Interior Design

By

Norman Bone

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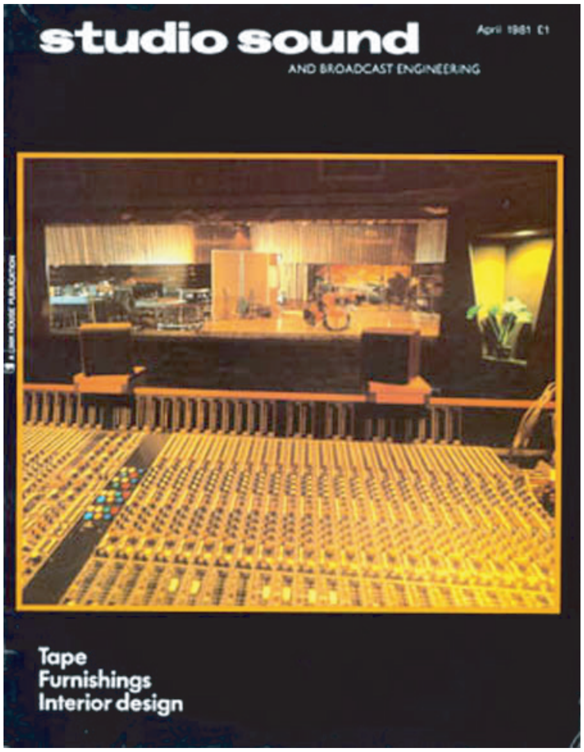


Interior design

Part one

Rupert Neve in his article Basic Studio Acoustics and Design (*Studio Sound,* October 1980) considered the structural aspects of recording and broadcast studios. Here Norman Bone offers equivalent thought on the no less important questions of interior design, furnishings and fitments.

RUPERT Neve stated the case very succinctly in the first four lines of his article: "A studio has to be an ideal environment enabling creative work to be carried out with a minimum of frustration or disturbance."

This is undeniably correct and it only remains to add: "but this environment will differ very considerably according to the programme requirements."

Facilities that will satisfy a pop group will be unsuitable for a symphony orchestra or a drama presentation, or more recently, a video production, and since one cannot please all of the people all of the time, the poor interior designer is often forced to accept a certain degree of compromise in the hope that he will please the majority most of the time. It would be ideal if he were able to design for a specific purpose, albeit radio, television or recording, but space and more often financial restrictions make it necessary for him to design in some degree for multipurpose use, and this is not always as difficult as might first be imagined.

This article is basically a follow on from Mr Neve's and attempts to provide sufficient information for the successful achievement of suitable environments for most situations. It is intended to be more practical than theoretical and where applicable, will point out the many myths and pitfalls which still abound even in the most modern studios.

Any studio, from the smallest talks studio to the largest orchestral studio or dubbing theatre, must be considered in its entirety. It must be made suitable for its purpose both technically and aesthetically, provide comfortable and acceptable working conditions for those using it and, most important of all, provide that environment which will enable the artistes, cast or orchestra to give their best.

The very first question one should consider, is 'For what purpose is the studio to be used?' and then 'Will its use be confined to radio, recording, television or video, or will it be a combination of any of these uses?'. If a harmonious and successful result is to be achieved, no design can even be considered until the answers are firmly established.

These basics resolved, it follows that the ambient noise levels and acoustics, ventilation, lighting, decor, furnishings, technical facilities (other than the actual apparatus—which does not form part of this article) down to the chairs on which the performers sit, should be eminently suitable for their purpose. The best course to pursue in dealing with these many and diverse requirements is to divide them into sections in order of priority, as follows:

1. **Structural items**
   This refers to those items which should be built into the structure rather than applied to it.
2. **Structural fittings**
   These are items applied to the structure.
3. **Ancillary fittings**
   These may be constructed or purchased externally and placed in the studio after completion of sections 1 and 2.

Truly a comprehensive list and capable of many interpretations but all items are important to the user and, if dealt with methodically and practically, by no means insurmountable as we shall see.

Assuming that we have a building 'shell' which, if the architect has done his homework, has an acceptable ambient noise level, the interior design can now commence.

