steel framed construction. Insulating the steel frame from the building does not seem to have been tried much in this country. Hofbauer and Bruckmeyer* in Austria have experimented with the special patent wall construction shown in Fig. 2. This method of building walls (termed Novadommauerwerk) dispenses with mortar appears to rely upon frictional forces for its stability. The bricks in any one course are laid touching each other but without any cement; between each course and its neighbour is a layer of a wood wool and cement material (of the Thermacoust or Heraklith type). There is said to be so much friction between bricks and the wood wool slabs that a building constructed in this way is perfectly stable and it is understood that a number of buildings have been built using Novadommauerwerk. Practical advantages such as speed of erection are obvious. It is to be expected that walls of this type would have acoustical advantages, since the layers of binding material would probably not transmit vibration as easily as does solid material, and the air spaces between the bricks should provide some insulation against sound travelling in a horizontal direction. The measurements gave an attenuation of about 10 decibels per foot which is very much greater than the corresponding figure for ordinary brickwork.

The problem is also being investigated by the National Physical Laboratory and the Building Research Station, a special building having been erected for this purpose at the Building Research Station at Garston, Watford. No results are at present available.

One other aspect of transmission by indirect paths should also be mentioned viz., its effect upon the sound insulation obtainable from a partition. Sound will travel from a noisy room to its neighbour, partly via the intervening partition, but also along the flanking walls and floors (see Fig. 3). Such transmission clearly puts a limit to the insulation which the partition can profitably possess. Very few measurements upon this effect have yet been made but it appears probable that in the ordinary building there is no purpose in installing a partition having an insulation greater than that of a 9-in. brick wall (55 decibels) unless steps are taken to deal with the indirect transmission as well†. The steps which should be taken to this end have still to be determined.

* G. Hofbauer and F. Bruckmayer, Akustische Zeitschrift 2, p. 249, 1937.

† G. W. C. Kaye and J. E. R. Constable, International Association for Testing Materials, 1936.

TECHNICAL DEFENCE

SOUND ABSORBING MATERIALS

[BY E. J. EVANS]

(Physics Department, National Physical Laboratory)

IT is well known that rooms finished mainly in hard, non-porous materials, with a comparative lack of soft furnishings, are inherently very noisy and reverberant. Materials such as hard plaster may reflect about 98 per cent. of the sound falling on them, and sounds whether originating from sources in the room or outside are repeatedly reflected and built up to a high value of intensity. Calculation shows that in untreated rooms the repeatedly reflected or reverberant sound is usually louder than the direct sound, except for positions near the source, so that the sound level over the greater part of the room is due largely to reverberant sound. In such rooms, substantial improvement can be obtained by reducing the level of the reflected sound by the application of sound-absorbing materials.

The general sound level in a room depends in a calculable manner on the quantity of absorbing material present. The total absorbing power of the surfaces is assessed as follows. For a surface of area S sq. ft., each sq. ft. of which absorbs a fraction "a" of the incident reverberant sound, the absorbing power is aS sabin. The quantity "a" is known as the absorption coefficient of the material, and values for various materials are given in Table I. If the total surfaces of a room consist of areas S_1, S_2, S_3 .. sq. ft. of materials having absorption coefficients a_1, a_2, a_3 .. respectively, the total absorbing power A of the room surfaces is given by $A = a_1 S_1 + a_2 S_2$

TABLE I

Material	Approximate absorption coefficients		
	Cycles per second		
	250	500	1000–2000
Ordinary wall and ceiling surfaces—			
Hard plaster	0·01–0·02	0·01–0·02	0·02–0·03
Unpainted brick	0·03	0·03	0·05
Wood panelling 2 cms. thick	0·10	0·10	0·10
Curtains, cretonne	—	0·15	—
,, medium weight	—	0·2–0·4	—
,, heavy, in folds	—	0·5–1·0	—
Floor coverings—			
Wood block floor laid in mastic	0·03	0·06	0·10
Cork carpet, ¼ in. thick	0·03	0·07	0·20
Porous rubber sheet, ¼ in. thick	0·05	0·05	0·20
Axminster carpet, ¼ in. thick	0·05	0·10	0·35
,, ,, on ¼ in. felt underlay ..	0·15	0·40	0·65
,, ,, on ¼ in. rubber underlay	0·05	0·20	0·45
Turkey carpet, ½ in. thick	0·10	0·25	0·60
,, ,, on ½ in. felt underlay ..	0·30	0·50	0·65
Special absorbents—			
Acoustic plasters (½ in. to 1 in. thick) on stone	0·15	0·25	0·30
Fibre boards, plain, ½ in. thick, on battens ..	0·30–0·40	0·30–0·35	0·25–0·35
Medium efficiency tiles, on battens ..	0·40	0·40	0·50
High efficiency tiles with perforated surfaces, on battens	0·50	0·80	0·85
Acoustic felts, 1 in. thick, perforated covers, on hard surface	0·30	0·70	0·80
Acoustic felts, ½ in. thick, on battens ..	0·25	0·45	0·70
Wood wool-cement board, 1 in. thick, on battens	0·30	0·60	0·70
Sprayed asbestos, 1 in. thick	0·50–0·60	0·65–0·75	0·60–0·75
Slag wool or glass silk about 2 ins. thick, on battens	0·70	0·85	0·90

$+a_3 S_3$ .. sabins. The reduction of the level of reverberant sound in a room when the total absorbing power is increased from A_1 to A_2 is given by the expression :—

Sound reduction in decibels = $10 \log_{10} \frac{A_2}{A_1}$

Since the expression refers to sound intensity levels the sound reduction is expressed in decibels. For medium frequencies this is approximately equal to the loudness reduction in phons.

The effect of treatment may be illustrated by the case of an office 50 ft. by 40 ft. by 10 ft. high, containing 25 typists, finished mainly in hard plaster, with the usual wooden office furniture. The total absorption before treatment, including the clothing of the occupants, would probably be about 250 sabins. Assuming an initial sound intensity level of 60 decibels above a zero level of 0·0002 dyne per sq. cm., Fig. 1 shows the effect of treating the ceiling with a material of absorption coefficient 0·7, as the area of treatment is increased. When the whole ceiling is covered the reduction is about 8 decibels. The improvement in noise conditions given by an 8-decibel reduction depends on the frequency and intensity of the sound. For frequencies in the region of about 500 to 2,000 cycles per second, this would be about 8 phons, and subjectively for a reduction from 60 to 52 phons the loudness would be judged to be nearly halved.

It is seen that the reduction depends on the ratio of the final to the initial absorption, and the addition of a given area of treatment produces less effect as the treatment proceeds. To obtain a reduction of 3 decibels it is necessary to double the absorption present, and in the above example, to increase the reduction from about 8 decibels to 11 decibels a further 2,000 sq. ft. of treatment would be required. There is thus a limit to the reduction that can reasonably be obtained, and it appears usual in practice to aim at reduction in the region of about 7 to 10 decibels.

The effect of absorbent treatment in reducing reverberation is a further important factor in increasing the sense of comfort and quietness in treated rooms. In reverberant rooms speech is difficult and people tend to speak more loudly in an endeavour to be understood, whereas when the reverberation period is short speech is comfortable and there is no need to shout. A further effect of reducing reverberation is that noises from other parts of a room appear to be more localized and further away, and hence less disturbing.

Table I gives average approximate values of absorption coefficients for various types of materials. The values are derived mainly from measurements in the reverberation chamber at the National Physical Laboratory, using specimens 10 ft. by 10 ft. in size. Most

Above, rock wool wall lining at Rock Studios at Elstree. Small mesh netting is stretched over wool and secured to battens.

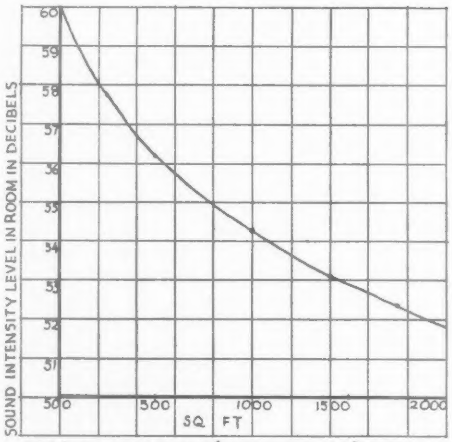


Fig. 1

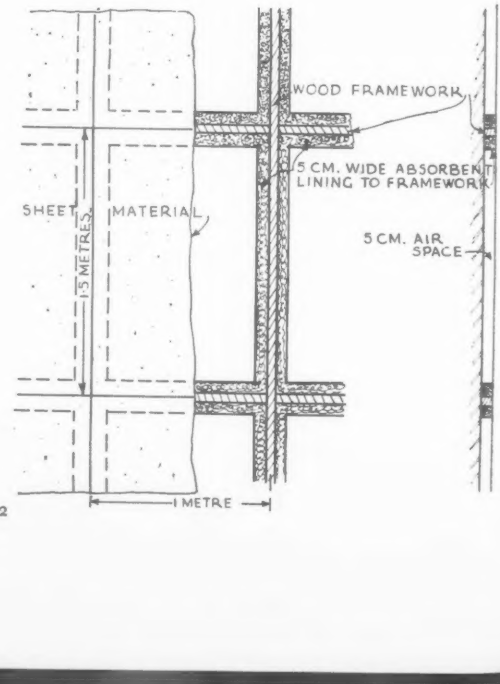


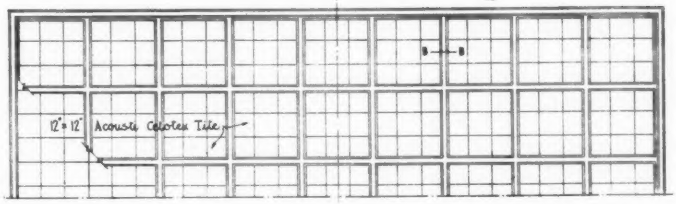
Fig. 2

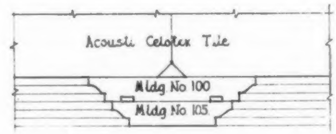
of the materials absorb mainly by virtue of their porosity, sound penetrating into the pores and being converted into heat, but in certain cases, such as fibre boards mounted on battens, there is appreciable absorption due to vibration of the material under the action of sound.

It is seen that a number of materials are available having high absorption, in the region of 0·7 or more at 500 cycles per second. Acoustic felts are usually mainly of asbestos-hair composition. They can be covered with perforated oilcloth, or with thin muslin which is painted and afterwards pinpricked. Other materials with perforated surfaces are fibre board tiles with holes drilled in the surface, and asbestos or mineral wool tiles with covers of soft plaster or thin metal, the covers being perforated with holes about $\frac{1}{16}$–$\frac{1}{8}$ in. diameter, $\frac{1}{2}$ in. or less apart. It is found that such covers effect very little reduction of efficiency, and the materials can be easily decorated, provided the holes are not filled up. The wood wool cement materials are in boards of somewhat open structure and consist of wood wool fibres bonded together with cement. Sprayed asbestos materials are sprayed directly on to brick or plaster surfaces, or alternatively, on to laths, and can be given various surface finishes. The decoration should be in accordance with the specifications of the manufacturers, since heavy painting will close up the pores and reduce the efficiency. Acoustic plasters are of a porous granular structure and likewise require care in decoration. It is seen that many ordinary fibre or insulating boards of the softer type when mounted on battens have useful sound absorbing properties. The figures refer to unpainted boards. Slag wool and glass silk are usually in mattress form, packed between wire netting, and covered with thin muslin. It may be added that examples of the use of a number of the above materials for ceiling treatments are on view at the Building Centre, 158 New Bond Street, London, W.1.