Structural items

Ventilation/air-conditioning

This is really the province of the architect in conjunction with the air-conditioning contractor, but these systems are the major source of background noise if the studio has been designed with a satisfactory ambient noise level, and the comfort of users is primarily dependent on the installation of a satisfactory system.

These two factors are of paramount importance to the success of any studio so here is food for thought on a subject which is often overlooked or thought to be of little consequence.

Two recent experiences highlight the lack of thought given to the provision of a suitable system. In the first case the system produced high velocity jets of air accompanied by enough noise to do justice to a steam locomotive standing in a main line railway station and in the second the studio was almost completed when it was realised that no provision at all had been made for any air-conditioning. The omission was 'rectified' by the installation of long lengths of snake-like convoluted tubing suspended from the studio ceiling, with ghastly results to the final appearance.

Surprisingly, it is still not generally realised that a good sound insulated studio is virtually airtight, and to make it workable in any sense, regular changes of air must take place. Since one cannot extract air from such an airtight cell without suffocating the occupants, an equal amount of air must be fed in.

In all cases therefore, be it studio, control room or recording room, there has to be a separate intake and extract system.

Dealing firstly with the noise problem, this would seem an appropriate point to define satisfactory ambient noise levels. A chart similar to **Fig 1** is used by most experienced studio designers and sets out the various types of studio, and their maximum permissible noise levels. These curves include any ventilation noise and vary from approximately NR15 to NR25 and here lies our first problem. Commercially designed air-conditioning systems used in open-plan office areas, theatres, etc, frequently have a noise rating of about NR40, which is not apparent and quite acceptable in those environments since it is generally masked by the higher ambient noise level of the area concerned—quite frequently NR60 in a busy office area.

Such a system in a studio would be useless, and it cannot be stressed too strongly that the maximum permissible noise rating of any studio system should not exceed NR20 when fully operational as in mid-summer conditions.

In small areas such as interview studios this is readily achieved. Relatively small fans installed on external walls of the building and connected to suitable trunking of sufficient length will usually provide sufficient air changes in the studio provided that a separate (and silent) heating system is available in the studio.

Larger studios, or groups of several studios with ancillary working areas will require the installation of a properly designed plant system and the services of an experienced air-conditioning contractor. This may involve the use of mixing and recirculating chambers, heating and refrigeration units, condensers, attenuators, dampers, thermostatic controls, etc. Since these are beyond the scope of this article the advice of the architect and contractor should be sought, but certain necessities remain constant.

If possible, the plant room should be in a separate enclosure to the studio structure, or at least as far from the studios as financial considerations will allow. Intake and distribution of fresh air should be by large centrifugal fans avoiding types of compressor as these nearly always produce vibration and rumble. All machinery with moving parts should be mounted on anti-vibration mountings, preferably on an isolated concrete base.

Between separate parts of the system, ie fans, ducting, etc, flexible couplings will minimise the transmission of noise from one section to the next. Large area ducting is preferable—what is required is a large slow moving mass of air, not a high velocity jet.

All ducting should be internally insulated, particularly intake ducts, to further reduce the air flow noise. This is usually achieved by gluing scrim-faced mineral wool about 1in thick weighing 5 to 8lb/cu ft to the inside of the duct with the scrim facing outwards. External lagging of ductwork is also necessary. A similar material which is foil-coated on the outside is usually used. These two laggings will reduce duct resonance and 'ringing' and should effectively reduce 'crosstalk' between ducts, and noise pick-up where the ducts pass through working areas such as workshops, test rooms and maintenance rooms.

All duct hangers should be suspended by anti-vibration mountings and ductwork isolated from the hangers by the use of felt strips.

Each area should be supplied with individual intake and extract ducts and both taken back as far as possible to the main plant before being joined to their respective terminal points. It is useless to allow the same duct to serve both studio and control room as the programme or conversation in one would be immediately transmitted to the other. Sharp bends in the duct runs should also be avoided as they cause turbulence and therefore noise and where ducts bridge cavity walls flexible connections or canvas bellows should be inserted across the air gaps.

Spreading the studio's air intake and extract over a number of grilles (ideally six to 12) evenly spaced round the studio walls or at least over the full length of one wall, will lower the velocity at any one grille and ensure the dispersal of the air flow over a large area. The intake grilles should be near the ceiling (even in the ceiling if possible) and the extract grilles near the floor to provide good air circulation and prevent interaction between intake and extract. If the ceiling of the studio is to be a cast concrete slab, the holes for the ducting will need to be cast into the slab as it is virtually impossible to cut them out once the slab is completed. The air flow at the face of any intake grille should not exceed 250cu ft/minute to minimise air flow noise.