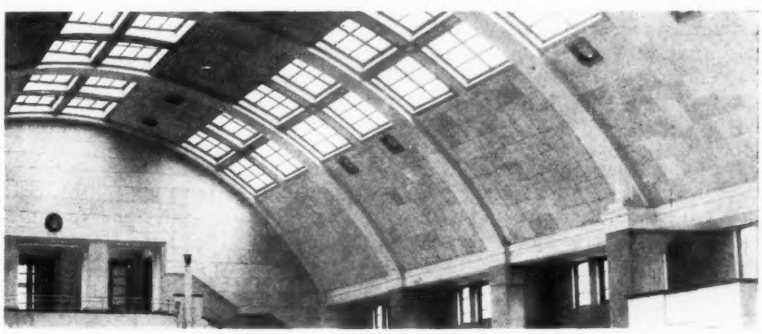
Absorbing materials are either cemented directly to the surface or mounted on battens. In the latter case the absorption is somewhat improved, particularly at low frequencies. In general, absorbing power decreases at low frequencies particularly for thin porous materials applied directly to a hard surface. For fibre boards on battens the absorption is maintained at 250 cycles per second, on account of the vibration of the material, but at 125 cycles per second the absorption would be considerably decreased. Measurements at 125 cycles per second (not shown) indicate that in order to obtain absorption coefficients in the region of 0·5 at this frequency with porous materials, thicknesses of 2 ins. or more are required.

Owing to the miscellaneous character of most noises, no fixed rule can be stated for the most desirable frequency-absorption characteristics. Since most general noises probably have components over the greater part of the frequency range, it is desirable that absorbing materials should have fairly uniform frequency characteristics and should not be too thin. The decrease of efficiency at low frequencies is offset to some extent by the properties of the ear, since loudness decreases more rapidly with decreasing intensity at low frequencies than at medium frequencies. The average absorption coefficient over the range 250 to 2,000 cycles per second is sometimes taken as the absorption coefficient for noise reduction purposes. In certain cases, however, low frequencies may be of chief importance, and it is necessary





Drawing showing fixing of one type of sound-absorbent tiling.



Another type of absorbent tiling used to prevent reverberation in a Rochdale swimming bath.

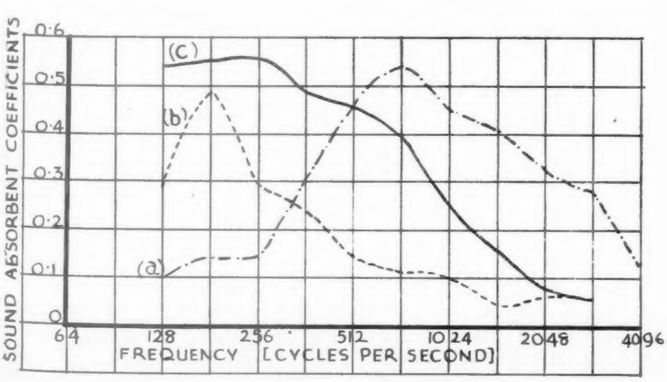


Fig. 3

K

to use either large thicknesses or specially designed constructions.

E. Meyer (Electrische Nachrichten-Technik, vol. 13, 1936) has developed a new type of sound-absorbing material, with a non-porous surface which offers considerable possibilities for control of frequency absorption characteristics, and can be easily cleaned and decorated. As shown in Fig. 2, it consists of thin sheet material mounted about 5 cms. away from a wall surface, on a wooden framework 5 cms. deep, made up of sections 1·5 by 1 metre in size. It is sufficient if each section of the framework is lined round its edges with a layer of absorbing felt or wadding about 5 cms. wide, along the depth of the framework. The remainder of the space between the sheet and the wall is left as an enclosed air space. It appears that the sheet material, vibrating under the action of sound, sets up vibrations in the air space behind, which are mainly parallel to the wall and are absorbed by the layer of material round the edges of the space. The materials used included plywood 0·5 cm. thick, oilcloth, brown paper and aluminium foil. Absorption coefficients of 0·2–0·5 over a wide frequency range are obtained, maximum absorption occurring at the resonance frequency of the system, which can be adjusted by suitable choice of the material and air space. For special low frequency absorption three air-spaced sheets (of oilcloth) are used, each supported on a framework lined with absorbent. The arrangement acts as a low pass filter, giving absorption coefficients in the region of 0·5 for frequencies from 128 to 512 cycles per second. Some typical results are shown in Fig. 3.

Sound-absorbing treatment is now extensively employed for noise reduction, particularly in cases where noise is due to internal sources. Large business offices, hospitals, banks where calculating machines are used, telephone switchboard rooms and swimming baths may be instanced as typical cases where absorbing treatment has been found to be of great value. In addition to the treatment of the main rooms, absorbent is also applied to corridors, which would otherwise be reverberant and convey sound with little attenuation from one part of a building to another. As regards hospitals, Neergard (Journal, Acoustical Society, America, vol. 2, July, 1930) has examined the suitability of various materials, and finds that many of the usual materials such as acoustical plasters and tiles can safely be used.

On the underground railways, absorbent treatment is applied to the tunnel walls, to reduce the noise in tube trains. Amongst the many other various applications, mention may also be made of the reduction of noise from aeroplane engine testing establishments by lining the exhaust ducts with about 4 ins. or more of mineral wool.

SILENCE

TECHNICAL DEFENCE

QUIET EQUIPMENT

[BY K. M. CONSTABLE]

OTHER articles in this issue show that it is by no means easy to prevent noise from spreading about a building. It is important therefore to reduce the noise to a minimum at its source. The sources of noise in a building are broadly speaking of two kinds :—

(1) Mechanical equipment such as lifts, ventilating fans, etc.

(2) The activities of the occupants of the building.

Both sources of noise, but particularly the latter, introduce the human factor and, as Lord Horder has pointed out, there is a real need for designs, devices and materials which will make buildings foolproof as far as creating needless noise is concerned.

Selection of Quiet Mechanical Equipment.

No doubt the ideal way to guard against the installation of noisy equipment would be to insert a clause in the contract for the installation to the effect that the noise of the equipment when in operation in the building in question must not exceed a certain level. This level would probably be determined by the existing noise on the site. It is highly probable that as noise-measuring instruments become more common, clauses of this kind will become the rule rather than the exception.

Failing such undertakings on the part of the manufacturer or contractor the purchaser should determine for himself the noisiness of the item in question by inspecting it in operation before accepting it. The conditions under which it is operating at the time of inspection should be carefully observed. If it is examined in a room, e.g. in a factory, in which the background noise level is considerably higher than in the building in which it is to be used, it may sound almost inaudible whereas it is in fact quite noisy. Another trap is to examine the equipment in a very absorbent room, for instance in a showroom containing heavy carpets and curtains and luxuriously upholstered furniture. It will sound considerably quieter in these surroundings than in a modern style reverberant room having hard plastered walls and ceiling and little furniture. The type of support should also be noticed when inspecting an electric motor or other machinery. On an insulating base the machine might appear fairly quiet, but if it will not be possible to provide such insulation when the machine is actually installed, a greater noise level should be allowed for.

Manufacturers in increasing numbers are including noise measurements in their routine tests. At the very least this indicates an increasing "noise-consciqusness." Whether these measurements are suitable for actual noise specifications has still to be determined but they do ensure a uniform product. Such figures are also valuable when comparing different models supplied by the same maker, but not necessarily for comparing equipment produced by different manufacturers, whose test methods may not be the same. When making comparisons of this kind it is useful to recall that over the range of noise levels likely to occur in domestic installations, differences of less than two phons have practically no significance but differences of five phons and upwards are important.

A few examples of silent mechanical equipment are briefly described below.

Lifts.

Several firms offer quiet lifts. For these, not only is quiet winding gear required, but silent car-levelling devices, and properly mounted, totally enclosed contactor boards are also desirable. Noise due to opening and closing lift gates can be minimized by using sliding or hinged wooden doors. Gates of the expanding metal type are ordinarily noisy, but silent models have been designed with quietening rubber buffers between the vertical elements. Winding gear is preferably installed in the basement rather than at the top of the shaft, as the noise is then less likely to cause disturbance.

Ventilating Plant.

Ventilating plant is dealt with elsewhere. In choosing small items such as desk fans, circulating and extractor fans, it should be remembered that silence in operation is at least as important as any other feature. Points to be looked for are : Slow running speeds, plain rather than ball bearings, and rigid construction.

Refrigerators.

Great progress has been made in refrigerator construction during the last few years, and most good makes are now very quiet. In a silent refrigerator the unit, if motor-driven, is mounted on insulating supports, and should be completely enclosed by the casing. If the casing is of pressed steel it should be treated with some "anti-drum" material. In general no sound should be audible outside the case of a good refrigerator, whether motor-driven or not. Central refrigeration is sometimes provided in blocks of flats. This has the merit of replacing the compressors in the individual cabinets by a central machine which can be placed so as not to cause disturbance.

Vacuum Cleaners.

A central vacuum cleaning plant has distinct advantages from the point of view of silence. A central plant is rather a luxury except in large buildings, but in hotels, hospitals and service flats it deserves serious consideration. A suction unit in the basement is connected by permanent pipeline with one or more outlets in each room, to which the usual hose and tools can be attached. When not in use the outlets are closed by heavy metal caps. This method concentrates the machinery in one room which can be adequately sound-proofed. Some makes of portable cleaners are notably more silent than others, but this is a choice usually concerning the client more than the architect.

Kitchen Machinery.

Kitchens are often put on the top floors of buildings. If the rooms beneath are to be reasonably quiet, special care must be taken with all the kitchen machinery. Any large item incorporating moving machinery, for instance dish-washing or potato-peeling machines, should be placed on insulating supports. Oven doors should be of a quiet-closing type.

OTHER EQUIPMENT

Other equipment can contribute to silence in various ways.

Doors.

The passage of sound through doors has been dealt with elsewhere. A door can, however, make most disturbing noises when being opened, closed, or, not to put too fine a point on it, slammed.

Doors closing against a rebate should be fitted with a controlling device which will reduce the impact of the door on the frame. Examples are pneumatic checks, check action hinges, or check action floor springs. Most door closers are designed to prevent slamming. If devices of this kind are deemed too expensive, rubber, leather or felt buffers may be used, though they are probably not as effective. These can be used as continuous strips similar to draught excluders, or can consist of small pads fixed in a convenient position.

At the risk of being obvious it may be remarked that unless some anti-slam device is fitted, doors which are likely to remain open for any length of time should be provided with a holding device. Foot-operated suction holders are convenient for this purpose.

Door fastenings deserve care in their selection. Ball catches usually click, and unless carefully maintained may become operable only by banging the door.

Sliding doors are often noisy. Attempts at quietening them have included substituting fibre wheels for metal in the overhead track. Another device is the use of a slotted tube fixed to the head of the frame, in which run two short lengths of tube attached to the top of the door. If kept well lubricated, this is said to be very successful. There is also a proprietary sliding door fitting in which the weight of the door is carried on a rubber-covered track fitted flush with the floor.

Windows.

Windows should be well fitting, and casement stays should be capable of holding a window firmly clamped so that it does not rattle in wind.

Switches.

Silent electric light switches are obtainable, and as they are not expensive, should be specified wherever quiet is important, particularly in corridors serving bedrooms. Power switches should not be placed on party walls.

Telephones.

Telephone bells should not be fixed on walls dividing two flats. The G.P.O. have tried to reduce the disturbance due to telephone bells by producing a more melodious bell. There is also available on the market a system of light signals which on receipt of a call during the daytime flash the lamps in the suite or building and during the evening dim the lights. The firm selling this device have arranged that the G.P.O. will connect it to the telephone system.

Office Equipment.

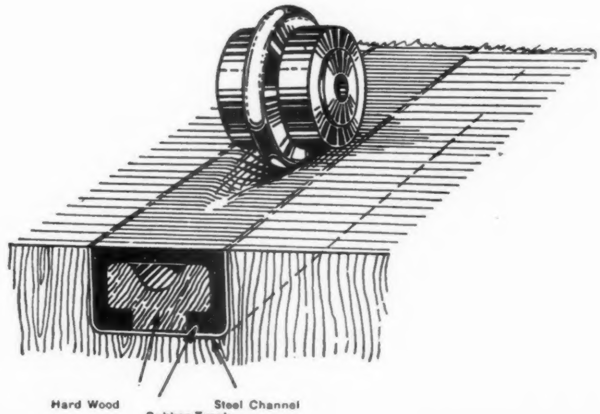
Silent typewriters have been known for some time and are of great value in offices. Rubber pads beneath office machinery of all kinds will help to reduce the noise. Silent clocks are appreciated where really quiet conditions are required. These are of the impulse type driven by a central master clock, but the usual half-minute click is avoided by making the armature in the form of a small motor, the rotor of which receives a torque on the arrival of the impulse.

Heating.

Where individual room heating is required no doubt the choice between electricity, gas, or solid fuel fires will be determined by considerations other than silence, but it may be remembered that solid fuel fires are a source of noise particularly objectionable in flats where poking and stoking are audible both through the party wall and on the floor below.

Use of Rubber.

Among materials used to reduce noise made by occupants of buildings, rubber takes a prominent place. The noise made by the domestic staff can be kept down by the use of rubber rims for coal buckets, pails and dustbins, rubber-edged broom heads and vacuum-cleaner tools, rubber sink linings, rubber lined plate racks. Noise made by children can be lessened by providing rubber buffers for toys of all kinds. Noise made by waitresses can be reduced by using rubber lined trays, rubber covered table and counter tops, and rubber trolley wheels.



A new type of sliding door track.

SILENCE

TECHNICAL DEFENCE

THE REDUCTION OF NOISE FROM MACHINERY

[BY A. J. KING]

WHEN machinery is installed in a building it is advisable always to consider carefully the possibility of trouble due to the noise of the machinery, both in the same room and in other parts of the building. Complaints regarding noise are usually based on the obtrusiveness of the noise above the sounds normally heard or to be expected in the particular location. It follows, therefore, that there are two starting points in the consideration of this matter: the noise due to the machine and the normal background sounds in the room in question; and it is the relative magnitude of these two in each case which determines whether or not the machine noise will be important. As might be expected, the differences in magnitude between noise and background corresponding to obtrusiveness and inaudibility vary somewhat with the character of the sounds. However, if the equivalent loudnesses of both (noise and background) are measured separately in phons, then it may be taken as a rough guide that if the noise is 10 or more phons greater than the background it will be obtrusive, while if it is 15 or more phons less it will be innocuous. In an existing building the background sound can be measured by one or other of the portable meters which are available and which are known to read correctly in phons for the type of noise considered, while in a proposed building some help may be obtained from Table I. In addition to the equivalent loudness in phons in the various locations, figures are given which are directly indicative on a loudness scale* of the sensations evoked in the average individual. Thus a noise with a loudness (*not* equivalent loudness) of 100 would normally be judged twice as loud as one of 50.

* "J. Ac. Soc. Am.," vol. vi, No. 4, April, 1935.

TABLE I.—NOISE IN TYPICAL LOCATIONS

		E.L. Phons	Loudness		
		110	160		
Near concrete drills.	..	100	100	Box factory—two circular saws. Large generating station and boiler house. Steel fabrication shop.	Workshop with large machines.
	In aeroplane	90	59	Automatic machines shop.	
Motor horns	..	80	33	Generating station — control room. Armature coil shop.	Workshop with small or no machines.
	In the train	70	17	Erection shop.	
Busy city street.	..	60	8	Busy office with typists, people walking about and talking.	Busy offices.
	Saloon car conversation.	50	3		
Average street	..	40	1	Office without typists.	Quiet offices.
	In the home quiet.	30	1/4		
Quiet street	..	20	1/32	Small, very quiet office, no machines near.	
Very quiet still night in the country.	Very quiet bedroom at night.	10	1/1000		
	Threshold of hearing.	0	0		

Having determined the equivalent loudness of the background sound associated with each room in the building we can consider in more detail the noise from machines.

Machine noise can be roughly divided into two categories, air-borne and structure-borne. The former is the primary radiation from the machine which is important in the same room or near by, while the latter is the secondary radiation from surfaces in solid connection with the machine mounting. As in all generalizations, this division is not clearly defined, as quite often both effects are taking place together and the noise in a given case may be a combination of the two types of radiation in any relative proportion. The treatment of such a case calls for special tests and wide experience, so for simplicity the two types will be considered separately.

The air-borne sound of a machine depends on its type, size, and speed, if rotary. The practice is growing among manufacturers of giving, on request, the equivalent loudness of their machines in phons as measured under approximately free space conditions at a specified distance. This is probably the best way of stating the magnitude of the sound emitted by a machine, especially if any noteworthy variation of sound in different directions is covered by a quantitative statement of uniformity or departure therefrom. This condition implies that the sound radiated by the machine either goes unimpeded into an infinite hemisphere or is completely absorbed by any surfaces it encounters. In practice the machine is usually installed in a room with far from completely absorbent walls, and the sound reflected from these causes the intensity in the room to build up to a higher value than the free space value. This is illustrated in Fig. 1, where the progress of the sound waves and the internal reflections in the room are represented by arrows. The effect is calculable from the volume of the room and the total absorption present and may account for an increase in sound intensity of the order of 10 phons in practical cases. This increase must be borne in mind when specifying the permissible equivalent loudness of the machine to the supplier, based on the tolerable sound level in the room. If this limit is unimportant it may be that the permissible noise level in adjacent rooms will be the predominant factor. The sound attenuation to be expected from walls and floors of known weight per sq. ft. can be obtained from the work of the National Physical Laboratory†, so the specified sound limits in the adjacent rooms can be translated into their corresponding limits in the machine room. The possibility of the

† Davis and Littler, Phil. Mag., 3, 177, 1927. Davis and Kaye, "Acoustics of Buildings," Bell, 1927. J. E. R. Constable and G. H. Aston. Phil. Mag, 23, 161, 1937.

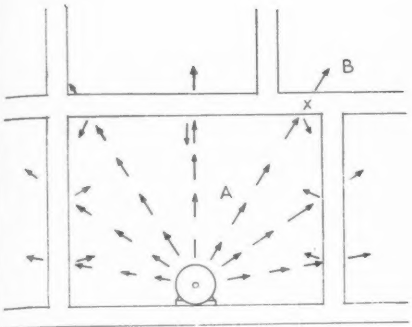


Fig. 1

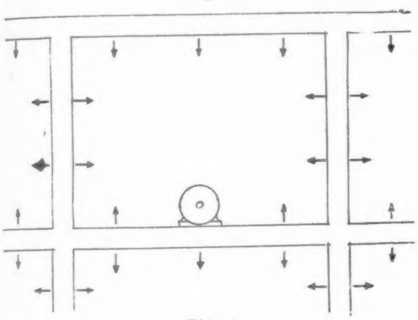


Fig. 2

walls and floors being short-circuited by opening doors and windows must not be forgotten.

Another point illustrated in Fig. 1 at *x* is sometimes overlooked. When a wall is not vertically continuous between one floor and the next, two rooms such as A and B may be separated by only comparatively light flooring instead of a heavy brick wall as might be assumed. The difference in sound attenuation between these two may make the noise in B 10 phons more than if the wall were vertically continuous. By carefully considering the acoustical conditions in this way the architect can specify to the machine manufacturer the upper limit of directly radiated noise which he can tolerate in any given case.

The structure-borne sound from a machine illustrated in Fig. 2 depends on the vibrating properties of the machine, the mass and stiffness of the foundations and the opportunities for radiation from surfaces in solid contact with the machine. This latter point has become very important in modern steel-framed buildings owing to the good conduction of vibration in such structures. To prevent this conduction of vibration, the machine should be mounted on a resilient support which should be designed to attenuate the vibration frequencies present by adequate amounts. The problem usually reduces to designing the support to give a certain attenuation, say 100 times or 40 db. at the lowest frequency component of the vibration. In a rotating machine this frequency usually corresponds to the revolutions per second, while in a static transformer it is twice the supply frequency. Higher frequency vibrations may be more important in a few cases, but the fact that the attenuation increases rapidly with frequency automatically prevents trouble there in most cases. The testing of suitable resilient materials to obtain data for designing supports calls for special laboratory facilities which have been described* recently. The required elastic properties, both static and dynamic, vary considerably with the problem. In particular, the amount of damping which is necessary and the change of dynamic stiffness over long periods of time are two points of great importance to the architect. Reliable quantitative information over a period of years is scarce, but tests have shown that, with suitable protection against sunlight, heat and oil, rubber is very reliable. As an example the case of a large transformer may be quoted. A large building divided vertically into two parts by a thick party wall had one half let as an office and the other was used as a transformer substation. The office tenants complained of the noise of the transformers and threatened to leave if the nuisance was not abated. Measurements with a noise meter showed that the hum in the office had an equivalent loudness of 80 phons and that the amount coming via the air was negligible. It was estimated that a reduction of 35 to 40 phons was

* "The Reduction of Structure-Borne Noise by Vibration Attenuating Supports," Engg., September 10, 1937, p. 296.

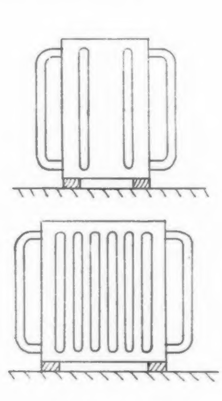


Fig. 3

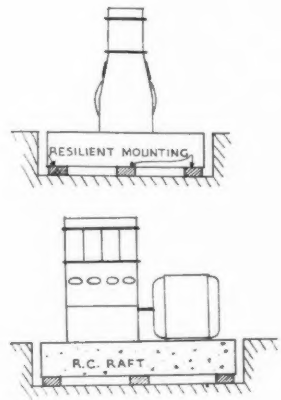
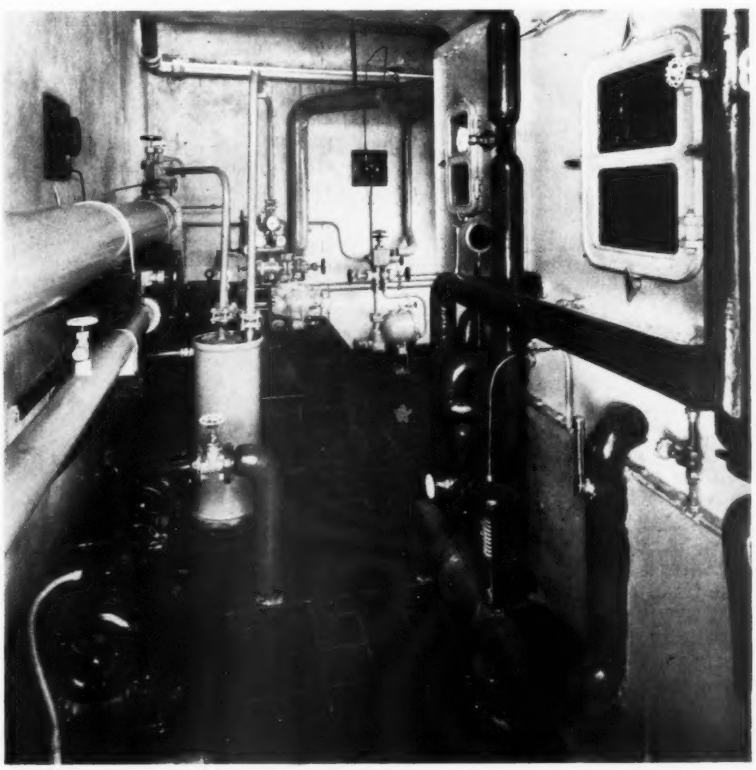


Fig. 4

Below, part of the air-conditioning plant of an office building. Pumps are mounted on resilient beds to prevent conduction of vibration.



necessary to make the residual hum unobjectionable against a normal office noise of 60 phons. This reduction was effected by mounting the transformers on large slabs of rubber 3 ins. thick, as illustrated in Fig. 3, and subsequent measurements confirmed that the hum had then an equivalent loudness of only 40 phons. It is important to be consistent and replace all rigid connections to the suspended machine, such as tubes and cables, by flexible ones.