If it is at all possible to provide a plenum (expansion) chamber say over the top of a drum booth or vocal booth, this has the advantage of assisting an even flow of air over a large area of the studio and reducing air flow noise to a minimum. Any such chamber should be acoustically treated internally.

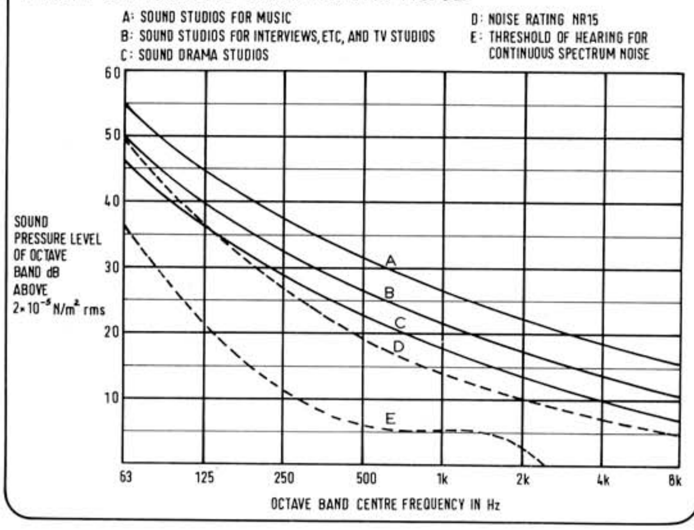
The comfort of the studio's users is also important and the system's capacity can be calculated bearing in mind a number of factors.

Estimate the maximum number of persons using the studio at any one time, and calculate the heat dissipation at 0.25kW/person/hour, ie 20 persons would be 20 x 0.25 = 5kW/hour. Add the total heat dissipation of lighting and equipment, say 40kW/hour. For economic reasons, since the studio will seldom be working at its maximum capacity for a maximum continuous period, calculate the plant capacity at 80% of this value, ie 45kW x 0.8 = 36kW. The plant should therefore be capable of dissipating 36 to 40kW continuously while maintaining a thermostatically controlled temperature of 69°F (21°C) ±4° whatever the outside temperature.

Heating batteries and refrigeration plant will obviously be necessary in nearly all cases other than the smallest studios, but it is normal to recirculate some of the warm air extract to assist with winter conditions.

Extremely dry air can not only cause sore throats but also be responsible for severe damage to some musical instruments in orchestral studios. Double basses and violins have been known to split when left in dry air conditions so some form of humidity control should be installed which will maintain a relative humidity of 55% (±5%) when the outside conditions do not exceed 85°FDB or 70°FWB.

FIG.1 PERMISSIBLE BACKGROUND NOISE



The system should be capable of providing no less than 15 complete air changes per hour for comfortable working conditions. Perhaps it is not generally realised but a large scale TV production would have to shut down within 15 to 20 minutes if the air-conditioning should fail, as working conditions would become unbearable.

Most of these facts and figures will be known to any experienced air-conditioning contractor and therefore dealt with in the general design. They are included here primarily to show that there is no cheap and easy way of overcoming ventilation noise problems and providing comfortable working conditions, and sufficient financial allowance must be made in the costing of any studio design. It is useless having an otherwise perfect control room or studio if the users cannot work in it.

Electrical wiring

The electrical requirements for any studio or control room area, should have been discussed and agreed long before building commenced and the electrical contractor should have designed the system accordingly. The provision of the mains supply, switchgear, distribution and installation are outside the scope of this article but the necessity of separate circuits for both lighting and power requirements and the positions at which they appear on the inside of the studio walls are of paramount importance and are detailed below. The terminations of these various circuits and the fittings will be discussed later under Structural Fittings.

All studios will require certain, if not all, of the following separate circuits: (a) lighting—for TV, video or film purposes, general and domestic; and (b) power—technical and domestic.