There are two special cases which may be mentioned here. Firstly, there is the case where it is necessary to construct a massive reinforced raft on to which the machine may be bolted, the combination of raft and machine then being mounted on resilient supports (Fig. 4). This increase in the total suspended mass naturally causes a corresponding decrease in the amplitude of vibration, but it also lowers the centre of gravity and broadens the base giving greater lateral stability to tall machines like vertical reciprocating engines. In addition it is a great help to punching and pressing machines which, to preserve their correct operation, require to be rigidly fastened to a mass many times as great as that of their moving parts.

The second case concerns the conduction of vibration down ventilating trunking in air-conditioning systems. It is quite common to mount the fan runner directly on the motor shaft and the fan case on a separate foundation. Under these circumstances the small clearance between the runner and case may make a good resilient mounting of the separate items inadvisable. It is better then to mount the motor and fan case on one rigid bedplate, the composite machine then being resiliently mounted as a whole. The fan case must then be flexibly connected to the inlet and outlet ducts or the vibration of the machine will be conducted down the ducts to the various rooms and may cause a noise there. A convenient flexible connection is made of rubberized canvas in the form of a tube 6 ins. or so in length which is bound on to the duct and fan case and so leads the air but not the vibration from one to the other. The vibrations already present in the air stream from eddies and vortices due to the impeller and obstructions can be absorbed by lining the ducts with sound-absorbent material. This also prevents the "drumming" of the sides of the ducts at their several natural frequencies by introducing damping.

The foregoing *résumé* of the points most frequently encountered by the architect when introducing machinery into buildings will, it is hoped, enable him to specify to the manufacturer the permissible noise of the machine in any particular circumstances and to cooperate with the manufacturer in the cause of silence by installing the machine in such a way as to create as little disturbance as possible.

SILENCE

TECHNICAL DEFENCE

SILENT WATER SERVICES

[BY K. M. CONSTABLE]

THE almost universal nuisance of noise caused by water services can be practically avoided if silent equipment is selected and if the plumbing is intelligently and carefully carried out. Some points will be mentioned which may be of assistance in these matters. If, however, for some reason noise should be generated in a water system, it can travel along metal pipes almost unhindered and cause disturbance in all parts of the building. Means which can be adopted to prevent the transmission of noise along water pipes will be discussed.

Silent Equipment.

Equipment which can cause noise not only in the room in which it is installed, but also in other rooms by means of the water system to which it is connected includes: w.c. suites, baths, handbasins, kitchen fittings, and also circulating pumps, boilers and other adjuncts of hot water and central heating systems.

W.c. Suites.

Of these the low level cistern with syphonic trap pan is among the quietest. Substitution of a flush valve (if of good design and sanctioned by the water supply undertaking) for the cistern of course eliminates the cistern noise. Although flush valves produce a slight hissing noise in the supply pipe this need not make itself objectionable if the recommendations given below on plumbing are followed. Cheap w.c. suites are bound to be noisy, but at least the "clank" of the water waste preventer can be lessened by inserting a pad of felt or rubber beneath the arm. The noise of the outflow presents a difficult problem. Probably the best remedy, where building regulations allow, is a properly designed service duct, as described later.

Bathroom and Kitchen Fittings.

The noise of bath filling can be almost completely avoided by the use of low-level inlets. These are not allowed by some water undertakings because of danger of contamination of the supply. The only other remedy appears to be the use of anti-splash fittings or taps which ensure a smooth flow. Concealed taps which allow the water to stream down the side of the bath would be fairly quiet, but are not popular on account of the resultant discoloration of the bath. The gurgle and splash in waste pipes appear to be inevitable and are best dealt with by the service duct system.

Central Heating and Hot Water Supply Equipment.

Particular care should be taken to obtain quiet equipment, as radiators and hot water cisterns form excellent sounding-boards which cause the noise of furnace stoking, etc., to be distressingly audible all over the building. Solid fuelled furnaces should be automatically rather than hand-stoked. Oil-fired boilers should be reasonably free from flame roar and blower noise and also from mechanical vibration of the burner unit. Circulating pumps should be of a low speed type. Any vibration in the water system caused by pumps can be appreciably reduced by interposing flexible hose connections in the flow and return sides (see below). Pumps, motors, automatic stokers, and any other vibrating equipment should, if possible, be insulated from the building structure by flexible mountings. This

Flexible hose connection to reduce vibration caused by pumps.

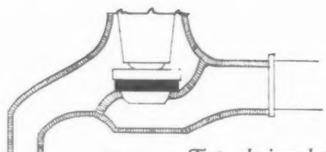


Fig. 1.—*Tap designed to shut flow off gradually. A specially shaped washer-nut is used for this purpose.*

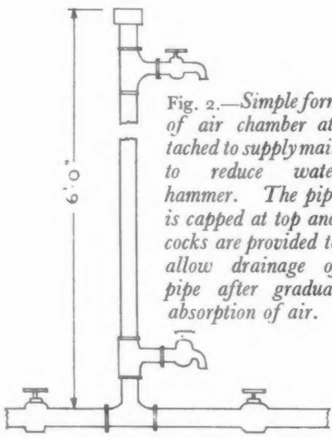


Fig. 2.—*Simple form of air chamber attached to supply main to reduce water hammer. The pipe is capped at top and cocks are provided to allow drainage of pipe after gradual absorption of air.*

alone makes the provision of flexible inserts in the piping connected to this equipment advisable in order to prevent fracture of the piping.

Plumbing.

A troublesome and very common noise which can be avoided by good design is water hammer. This occurs when a rapid flow of water is suddenly set in motion or stopped by opening or closing a tap or valve. One remedy is to modify the tap design so as to shut off the flow gradually. A tap which would fulfil this requirement is shown in Fig. 1. Another remedy is to attach to the supply main an air-chamber, which acts as a shock-absorber (Fig. 2). Another variety

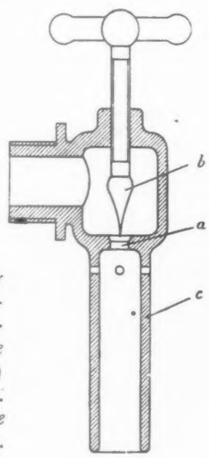


Fig. 3.—*Design for quiet tap incorporating (a) short throttling tube below the valve seating. (b) Streamlined valve. (c) Delivery tube with small airholes.*

of noise is a loud hum, which is usually caused by a loose tap washer, or by vibration of the edge of a valve which has worn thin. Hiss in pipes is caused by turbulence at sharp corners particularly in iron and copper pipes, or, more often, by the rapid flow of water through constrictions in taps, ball valves, etc. One remedy is to reduce the rate of flow at the constriction by a pressure-reducing throttle elsewhere in the system, but a better scheme is to "streamline" pipes, and more particularly taps. Fig. 3 shows a tap designed by Kreuger and Sager,* which incorporates both these features. Even given a relatively "silent" tap, the plumber has to see that each tap in a building works under a pressure which gives the least possible noise consistent with a reasonable discharge. To do this it is preferable, in a high building, to arrange for taps on the different floors to be fed from a descending rather than from a rising main: the fall in pressure along the main then counterbalances the increased pressure due to gravity, making it possible by the selection of suitable diameter piping to secure a reasonably equal pressure at taps on all floors. This pressure can then be

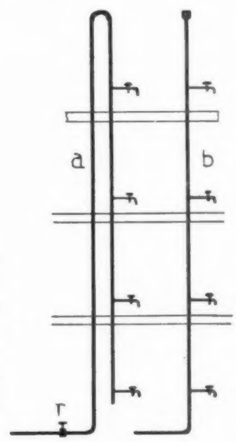


Fig. 4.—*(a) Taps on all floors of a high building can work at about the same pressure. (b) Taps working at widely different pressures.*

regulated by a main supply valve to a suitable value. The arrangement is illustrated in Fig. 4.

TRANSMISSION OF SOUND BY WATER PIPES

Metal pipes can transmit sound to considerable distances with very little attenuation. Flexible inserts, usually rubber with or without reinforcing, or flexible metal tubing of the Tombac type, are often used with the object of cutting out machinery vibration, hum, and also high-pitched sound such as tap hiss. Measurements recently made at the National Physical Laboratory indicate the reduction in noise transmission to be expected by this means and the length of insert necessary. Tests made on the hot water circulating system of the Acoustics Laboratory show that a flexible insert consisting of a 3-ft. length of canvas reinforced rubber hose afforded an insulation of some 10 db. against the low frequencies generated by the pump.

* Proceedings of Royal Swedish Institute for Engineering Research, No. 132, 1934.

It appears that the insulation obtainable from this type of connection increases with the frequency of the vibration and with the length of the rubber pipe used. Conduction by the water column does not appear to be important. Thus, to cut out low frequency sound a considerable length of rubber (of the order of some feet) is required; high frequencies such as tap hiss can be dealt with by a few inches. A tight connection between the rubber hose and the water pipes can be obtained by using hose clips. Lead pipes require a brass nipple for the hose to grip. As a precaution against bursts periodic renewal may be necessary, and for this purpose shut-off cocks should be provided on each side of the insert. Experience with this kind of material under the arduous conditions imposed on motor-car radiator connections indicates that a reasonable life may be expected. Figures are not yet available on the insulating value of flexible metal inserts; these are, however, used in refrigerating compressors and other positions where rubber hose is not desirable.†

INSTALLATION OF PIPING

In spite of, or failing, the above precautions, certain pipes may be noisy. These should not be rigidly affixed to, or in, any thin partition which might, by acting as a sounding board, greatly amplify the noise. Insulated clips of the type shown in Fig. 5 should then be used, and any caulking of holes made by the passage of such pipes through walls or floors should be done with resilient material. Cisterns and radiators should also be insulated by resilient mountings from floors or walls to which they are attached. Service ducts have been advocated for enclosing noisy piping. Such ducts should be as massive in construction as possible, preferably equivalent to 9-in. brickwork. The walls should not, however, form part of the wall of any room in which quiet is required. To prevent conduction of noise by the ducts themselves about the building, it is advisable to break the continuity of the shafts by carrying the floors across them, carefully caulking holes for the piping, as above. The interior surfaces of the duct should be as sound-absorbing as possible, i.e. they might be of unplastered clinker—or, better, pumice-concrete.

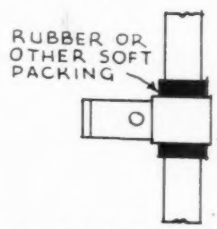


Fig. 5.—*Pipe in insulated clip.*

† J. E. R. Constable, "Engineering," Nov. 26 1937.

SILENCE

TECHNICAL DEFENCE

SILENT VENTILATION

[BY K. M. CONSTABLE]

IN this country many people still believe that all the ventilation any reasonable person could require is supplied by an open window. This may be quite satisfactory if the air is clean, the surroundings are quiet, and the occupant of a room has only himself to please. In the centre of cities, in offices, restaurants and cinemas, these conditions are never fulfilled, and some kind of ventilation or air-conditioning system is a necessity. Conditions of comfort can be assured with the windows shut, and double windows can be usefully employed to exclude the noise and dirt. A ventilation system must be silent if it is not to defeat one of its main objects.

SILENT PLANT

A complete air-conditioning equipment must not only clean and circulate the air, but be able to raise and lower the temperature and humidity. The items of this equipment liable to make noise are: Fans, sprays, pumps, refrigerating compressors, and the necessary motors. This equipment is best installed in the basement or cellars in a room in which special precautions are taken to prevent escape of noise through doors, etc. All moving machines should be on insulating supports (Fig. 1a), a precaution which is especially necessary if—for example in already existing buildings—the plant is to be installed on an upper floor. Any water pipes or other rigid connection made to machines on insulating supports must contain a flexible insert to avoid fracturing the connection (Fig. 1b).

All individual items of equipment should be as silent in operation as possible. The following points may assist in their selection :—

Fans.—Noise increases rapidly with the tip speed. High speed fans should therefore be rejected in favour of larger fans running at slower speeds. Makers will usually quote the maximum speeds consistent with silent operation.

Motors have been dealt with elsewhere. To avoid transmission of motor noise to the fan blades and hence down the duct, a flexible—preferably a belt—fan drive is recommended.

Water Sprays are often very noisy, but are convenient as they afford a certain amount of cleansing as well as humidity control. If, however, the latter is not deemed necessary, cleaning can be more quietly performed by viscous or fabric filters, or possibly by electrostatic precipitation; and any temperature control performed by means of the spray water can be done by heating or cooling batteries instead. Sprays should also be mounted on insulating supports, and any associated pumps should be of good construction and run at low speeds.

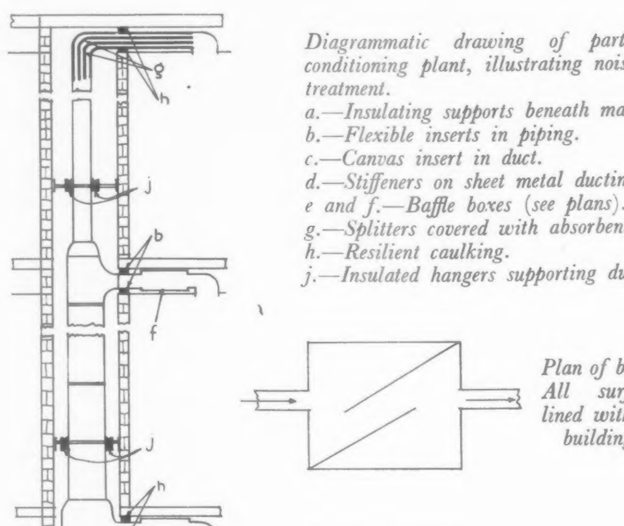
Refrigeration Compressors.—Centrifugal types are said to be quieter than reciprocating, although the latter are more commonly used.

TRANSMISSION OF NOISE BY DUCTS.

Ducts form a very easy path for the transmission of noise about a building, either from the plant room, or between neighbouring rooms. Noise from the plant room, in the form of vibration of sheet-metal duct walls, can be reduced by inserting a length of flexible material, usually canvas, in the duct immediately after leaving the fan. Such inserts should be fireproofed. The canvas should not be tightly stretched, and the joints should be airtight (Fig. 1c). Any resonances or "drumming" of sheet metal ducts or fan housings can be reduced by the use of heavy gauge metal or by stiffening at intervals of a few feet with angle iron carried completely round the duct (Fig. 1d).

The use of "anti-drumming" material wrapped round the outside of the duct is also sometimes recommended for this purpose, and may be useful in treating a completed duct; the same purpose should, however, be served equally well by treating the inner surface with suitable sound-absorbent material, which is also very useful in preventing the transmission of sound by the air-column in the duct.

Sound-Absorbent Treatment can either be distributed along the length of the duct or can be concentrated in a short distance by means of a baffle box, which is equivalent to a length of absorbent-lined duct folded up so as to ensure several reflections of sound at the absorbing surfaces. These are usually placed at or near room outlets.



Diagrammatic drawing of part of air-conditioning plant, illustrating noise reducing treatment.
a.—Insulating supports beneath machinery.
b.—Flexible inserts in piping.
c.—Canvas insert in duct.
d.—Stiffeners on sheet metal ducting.
e and f.—Baffle boxes (see plans).
g.—Splitters covered with absorbent.
h.—Resilient caulking.
j.—Insulated hangers supporting duct.

Plan of baffle at (e). All surfaces are lined with absorbent building board.

Plan of baffle at (f). All surfaces are lined with absorbent building board.

Fig. 1

For the baffles illustrated (Figs. 1e and 1f) insulations of 24 and 37 db. respectively have been claimed by their designers. (*) (†)

The insulation afforded by absorbent lining along straight lengths of duct is—

1. Proportional to the length of treatment.

2. Dependent on the size of the duct and also on its shape, e.g. thin, flat ducts attenuate more than square ducts of equal cross section.

3. Dependent on the absorption coefficient of the lining. There is evidence that a high absorption coefficient (greater than 0·5) is more than proportionately effective. To give an idea of the effect obtainable, Parkinson(‡) records an average attenuation of 2.4 db. per foot in an 18-in. by 18-in. duct lined with material of average absorption coefficient 0·64.

Wind Noise.—It has been found that in systems in which air is passing rapidly along the duct, the effect of absorbent has been less than expected, i.e. that the noise instead of decreasing in proportion to the length of the treatment, has reached a constant value. This effect is due to noise made by the air stream as it passes along the duct, and can only be avoided by working at low air-speeds.

Opinions differ as to what maximum speed to recommend for this purpose. In straight ducts without obstructions 600 ft. per minute is probably reasonable, but this figure may be appreciably lessened by sharp edges, etc. To prevent this noise from entering rooms, absorbent treatment should obviously be placed at or near room outlets either in the form of baffles, as mentioned, or as "honeycombing." This, as the name suggests, consists in dividing the duct into a number of sections, parallel to its length, by "splitters." These, as well as the duct walls, are lined with sound-absorbent. Not only is the area of absorbent treatment increased, but a streamlining effect is also obtained which is valuable in reducing wind noise, particularly at bends. Bends are in any case an effective position for absorbent treatment. Splitters at a bend in a duct are shown in (Fig. 1g). It may be well worth while to instal some treatment of this kind to insulate against wind noise rather than to use very low air-speeds, which necessitate large ducts.

Suitable Sound-absorbent Materials.—Not all sound-absorbent materials are suitable for application (without further treatment) to the interior of ducts. Among the properties which an absorbent should possess, in addition to an absorption coefficient which is high over a wide frequency range, the American Society of Heating and Ventilating Engineers (Guide, 1937), include: A low surface coefficient of friction, high resistance to moisture absorption, fire and vermin resistance. Among materials in use may be mentioned fibre board, asbestos, mineral wool, glass wool, Balsa wool. The loose-fibred materials are usually covered with perforated metal, which does not appreciably affect their absorption, but has the advantages of preventing the disintegration of the lining by the air-stream, and of practically abolishing frictional losses due to the material. While on the subject of frictional losses, it should be pointed out that absorbent treatment introduces another unavoidable but calculable loss by reducing the effective area of the duct.

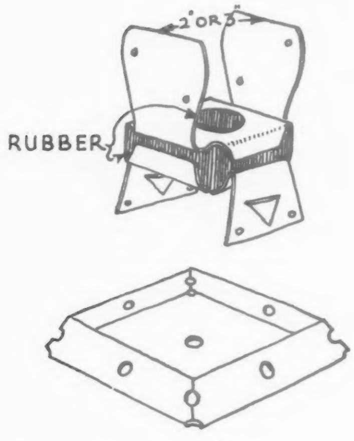
The panel-type absorbent which has already been described probably has a future in ventilating duct lining, for it can be adjusted to absorb low frequencies, which are usually present in strength in ventilating systems; porous absorbents of course are much less efficient at low frequencies. The panel-type absorbent has also a smooth impervious surface which satisfies most of the above desiderata.

Duct Construction.—It will be noticed in the diagram that the main duct is enclosed in a masonry shaft, which may also take other services, water, electricity, etc. This shaft is carefully caulked with resilient packing round the duct at suitable points (Fig. 1h) to prevent noise from the equipment rooms spreading about the building. The shaft itself may, however, be made to serve as the duct, as was done in the Bank of England building. This arrangement has, among other advantages, the merit of reducing the use of sheet iron which, as mentioned above, is always liable to amplify noises by resonance. Masonry ducts, whether general service shafts or not, have acoustical advantages. If general service shafts are used as ventilating ducts, special care must be taken to prevent entry of noise from the shafts into the rooms. Treatment of the branch ducts is indicated, on the lines suggested above.

(*) Lindner, Zeits. f. techn. Physik, 1932, No. 6, p. 290.

(†) Zwikker and Costen, Rev. d'Acoustique. Jan.-March, 1935, p. 1.

(‡) Parkinson, "Heating, Piping, and Air-Conditioning." March, 1937, p. 183.



TRADE NOTES

[*BY PHILIP SCHOLBERG*]

Noise . . .

SINCE this issue of the JOURNAL is devoted to the subject of Silence it seems worth while trying to pick out such materials and fittings as are useful for noise reduction. But first of all it may be best to draw attention to a very useful small book on the general principles of sound itself which has been written by Dr. A. H. Davis, of the National Physical Laboratory, and which is published by Watts & Co. in the "Changing World" Library at the very reasonable price of 2s. 6d. The book is not, of course, intended for the specialist, but mainly for the general public, and although it shows sections of typical sound-absorbing partitions, motor mountings, car silencers and other things of this kind, the thicknesses and general constructional dimensions are naturally outside its scope. It does, however, provide a very good introduction to the subject, and may be regarded as an excellent preliminary survey for designers who would like to know about decibels and phons, the ways in which sound waves are propagated or the problems of acoustical reflection and silence zones. It is simply and straightforwardly written and the mathematics need frighten nobody who has reached preparatory school standards.

. . . and its Measurement

In spite of the fact that technicians have been talking about decibels and phons for several years I do not suppose that many architects have ever seen noise measurements being made on a job, still less that, having designed sound-proof partitions, they insist that the sound reduction shall be checked. The reason for this, I suppose, is that noise meters are expensive, and their use is confined to the specialist manufacturers who have enough work to be able to keep such an instrument busy. Yet it seems that this is obviously a job which could be done by the consulting engineer, who could come along and measure a noisy lift motor and then check up on it afterwards to see that it had been properly dealt with. At the moment I know of only one consulting engineer who is prepared to take measurements of this kind, and who has the equipment to do so. For all I know there may be others, but architects do need a service of this kind, and as soon as they start demanding it there will doubtless be an adequate supply.

Double Windows

Double windows are in fairly common use in most European countries, though probably more for the sake of reduced heat losses than for the sound insulation which they give. For commercial jobs, such as hotels, offices and flat blocks, the two factors work together, and although we do not suffer in this country from the extremes of temperature common in the rest of Europe it is frequently worth while considering double windows from the point of view of noise resistance alone. At any rate, several London hotels have thought it a good move to fit double windows and some form of mechanical ventilation purely for the sake of keeping out traffic noise. It is interesting, therefore, to see that the English agent of the Swiss window manufacturing firm of Kiefer has thought it worth while to import (among a large range of standard types) double-glazed casement and sliding fittings, one of which is shown in the drawing overleaf. To give a maximum of sound insulation the windows should, of course, be structurally separate, preferably on the inner and outer faces of the wall, and it is also better if the panes can be of different sizes, for they will then not be transparent through resonance to the same tones. If, however, the same pane sizes are necessary for the sake of appearance the differentiation in response can be obtained by using different thicknesses of glass in the two windows. These are, perhaps, counsels of perfection, for much can be done with a window of the type shown here, particularly as each casement is made up of two separate frames hinged together at the side and screwed near the meeting stile so that the two halves can be opened for re-glazing or for cleaning the inner faces of the glass should this ever be necessary, though it is possible that sound transmission might be decreased by the insertion of a strip of oiled felt between the two halves. It is a good point, too, that the furniture pulls the frames up nice and tight, for a loosely-fitting window will transmit noise because the whole frame vibrates.