The capacity of lighting circuits for TV, video or films will depend on the size of the studio and the nature and complexity of the productions envisaged, but in all cases they must comprise a separate supply direct from the mains intake distribution board and should enter the studio through the walls at high level, normally some 3 to 4ft below ceiling level for reasons described later. The capacity of these circuits is likely to be some 50kW upwards.

General lighting circuits are totally independent from the previous item and relate either to the lighting required at times other than when production is taking place or, in the case of sound or recording studios, will provide the main studio lighting for production purposes. These circuits should also enter the studio at a high level.

A third separate circuit is also necessary to provide low-level general lighting for cleaning and tidying purposes and where the use of the main lighting would be a waste of energy and create unwanted heat.

Technical power refers to the main studio circuits. In TV and video studios two independent supplies will be necessary—one to supply the power required for the cameras, and the other to supply power for electrical instruments, mic power, cue lights, signal lights, etc. As in the case of lighting, these circuits should enter the studio at high level.

A few outlets will be required inside the studio for the use of vacuum cleaners, soldering irons, etc, and these should be separate from the technical supply so that any fault developing on these will not affect the technical power and shut down the studio.

Stress has been laid on the position of entry into the studio of all the above circuits for a very good reason.

Every engineer will know only too well that one of the worst problems to cure in any studio or technical installation is that of hum. This occurs only too frequently where mains cabling runs adjacent to technical cabling, particularly mic runs, and in some of the circuits mentioned we are talking in thousands of watts not just a few.

One method of avoiding this, which has been adopted with great success, is to bring all the electrical circuits into the studio as near to the ceiling as possible, bringing them vertically down the walls to their terminating or switching points, and to run all the technical circuits (mic cables, etc) in suitable ducts at floor level and take them vertically up the walls to their respective terminations.

If sufficient thought is given to this method hum will be reduced to an absolute minimum as mains and technical cables are separated by a maximum distance and approach their termination points diametrically opposed. Descriptions of suitable termination fittings will also be detailed later under Structural Fittings.

If at any point mains and technical cables do have to cross they should do so at right angles.

Fig 2 shows a typical layout for power and lighting distribution.

Doors

This item refers, of course, only to access doors to the studio(s) and ancillary technical areas. All other areas, such as maintenance rooms, storage areas, test rooms, etc, can have normal domestic doors fitted.

Commonly called 'sound-proof' or 'acoustic' doors, the more correct term, particularly in view of the

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Trades Descriptions Act, would be 'sound resisting'. Together with the observation windows, they normally form the two weakest links in the sound isolation of the studio and care must be taken in their design and installation.

A multitude of designs have been tried over the years with varying degrees of success. Some 10 years ago, it was quite usual to construct a form of door slab with a hollow core which, when completed was filled with dry sand. More or less successful, the disadvantage revealed itself when it became necessary to drill holes, for door handles or other fittings. Quite often too, the door would bulge at the bottom when the sand settled. Similarly, other hollow-core slabs were filled with a concrete mixture, which gave great mass, but these also tended to bulge, and providing any door furniture such as door closers, push plates, kicking plates and handles became a major operation. Ironically, the great mass, and consequently weight, became a disadvantage due to the effort required to push them open. Not all our lady artistes are Amazons.

Latterly it has been found that a more standard but satisfactory form of construction can be utilised which will provide a sound isolation value of 35dB upwards over most of the frequency range, without any of the previous disadvantages, and the majority of the doors now being installed adopt this form of design. Basically, they consist of a solid core construction formed by using layers of high density inert material to prevent twisting and warping, between which is sandwiched a complete layer of at least 4lb/sq ft lead. These are glued together under pressure and additionally screwed when pressed. This composite slab is then faced on both sides with the required finish, and finally hardwood lipped for resistance to wear. Asbestos sheets have been used as part of the inert core, but these have now been discarded due to the health hazard. Such a door slab of 2¼in or 2½in thickness will weigh about 2cwt, and provide sufficient mass and sound isolation if properly hinged into a suitable frame with an appropriate seal.

In a high-class door of this type, the door slab would be constructed first, and then fitted and hinged into a solid hardwood frame specifically made to fit each individual slab with a maximum gap of 2mm between door and frame. At least three 4in solid-drawn brass hinges, steel-bushed for long service, would be used and handles would be bolted through and not screwed, with the nuts being covered on the other side by a push-plate.