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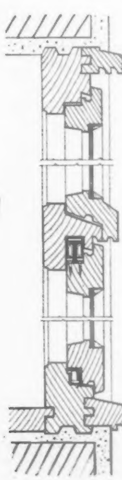
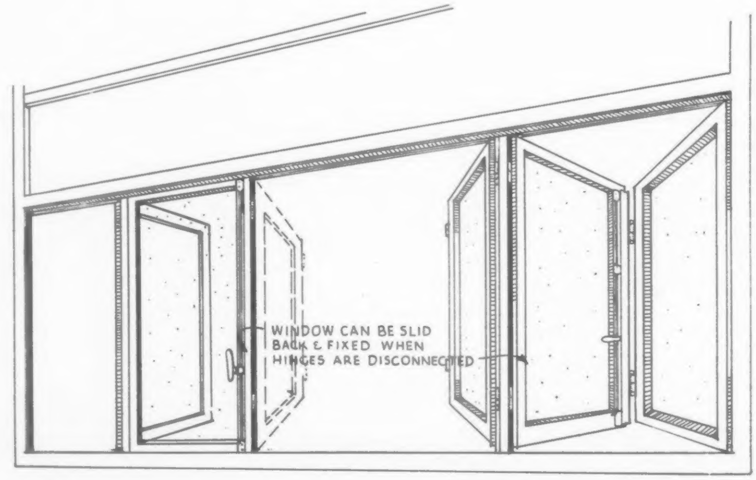
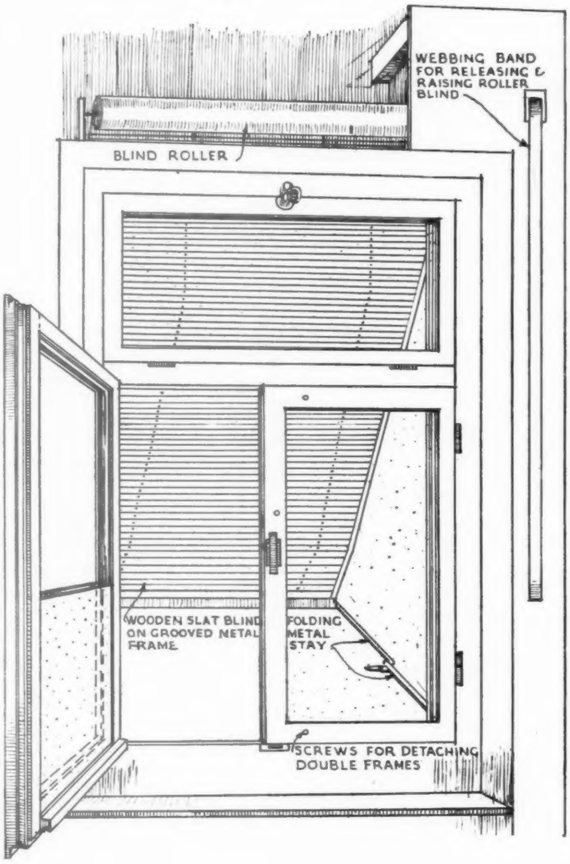
Most of the other windows shown in this country have no special pretensions to soundproofness, but are very well worth seeing as they provide almost every conceivable combination of sliding and folding types as well as the more usual casements and sashes. All in wood, and made by a firm which evidently has a very high standard of workmanship. Elaborate precautions are taken to ensure weathertight-

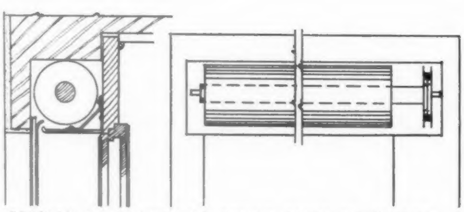




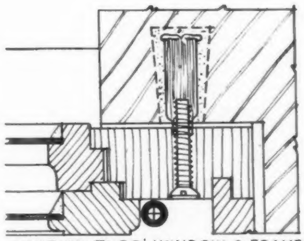
Section and sketch of the window described overleaf



Sketch and sections of the double-glazed casement window described overleaf.



SECTION & ELEVATION OF ROLLER BLIND ON ROLLER



SECTION THRO' WINDOW & FRAME

ness, and although such measures may be only normal Swiss practice, one may assume that anything good enough to keep out the weather in Switzerland should be capable of dealing with the English climate quite adequately. The other illustration on the previous page shows a comparatively normal sliding and folding type, but there are so many models that it is impossible to describe them all, and the best thing to do is to go and have a look. Notice particularly the locks for use with espagnolette bolts in glazed doors—their appearance is very good, and they are well made and cheap; there is also one of the neatest casement stays I have ever seen. As a detail point it is worth mentioning that in all the standard types of transoms, mullions and glazing bars are kept small and light in section, though they look quite strong enough for the job.

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Prices, considering the high standard of workmanship, are much lower than one would expect, and delivery can be made in four weeks on nearly all models. While the standard types are varied enough for almost anyone to be able to find what he wants, special designs can be purpose made without knocking the price up too far.—(*M. Bachtold, Kiefer Windows, 283 High Holborn, London, W.C.1.*)

Insulating Floor Clips

It has for some time been realized that a floor arranged to float on rubber pads will not transmit very much noise to the room below or, for that matter, anywhere else through the structure. So far, however, the only floating floor employing rubber has rebated battens carrying concrete slabs designed to apply an initial load to the rubber, for otherwise the movement of the floor is too great. In the engineering trades a common form of mounting is the Silentbloc, which consists of an inner and an outer bush with an annulus of rubber between them, the rubber being forced in and so distorted, this giving the preliminary loading and corresponding to the concrete slabs in the floating floor. This principle of preliminary loading or distortion of the rubber has now been applied to floor clips, and the product is marketed under the name of Sylenz. One of the several types produced is illustrated at the head of these notes, and it can be seen that it is very like the ordinary floor clip that everyone has been using for a good many years now, the difference being that the clip is in two halves with a pad of rubber in between and that the initial loading is given by the two halves, which also stop the rubber spreading. Projecting through the top half is a small rubber dome which should be compressed by the batten before the nails are driven through the side ears. It should be understood that these clips are meant to be nailed to the battens before they are placed in the concrete, the type of clip used depending on the floor and the way the job is being organized.

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For pre-cast floors there is a clip with a single longitudinal or transverse leg, sand being inserted in the beam joint where the clips will finally be, the clips being grouted in when the floor has to be laid. With *in situ* floors the clips and battens would inevitably be damaged by following trades if they were placed in the green concrete, and the manufacturers have therefore evolved an anchor mould which is placed in position when the floor is poured, the clips with their battens being grouted in when the other trades have finished. The anchor moulds are sent out with a swab of wool inside to prevent them getting filled up with dirt and rubbish before the grouting is done. The remaining type has a flat base pierced for nailing and screwing to a wood beam or to a fixing block set in a concrete floor.

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On the job there does not seem to be any particular snag or any need for specialist workers. The essential points raised by the manufacturers are that clearance must be left between the floor boards and the wall to allow for movement, and that the clips should be staggered on adjoining battens. Since they also stipulate that a clip should be fitted at about 4 ins. from the wall end of every batten it follows that alternate battens will have two clips rather close together at each end, but once the point is made clear it should not lead to any difficulties. It is also worth remembering that rubber has a very long life provided it is kept in the dark and at a reasonable temperature, both of which conditions should be fulfilled in the normal floor.—(*J. C. Birch, School Hill Works, Bolton, Lancs.*)

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Ellington Court

We regret that the name of Messrs. Joseph Freeman, Sons & Co., Ltd., was omitted from the list of contractors for Ellington Court (architect: Frederick Gibberd), illustrated in the March 31 issue. "Cementone No. 9" was used for the exterior finish to the concrete surfaces.

Copies of the loose supplement containing the labour rates for the principal towns and districts throughout the country can be obtained from the JOURNAL, price 2d. to cover postage.

P R I C E S

ON the following pages appears Prices of Materials —Part I, with the prices, last published on April 21, brought up to date.

Immediately below, Messrs. Davis and Belfield mention the principal changes which have occurred in the last month. Similar notes, and the deductions that may be drawn from them, will be published on this page each month.

NOTES ON PRICE CHANGES

The principal change this month is in the prices of carcassing timber, which have fallen generally by 10s. to 20s. per standard.

The other changes marked do not appear to be of any special significance.

O. A. DAVIS, P.A.S.I.

★ ***ANSWERS TO QUESTIONS***

While the JOURNAL, naturally, cannot presume to undertake the responsibilities of a quantity surveyor, it has arranged with the authors of this Supplement to answer readers' questions regarding any matter that arises over their use of the Prices Supplement in regard to their work, without any fee. Questions should be addressed to the Editor of the JOURNAL, and will be answered personally by Messrs. Davis and Belfield. As is the normal custom, publication in the JOURNAL will omit the name and address of the enquirer so that it is unnecessary to write under a pseudonym.

● *Items marked thus have risen in price since last quotation on April* 21.

* *Items marked thus have fallen in price since last quotation on April* 21.

The complete series of prices will consist of four sections, one section being published each week in the following order :—

1. Current Market Prices of Materials, Part I.
2. Current Market Prices of Materials, Part II.
3. Current Prices for Measured Work, Part I.
4. A.—Current Prices for Measured Work, Part II.
   B.—Prices for Approximate Estimates.

★ ***The previous complete Supplement is contained in the issues of the JOURNAL for April 21, April 28, May 5 and May 12.***

Prices vary according to quality and the quantity ordered.

Those given below are average market prices and include delivery in the London area, except where otherwise stated, but do not include overhead charges and profit.

PART 1

CURRENT MARKET PRICES OF MATERIALS-I

BY DAVIS AND BELFIELD, P.A.S.I.

CONCRETOR

Cements

All delivered in paper bags (20 to the ton) free and non-returnable.

		4 Tons and over
Portland	per ton	42/–
Rapid hardening	per ton	48/–
Water repellent	per ton	72/–
Atlas White (1 barrel 376 lbs.)	per barrel	44/–

		1 ton upwards
Colorcrete rapid hardening, Nos. 1 and 2	per ton	69/–
Colorcrete non rapid hardening ..	per ton	140/– to 300/–
Snowcrete	per ton	175/–

		1–10 cwts.	11–15 cwts.	16–20 cwts.	1 ton and upwards
Ciment Fondu, delivered Central London area ..	per cwt.	7/9	7/3	6/–	6/-

Aggregate and Sands (Full Loads)

2″ Unscreened ballast	per yard cube	6/–
¾″ (Down) Washed, crushed and graded shingle	per yard cube	6/2
⅜″ (Down) Ditto	per yard cube	7/6
2″ Broken brick	per yard cube	10/6
¾″ Ditto	per yard cube	11/9
Washed pan breeze	per yard cube	5/3
Coke breeze 1″ to dust	per yard cube	13/6
$\frac{3}{16}$″ Sharp washed sand	per yard cube	8/3
White Silver Sand for white cement (one ton lots)	per ton	25/–

(For Sands for Bricklaying and Plastering see respective trades)

Pavings

Brick hardcore	per yard cube	2/9
Concrete ditto	per yard cube	3/9
Clean furnace clinker and boiler ashes ..	per yard cube	3/6
Coarse gravel for paths	per yard cube	6/9
Fine ditto	per yard cube	9/6
Clean granite chippings	per ton	18/6
Red quarry tiles, 6″ × 6″ × ⅞″ ..	per yard super	6/–
Buff ditto, 6″ × 6″ × ⅞″	per yard super	6/6
Hard red paving bricks	per 1,000	150/–

Reinforcement

Basis price for mild steel rods, ⅝″ diameter and upwards, from London stocks	per ton	£15 0 0
Extras for :—		
$\frac{9}{16}$″ and ½″ diameter	per ton	10/–
$\frac{7}{16}$″ diameter	per ton	15/–
⅜″ diameter	per ton	20/–
$\frac{5}{16}$″ diameter	per ton	30/–
¼″ diameter	per ton	40/–
$\frac{3}{16}$″ diameter	per ton	60/–
Lengths of 40 ft. to 45 ft.	per ton	10/–
Lengths of 45 ft. to 50 ft.	per ton	15/–

● Items marked thus have risen in price since April 21.

CONCRETOR—(*continued*)

Sundries

Retarding liquid, in 5-gallon drums (for exposing aggregate)	per gallon	20/–	Ex Warehouse, Southwark Bridge. Drums chargeable and credited, if returned.
Ditto. (for obtaining a bond)	per gallon	12/6	

BRICKLAYER

Common Bricks

✱Rough stocks	per 1,000	69/6
Third stocks	per 1,000	54/6
Mild stocks	per 1,000	71/6
Sand limes	per 1,000	50/–
* Phorpres pressed Flettons	per 1,000	46/8
* Phorpres keyed Flettons	per 1,000	48/8
Blue Staffordshire wirecuts	per 1,000	165/–
Lingfield engineering wirecuts	per 1,000	95/–
Breeze fixing bricks	per 1,000	57/6
Firebricks, best Stourbridge 2½″	per 1,000	155/–
Firebricks, best Stourbridge 3″	per 1,000	190/–

* At King's Cross. For delivery in W.C. district add 4/8 per 1,000.

Facing and Engineering Bricks

Sand Limes, No. 1	per 1,000	85/–
Sand Limes, No. 2	per 1,000	70/–
*Phorpres rustic Flettons	per 1,000	66/3
Midhurst Whites	per 1,000	75/–
● Hard stocks, firsts	per 1,000	97/–
● Hard stocks, seconds	per 1,000	89/–
Sand-faced, hand-made reds	per 1,000 from	115/–
Sand-faced, machine-made reds	per 1,000 from	110/-
Red rubbers (9¾-in.)	per 1,000	300/–
Hunziker (white)	per 1,000	67/6
Hunziker (creams, light greys, etc.) ..	per 1,000 from	100/–
Dunbricks (concrete), multi reds, ex works	per 1,000	72/–
Dunbricks (concrete), multi lavender, ex works	per 1,000	75/-
Southwater engineering No. 1 (first quality red pressed)	per 1,000	145/–
Southwater engineering No. 2 (second quality red pressed)	per 1,000	125/–
Blue pressed	per 1,000	174/–

* At King's Cross. For delivery in W.C. district add 4/3 per 1,000.
Discount if accompanied by order for pressed 2/– per 1,000.

✱ Items marked thus have fallen in price since April 21.

CURRENT PRICES

BY DAVIS AND BELFIELD, P.A.S.I.

BRICKLAYER AND DRAINLAYER

BRICKLAYER—(*continued*)

White, Salt and Coloured Glazed Bricks (9″×4½″×2⅞″)

The following prices are subject to 2½ per cent. trade discount and 2½ per cent. cash discount, and include delivery to any railway station (minimum 4-ton loads). Add 10/– per 1,000 for delivery in London area.

Prices per 1,000	White, Ivory and Salt Glazed		Buff, Cream and Bronze	Other Colours	All Colours
	Best	Seconds	Best	Best	Seconds
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Stretcher, glazed one side ..	24 0 0	22 0 0	26 0 0	29 10 0	23 0 0
Header, glazed one end	23 10 0	21 10 0	25 10 0	29 0 0	22 10 0
Double stretcher, glazed two sides	32 10 0	30 10 0	34 10 0	38 0 0	31 10 0
Double header, glazed two ends	29 10 0	27 10 0	31 10 0	35 0 0	28 10 0
Quoin, glazed one side and one end	30 10 0	28 10 0	32 10 0	36 0 0	29 10 0

Limes and Sand

		1-ton lots	6-ton lots
Lime, greystone	per ton	43/–	37/6
Lime, chalk	per ton	43/–	37/6
Lime, blue Lias (including paper bags)	per ton	47/–	42/6
Lime, hydrated (including paper bags)	per ton	47/–	42/6
Washed pit sand	per yard cube		7/9

(For cements, *see* "Concretor.")

Hire of jute sacks charged at 1/6 and credited at 1/6. If left, charged at 1/9.

Sundries

Wall ties, self coloured	per cwt.	19/–
Wall ties, galvanized	per cwt.	24/6
Hoop iron, black	per cwt.	25/–
D.P.C. slates, size 18″×9″	per 1,000	157/6
D.P.C. slates, size 14″×4½″	per 1,000	61/3
*Ledkore D.P.C. Grade A	per foot super	5d.
*Ledkore D.P.C. Grade B	per foot super	6½d.
*Ledkore D.P.C. Grade C	per foot super	8d.

* Trade discount 5 per cent. and cash discount 5 per cent. Prices include delivery on minimum of £4 orders.

	9″×8″	9″×6″	9″×9″	12″×9″	14″×9″
Earthenware airbricks: red, blue, vitrified and buff terra cotta each	–/8	1/4	2/4	4/–	6/8

	9″×3″	9″×6″	9″×9″	12″×6″	12″×9″
Black cast iron, School Board pattern airbricks per doz.	3/–	5/6	11/–	11/–	20/–
Galvanized ditto per doz.	5/6	11/–	22/–	22/–	40/–
Black hit and miss cast iron ventilators per doz.	12/–	15/–	21/–	21/–	36/–
Galvanized ditto per doz.	24/–	30/–	42/–	42/–	72/–

	1′ 0″	1′ 6″	2′ 0″	2′ 6″	3′ 6″	5′ 0″
Buff terra cotta chimney pots .. .. each	2/6	3/–	4/4	5/9	13/4	22/6
Fireclay .. per cwt.	4/–					

Wall reinforcement supplied in standard rolls containing 25 yards lin.

2″ wide black japanned	per roll 2/1	Greater widths pro rata 2½″ price carriage paid on orders of £5. Discounts for quantities.
2″ wide galvanized ..	per roll 3/2	
2½″ wide black japanned	per roll 2/7½	
2½″ wide galvanized	per roll 3/10½	

Partitions

		2″	2½″	3″	4″
Breeze ..	per yard super	1/3½	1/5½	1/8	2/3
Clay tiles ..	per yard super	2/3	2/6	2/9	3/1
Pumice ..	per yard super	2/8	3/–	3/6	4/–
Plaster ..	per yard super	2/3	2/9	3/3	4/–

BRICKLAYER—(*continued*)

Shepwood Partition Bricks size 9″ × 2⅞″ and 2½″ on bed. Terms, as for Glazed Bricks

Prices per 1,000 except where stated per brick	White, Ivory and Salt Glazed		Buff, Cream and Bronze	Other Colours	All Colours
	Best	Seconds	Best	Best	Seconds
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Double stretcher, glazed two sides	32 10 0	30 10 0	34 10 0	38 0 0	31 10 0
Single stretcher, glazed one side	24 0 0	22 0 0	26 0 0	29 10 0	23 0 0
	Each	Each	Each	Each	Each
Round end glazed two sides and one end ..	–/10½	–/10	1/0½	1/0½	–/10½

Gas Flue Blocks

		Single Flues	Double Flues
Straight blocks	each	1/1	1/11
Building in set	Per set of 3	2/8	4/10
Cover blocks	each	1/5	3/–
Raking blocks 45°	each	2/9	3/11
Raking blocks 60°	each	1/11	2/10
Offset blocks	each	3/4	4/10
Closer blocks	each	1/1	1/11
Closer flashing blocks	each	1/–	1/8
Straight flashing blocks	each	1/–	1/8
Terminal and cap	per set	6/9	11/6
Middle terminal and cap	per set	6/3	10/9
End terminal and cap	per set	6/6	11/3
Corbel block	each	4/10	3/2
Gathering block	each	—	9/8

DRAINLAYER

Agricultural Pipes

		2″	3″	4″	6″
Pipes in 12″ lengths ..	per 1,000	67/6	92/6	120/–	210/–

(Delivered in full loads Central London Area.)

Salt Glazed Stoneware Pipes and Fittings

		4″	6″	9″
Pipes (2′ lengths)	each	1/8	2/6	4/6
Bends, ordinary	each	2/6	3/9	6/9
Single Junctions, 2′ long	each	3/4	5/–	9/–
Yard Gulley, without grating ..	each	6/3	6/10½	11/3
Ordinary 6″ × 6″ Grating, painted ..	each	–/7½	1/3	2/6
Ordinary 6″ × 6″ Grating, galvanized	each	1/0½	2/1	4/4½
Extra for Inlets, horizontal	each	1/6	1/6	1/6
Extra for Inlets, vertical	each	2/3	2/3	2/3
Intercepting Trap with Stanford Stopper	each	17/6	22/6	37/6

Grease and mud interceptor with bucket for removing silt and grease for 6″, 9″ and 12″ drains, with iron grating, painted .. .. each 20/–
Ditto, with iron grating galvanized .. .. .. each 21/10½

The above prices to be varied by the following percentages for the different qualities given. All subject to 2½ per cent. cash discount.

	British Standard	British Standard Tested
Orders for 2 tons and over	Less 20%	Plus 5%
Orders under 2 tons, 100 pieces upwards	Less 2½%	Plus 22½%
Orders under 2 tons, less than 100 pieces	Plus 7½%	Plus 32½%

	Best	Seconds
Orders for 2 tons and over	Less 27½%	Subject to 15% off the price of best quality for all sizes
Orders under 2 tons, 100 pieces upwards	Less 10%	
Orders under 2 tons, less than 100 pieces	Nett	

CURRENT PRICES

BY DAVIS AND BELFIELD, P.A.S.I.

DRAINLAYER AND MASON

DRAINLAYER—(*continued*)

Cast Iron Drain Pipes and Fittings

Socket and Spigot Pipes :—

Weight (per 9 ft.)	Size.	9 fts.	6 fts.	4 fts. each	3 fts. each
1 . 1 . 8	4″ per yard ..	6/6	7/3	11/7	8/9
1 . 1 . 20	4″ per yard ..	6/9	7/5	11/10	9/–
2 . 0 . 6	6″ per yard ..	10/–	11/11	19/3	15/4
4 . 0 . 2	9″ per yard ..	18/2	23/9	41/3	31/5

Socket and Spigot Pipes :—

Weight (per 9 ft.)	Size.	2 fts.	18 ins.	12 ins.	9 ins.
1 . 1 . 8	4″ each	7/3	6/6	5/8	5/2
1 . 1 . 20	4″ each	7/4	—	—	—
2 . 0 . 6	6″ each	11/6	—	—	—
4 . 0 . 2	9″ each	—	—	—	—

Tonnage Allowances :
Orders up to 2 tons nett.
Orders 2 to 4 tons less 2½%
Orders 4 tons or over less 5%

		4″	6″	9″
Bends	each	6/3	12/10	40/7½
Single junctions	each	11/–	22/–	70/11
Intercepting traps	each	37/6	48/3	137/6
Gulleys ordinary trapped ..	each	15/–	—	—
Extra for inlet 4″	each	4/3	—	—
Grease Gulley trap	each	117/6	—	—
H.M.O.W. large socket gulley trap with 9″ gulley top and heavy grating and one back inlet ..	each	23/9	42/9	—

Cast Iron Inspection Chambers

The larger figures below refer to the main pipes and the smaller figures to the branches

		4″×4″	6″×4″	6″×6″	9″×6″
Straight chambers with two branches one side ..	each	56/3	66/10	78/9	153/9
Straight chambers with three branches in all ..	each	66/3	76/10	91/3	166/3
Straight chambers with four branches in all ..	each	76/3	87/10	103/9	178/9
Straight chambers with three branches one side ..	each	71/3	88/9	101/3	—
Straight chambers with four branches in all ..	each	81/3	98/9	113/9	—
Straight chambers with five branches in all ..	each	91/3	108/9	126/3	—
Straight chambers with six branches in all ..	each	101/3	118/9	138/9	—
Straight chambers with four branches one side ..	each	93/9	111/3	133/9	—
Straight chambers with five branches in all ..	each	103/9	108/9	146/3	—
Straight chambers with six branches in all ..	each	113/9	131/3	158/9	—
Straight chambers with seven branches in all ..	each	123/9	141/3	171/3	—
Straight chambers with eight branches in all ..	each	133/9	151/3	183/9	—

The branches to the above are at 135°

		4″	6″
Extra for branches between 135° and 180°	each	7/6	7/6
Extra for branches between 90° and 135° other than standard angles	each	6/3	6/3

		4″×4″	6″×4″	6″×6″
Curved chambers, no branch 90°–112½°	each	26/10	—	38/2
Curved chambers, no branch 135°	each	26/10	—	38/2
Curved chambers, one branch 135°	each	33/9	48/9	55/–
Curved chambers, two branches 135°	each	40/8	65/8	76/3

Channels in White Glazed Ware (*Unselected Quality*)

		4″	6″	9″
Half round straight channels, 6″ long	each	2/4	3/2	5/3
Half round straight channels, 12″ long	each	3/3	4/5	6/11
Half round straight channels, 18″ long	each	4/–	5/3	8/5
Half round straight channels, 24″ long	each	4/8	6/4	10/6
Half round straight channels, 30″ long	each	5/10	7/11	13/2
Half round straight channels, 36″ long	each	7/–	9/6	15/9
Half round ordinary or long channel bends	each	8/5	12/11	21/–
Half round ordinary or short channel bends	each	6/–	8/5	—
Three-quarter round ordinary branch bends	each	8/1	11/8	—
Three-quarter round ordinary branch bends, midgets	each	7/3	—	—

		6″×4″	9″×6″
Half round taper channels 24″ long ..	each	7/10	11/3
Half round taper channel bends ..	each	10/3	17/9

These prices are subject to 20% discount.