Even this form of construction demands the addition of some form of sealing, and many types have been tried, from foam-rubber to phosphor-bronze strip, all of which appear to deteriorate with use. Without doubt the most satisfactory is the concertina-type continuous magnetic strip which, when correctly rebated into the door frame and mated with a mild steel strip similarly rebated into the appropriate door edges and threshold, provides what is virtually

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FIG.2
POWER AND LIGHTING LAYOUT

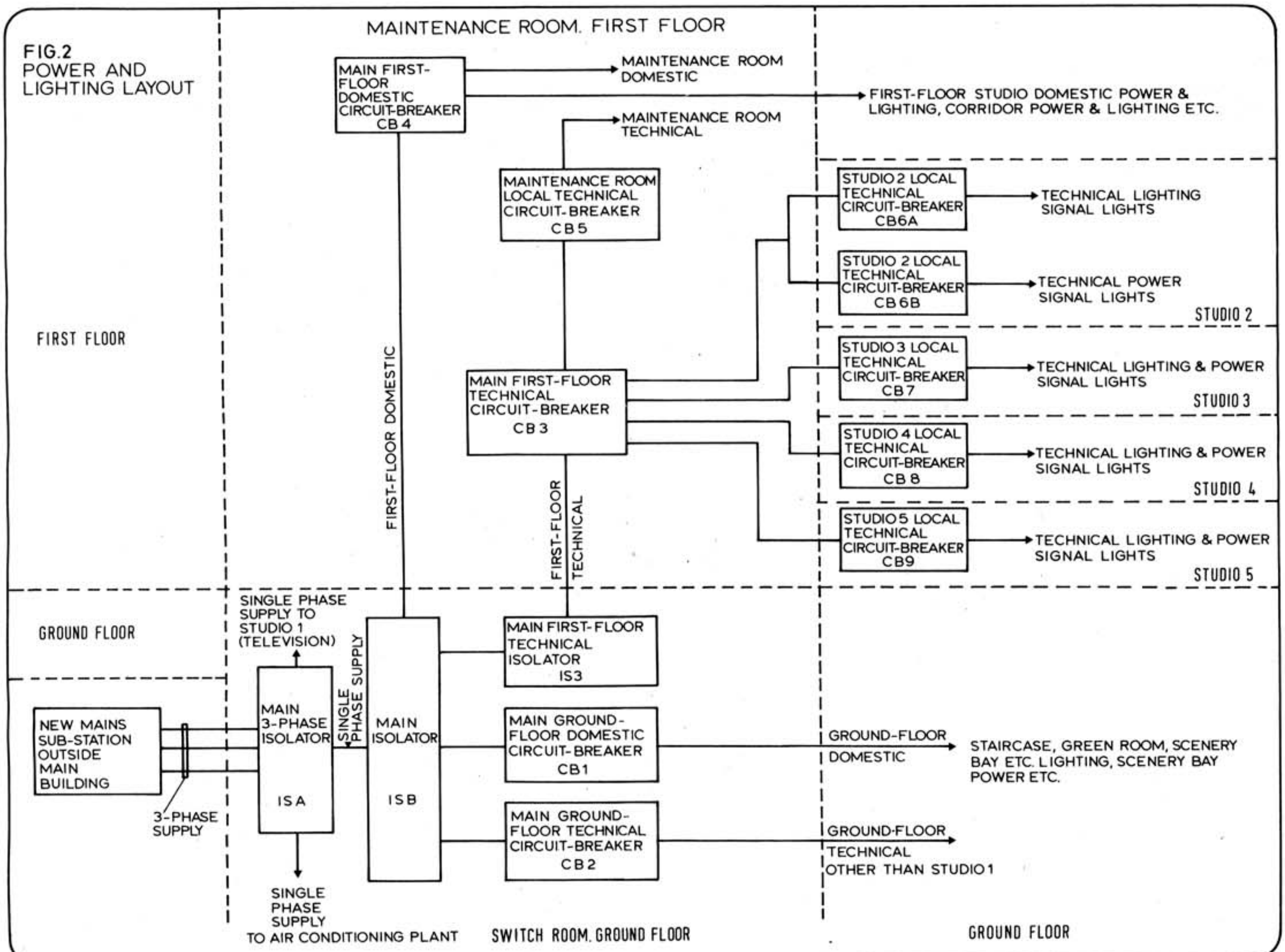


FIG.3
ACOUSTIC DOOR UNIT ISOLATION VALUES

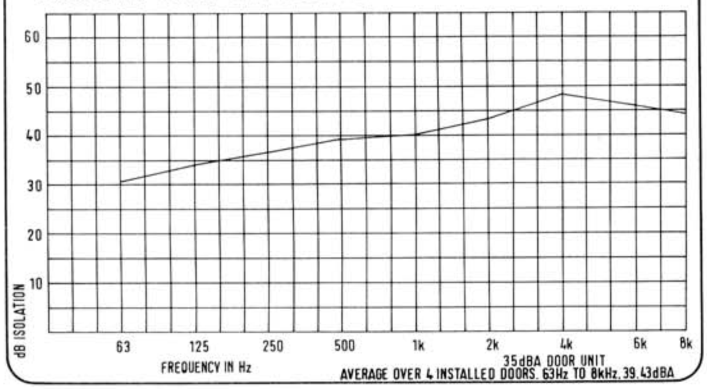
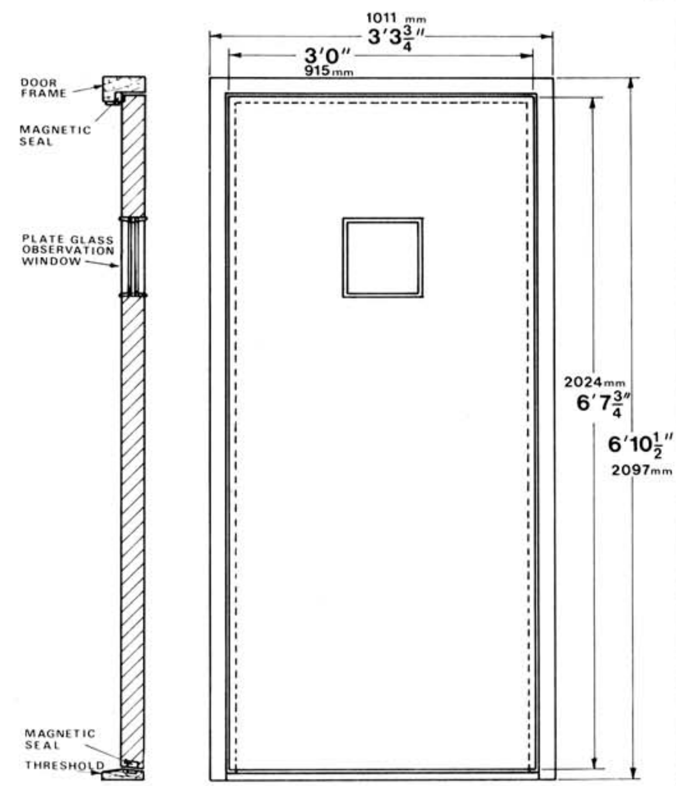


FIG.4
SOUND RESISTING STUDIO DOORS



an airtight seal around the complete door periphery when the door is closed, and what is airtight is good for sound isolation. Furthermore, this type of seal holds the door gently but firmly closed against draughts and air pressure, while still leaving it easy to open, and no locks, catches or bolts are necessary, unless for security reasons. The main reason this type of seal has been so successful is that there is no rubbing action whatever, and the life of the seal can be estimated at 10 to 15 years without deterioration.

This type of complete door unit is now in commercial production, and can be fitted by two competent carpenters in about four hours with the secure knowledge that a guaranteed isolation value will be achieved, provided always that any gaps between door frame and structure and/or the builder's subframe are fully sealed with mastic and finally covered by an architrave. Experience has shown that any sound leakage occurs at these points, and under the threshold rather than through the door itself. **Fig 3** shows an isolation curve for a standard commercially produced door of this type.

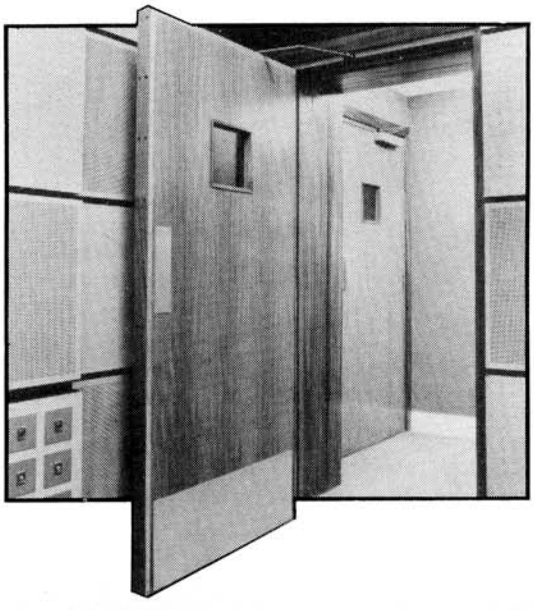
The size of the door, or more importantly, the actual clear door opening space is very important and, regrettably, many cases are found where this opening is too small. Normal domestic doors are usually 2ft 6in wide and 6ft 6in high, and even in the smallest studio the clear opening width should be at least 2ft 10in and the height could well be 6ft 8in with advantage. In metric figures this becomes about 870 x 2,000mm and **Fig 4** shows a typical example. These sizes ensure that such items as tape-trolleys, electric organs and even pianos can be wheeled in and out without damage to either instrument or door surfaces.

It is quite usual to have a small (9in square) double-glazed observation panel inserted in the door so that, without entering, it can be seen whether the studio is in use, but primarily to ensure that nobody is coming out at the same time as someone wishes to enter. Being hit in the face by a 2cwt door is not the most pleasant experience.

In larger studios where large musical instruments such as grand pianos are employed, double doors are usually installed. These consist of two leaves in one frame and sizes up to 8ft square are frequently used and present no difficulty in manufacture. In these cases a magnetic seal is provided where the two leaves meet, thus maintaining the sound isolation.

Door surfaces can be in plywood for subsequent painting, veneered plywood (or hand-veneered in most timbers to match the studio woodwork), many of the excellent laminates available, steel for fire protection and latterly, with great success, carpet recessed into the hardwood lipping, providing further sound-absorption and quite remarkable resistance to wear and tear.

FIG 5



Two such doors should always be fitted between adjacent working areas, preferably with a small sound lobby between. **Fig 5** gives a typical example. With such a sound lobby acoustically treated in a simple manner, sound isolation of 55 to 60dB between areas is easily obtainable.

For television studios, doors up to 12ft high and 10ft wide are available, if somewhat costly and these are normally used where studios are adjacent to television scenery storage areas, or even external areas such as car parks or where drive-in facilities exist. Such doors usually have two layers of lead and increased thickness up to 4in but are still capable of being hinged with special hinges.

The older continental method of a plain rubber seal compressed by a form of cold storage lever type handle is now obsolete in the UK and is indeed frowned upon by the authorities particularly because of the fire risk.

Handles, push-plates, kicking-plates should be fitted to the completed door in a finish to match the studio decor, and finally a heavy duty spring closer. This latter item should be adjusted to close the door gently and not to slam it shut as in practice the magnetic seal takes over during the last ½in of door travel and holds the door closed.

To be continued

Interior design

Part two

The second part of Norman Bone's insight into interior design continues his coverage of structural items and takes up the story with observation windows.

It is standard practice, where possible, to install observation windows between adjacent working areas, such as studio, control room and recording room, particularly where recording is carried out as a separate function. Sometimes the use of a second or slave studio is required, and vision between all these working areas can only enhance the smooth running of the production.

It has already been mentioned that these windows are the second weakest point in sound isolation, and every effort must be made to reduce any sound leakage that might occur.

Almost certainly the architect will have provided at least two, if not three, separate walls between the areas concerned, and it is vitally necessary to install a separate window unit in each wall, with as large an air-gap between the units as the structure permits. Two 4½in walls with a 2in air gap between will enable a distance of 11in to be achieved and this is excellent. Where there is a third and additional wall in the centre, a third window unit will, naturally, reduce the air gap, but the third window will more than compensate for the reduced air gap and greatly increase the sound isolation. **Fig 6** shows a typical example of a triple window.

The thickness of the glass is most important. Normal domestic glass of about 4mm is useless, 6mm only slightly better, and in most modern studios it is now normal to use glass of not less than 10 or 12mm thickness.