DRAINLAYER—(*continued*)

Channels in Brown Glazed Ware

		4″	6″	9″
Half round straight channels 24″ long ..	each	1/3	1/10½	3/4¼
Half round straight channels 30″ long ..	each	—	—	4/2⅜
Ditto, short lengths	each	1/3	1/10½	—
Half round ordinary channel bends ..	each	1/10½	2/9¾	5/0¾
Ditto, short	each	1/10½	2/9¾	—
Ditto, long	each	3/9	5/7½	10/1½
Three-quarter round branch bends ..	each	5/–	7/6	—

		6″×4″	9″×6″
Half round taper channels 24″ long ..	each	3/9	6/9
Half round taper channel bends ..	each	4/8¼	8/5¼

The above prices are subject to the same discounts as those given for "Best" quality salt glazed stoneware pipes.

Manhole Covers

		Black	Galvanized
24″ × 18″ single sea for foot traffic. (Weight 0.3.0 in lots of 24)	each	12/–	23/3
24″ × 18″ single seal for light car traffic. (Weight 2 cwt. in lots of 24) ..	each	35/–	61/6
24″ × 18″ Wood Block pattern. For road traffic. (Weight 3 cwts.)	each	Coated 55/9	

		Fine Cast	Galv.
Cast step irons, 13½″ long, 6″ wide, 9″ in wall, approximate weight 5½ lbs. each	per dozen	12/6	20/6

		4″	6″
Galvanized fresh air inlets, with cast brass fronts (L.C.C. pattern)	each	5/6	20/3

MASON

Yorkstone

Building quality Robin Hood and Woodkirk Blue Stone.

Blocks scrappled, random sizes	per foot cube	4/6
Add for blocks to dimension sizes	per foot cube	6d. (each dimension)
Templates with sawn beds, edges rough (up to 4 ft. super and not over 2′ 6″ long)	per foot cube	5/–
Templates with sawn beds, sawn one edge	per foot cube	6/–
Templates with sawn beds, sawn two edges	per foot cube	7/–

Prices f.o.r. Yorkshire, railway rate to London Station per ton. (Minimum 6-ton loads.) 18/3

Ancaster Stone

Freestone, random blocks	per foot cube	3/6
Brown weather bed stone selected for polishing all brown blocks	per foot cube	8/-
Brown and blue weather bed stone selected for polishing	per foot cube	7/–

Prices f.o.r. Ancaster, railway rate to London Station approximately 11½d. per foot cube (minimum 6-ton loads).

Bath Stone

Random blocks, delivered railway trucks, Paddington or South Lambeth	per foot cube	2/10¾

Portland Stone

Whitbed, in random blocks of 20 feet cube average, delivered railway trucks Nine Elms, South Lambeth or Paddington	per foot cube	4/5
Basebed—add to the above	per foot cube	–/3
For every foot over 20 ft. cube average—add	per foot cube	–/1
For every foot over 30 ft. cube average—add	per foot cube	–/0½

¾″ Thick Plain Marble Wall Linings

Roman Travertine	per foot super	5/–
Golden Travertine	per foot super	6/3
Roman stone	per foot super	4/6
Hopton-wood stone	per foot super	5/–
Second statuary	per foot super	4/6
Sicilian	per foot super	4/–

Artificial Stone

6″×3″	Copings and sills	per foot run	1/6
6″×6″	Copings and sills	per foot run	2/4
9″×3″	Copings and sills	per foot run	2/–
9″×6″	Copings and sills	per foot run	3/4
12″×3″	Copings and sills	per foot run	2/4
12″×6″	Copings and sills	per foot run	3/9

Cornices according to detail, per foot cube (from) 6/9

CURRENT PRICES

BY DAVIS AND BELFIELD, P.A.S.I.

MASON, SLATER, TILER AND ROOFER, AND CARPENTER

MASON—*(continued)*

Reconstructed Stone to match Natural Stone

Sills, lintols, coping, cornices, ashlar, etc., average size	per foot cube	11/-
Window sills, 9″ × 3″ section	per foot run	2/1
,, ,, 7″ × 3″ section	per foot run	2/-

Slate Slabs, cut to size and Planed

		1″	1¼″	1½″
Not exceeding 4′ 6″ long or 2′ 3″ wide	per foot super	3/1	3/4	3/11
,, ,, 6′ 6″ long or 3′ 3″ wide	per foot super	3/9	4/1	4/10
Exceeding 6′ 6″ long or 3′ 3″ wide	per foot super	4/1	4/6	5/2
Rubbed faces	per foot super	-/5	-/5	-/6
,, edges	per foot run	-/4	-/4	-/5

Combined Slate Cills and Window Boards for Metal Windows

Window Width	Straight Cills, Wall thickness 9″	11″	13½″	Circular Cills for C.O.P. Frames, Radius	External reveals 2″	4½″
1′ 8″ ..	4/-	4/8	5/8	2′ 4¼″ ..	21/-	24/-
3′ 3¼″ ..	7/4	8/7	10/4	2′ 7¼″ ..	25/6	28/6
4′ 10½″ ..	10/6	12/3	14/10	2′ 10¼″ ..	30/-	33/3

SLATER, TILER AND ROOFER

Best Bangor Slates

		£	s.	d.
24″ × 12″	per 1,000 actual	33	6	6
22″ × 12″	per 1,000 actual	27	19	0
22″ × 11″	per 1,000 actual	25	4	9
20″ × 12″	per 1,000 actual	24	14	6
20″ × 10″	per 1,000 actual	21	15	5
18″ × 12″	per 1,000 actual	20	19	3
18″ × 10″	per 1,000 actual	17	4	0
18″ × 9″	per 1,000 actual	15	11	9
16″ × 12″	per 1,000 actual	17	14	9
16″ × 10″	per 1,000 actual	15	11	9
16″ × 9″	per 1,000 actual	13	19	6
16″ × 8″	per 1,000 actual	12	1	11

Prices include for delivery to site in lots of 1,000 and upwards.

Old Delabole Slates (f.o.r.)

Standard sizes.

Prices and computed weights per 1,200.

		20″ × 12″	16″ × 10″
Grey medium gradings	per 1,200	597/-	366/-
	cwts.	46½	30
Unselected greens (V.M.S.) ..	per 1,200	672/-	413/-
	cwts.	55½	36

Random sizes.

Prices per ton and computed covering capacities in squares per ton.

		No. 1 Grading 24″/22″ to 12″/10″
Ordinary grey greens	per ton	128/-
Covering cap.:	per ton (3″ lap)	2·37 squares
	per ton (4″ lap)	2·19 squares

		No. 2 Grading 24″/22″ to 12″/10″
Weathering grey greens (V.M.S.)	per ton	139/-
Covering cap.:	per ton (3″ lap)	2·25 squares
	per ton (4″ lap)	2·08 squares

		No. 2 Grading 24″/22″ to 12″/10″
Weathering greens (V.M.S.) ..	per ton	149/-
Covering cap.:	per ton (3″ lap)	2·25 squares
	per ton (4″ lap)	2·08 squares

		No. 2 Grading 24″/22″ to 12″/10″
Rustic reds (25%) and weathering greens (V.M.S.)	per ton	174/-
Covering cap.:	per ton (3″ lap)	2·25 squares
	per ton (4″ lap)	2·08 squares

Railway rate to Nine Elms, London, minimum 4 tons, 21/9, minimum 6 tons per truck, 18/1 per ton.

Tiles

		£	s.	d.
Hand-made sandfaced 10½″ × 6½″ red roofing tiles	per 1,000	4	15	0
Machine-made sandfaced 10½″ × 6½″ red roofing tiles	per 1,000	4	0	0
Berkshire rustic pantiles	per 1,000	18	10	0

SLATER, TILER AND ROOFER—*(continued)*

Westmorland Green Slates

Bests, 24″ to 12″ long. Proportionate widths

	Price per ton	Computed cover in sq. yds. per ton
Random sizes.		
No. 1 Buttermere fine light green ..	240/-	30
No. 2 ,, light green (coarse grained)	215/-	27–28
No. 5 ,, olive green (coarse grained)	197/-	25–27
No. 5 Medium green	197/-	25–26
No. 7 Elterwater fine light green ..	216/-	27–28
No. 15 Tilberthwaite fine light green ..	214/-	26–28
No. 16 ,, light green (coarse grained)	202/-	25–27

Prices include for delivery to any station, minimum 6-ton truck loads.

Asbestos-cement

6″ corrugated sheets, grey	per yard super	2/11
Standard 3″ corrugated sheets, grey	per yard super	2/7¾
Slates :—		
15¾″ × 7⅞″ grey	per 1,000	£6 16 3
15¾″ × 15¾″ diagonal, grey	per 1,000	£12 18 6
15¾″ × 15¾″ diagonal, russet or brindled	per 1,000	£16 6 6
Pantiles.		
Large russet brown	per 1,000	£19 8 6

Prices are for minimum two-ton loads.

Cedar Wood Tiles

Canadian cedar wood shingles .. per square 32/- (normal quantity).

Prices include for delivery to nearest railway station in England but vary with quantity.

CARPENTER

Carcassing Timber

Prices are for Standards in one delivery; when less than a standard is required, or special lengths, add £1 per standard.

	Per standard £ s. d.	Per foot cube
4″ × 11″ Scantling	26 10 0	3/2¾
4″ × 9″ ,, ...	26 10 0	3/2¾
* 3″ × 11″ ,, ...	23 10 0	2/10¼
* 2″ × 11″ ,, ...	23 10 0	2/10¼
* 3″ × 9″ ,, ...	22 10 0	2/8¾
* 2″ × 9″ ,, ...	23 10 0	2/10¼
* 3″ × 8″ ,, ...	22 0 0	2/8
* 2″ × 8″ ,, ...	21 10 0	2/7½
3″ × 7″ ,, ...	22 10 0	2/8¾
* 2″ × 7″ ,, ...	22 0 0	2/8
* 4″ × 6″ ,, ...	24 0 0	2/11
* 3″ × 6″ ,, ...	23 0 0	2/9½
* 2″ × 6″ ,, ...	20 0 0	2/5¼
3″ × 5″ ,, ...	22 10 0	2/8¾
* 3″ × 4″ ,, ...	20 0 0	2/5¼
* 2″ × 5″ ,, ...	19 10 0	2/4½
* 2″ × 4″ ,, ...	19 10 0	2/4½
1½″ × 11″ ,, (20 ft. lengths and over)	per ft. run	-/5
1½″ × 9″ ,, (20 ft. lengths and over)	per ft. run	-/4
1½″ × 7″ ,, (20 ft. lengths and over)	per ft. run	-/2¾

Yellow Deal Battens

* ¾″ × 1″	per 100 feet run	1/7
* ¾″ × 1½″	per 100 feet run	2/-
* ¾″ × 2″	per 100 feet run	3/3
1″ × 2″	per 100 feet run	4/6
1½″ × 2″	per 100 feet run	6/3

Weather Boarding

Deal :—		
* ¾″ × ¼″ × 6″ Feather edge	per square	12/-
* ¾″ × ¼″ × 4″ Feather edge	per square	9/9
Western red cedar :—		
1″ × 6″ Rebated	per square	35/-
11/16″ × 3/16″ × 6″ Feather edge	per square	13/6
¾″ × ¼″ × 4″ Feather edge	per square	12/6

Roof Boarding

Deal :—		
¾″ × 6″	per square	18/-
* 1″ × 6″	per square	22/6

*** Items marked thus have fallen since April 21.**

TO BE CONTINUED IN NEXT ISSUE