To avoid sympathetic resonance between the two panes, one is usually of 10mm and the other of 12mm thickness. With an air gap of 11in two panes should provide a sound isolation of up to 40dB if fitted as described later, and the use of a 10mm third pane between two 12mm outer panes will increase this isolation up to about 55dB which is near the maximum obtainable.

The construction of the window frames is very important. Preferably they should be of hardwood and should fit the aperture as closely as possible. The glass should also fit into the rebates without undue gaps and it is an advantage to cover the edges with wash-leather, with a cover fillet nailed into position. Any remaining gaps between frame and structure should be filled with mastic and covered with an architrave.

In most cases the builder will have fitted a 4 x 2in (100 x 50mm) wooden subframe to the structure, and again all gaps must be mastic filled as this is where any sound leakage will normally occur.

The disadvantage of wooden frames is that, under the prolonged influence of studio air-conditioning, even hardwood frames tend to shrink and gaps appear at the joints, eventually lowering the isolation value.

In the last two or three years factory-glazed commercial units have become available, constructed of heavy duty satin-anodised aluminium alloy extrusions into which is incorporated a complete U-shaped or double vinyl seal into which the glass is factory-fitted. No shrinkage can occur in these units and the glass is completely isolated from the frame and therefore also from the structure. A self-adhesive rubber or plastic strip is usually fixed to the back of these frames as an additional seal between frame and structure.

With regard to window area, this naturally depends on the size of the studio. The minimum size should be 3ft square, and in an average studio 6ft wide by 3ft high would be considered normal. In large orchestral or similar studios, with control rooms incorporating 24, 36 or even 48-channel desks, 8 x 4ft or even 10 x 4ft are not abnormal. In all cases the bottom glazing line should be about 3ft above floor level.

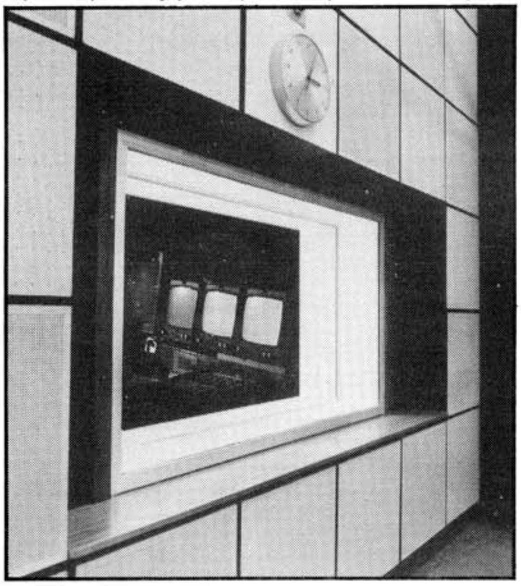
It is necessary to consider the weight of these windows. The weight of 12mm glass is about 10lb/sq ft therefore a 10 x 4ft single unit will be some 400lb (3½cwt). Multiply this by three units and the total weight becomes about half-a-ton. This necessitates very secure fixing of the units, though admittedly, the bottoms of the frames will rest on the supporting walls and take most of the weight. This mass and weight may sound a little extreme but with studio noise levels that can be up to 120dB the 55dB isolation of the window becomes very necessary.

The sound isolation of the windows is considerably increased if the internal wall surfaces between the separate units, technically known as the reveals are lined with a soft and sound absorbent material. Suitable materials are *soft* building board such as *Celotex,* absorbent acoustic tiles (not the plaster type), or ½in thick felt on simple wooden frames. Some lining is necessary to cover the gaps between the cavity walls.

In some cases silica-gel crystals are placed in the areas between the units to prevent condensation, or at least absorb it, but the writer has never yet found this necessary, as there is almost always a slight air movement between the cavity walls and sufficient normally percolates through the absorbent reveal linings to prevent any moisture forming.

Finally, it is sometimes an advantage to slope or slightly incline one of the glass panes. This is not primarily, as is commonly thought, to reduce resonance between the panes by breaking up any standing waves, but more particularly to divert any unwanted reflections from the control room or studio lights away from the eyes of the panel operator, and thus maintain clear and unobstructed vision.

FIG. 6



Structural fittings

The building shell being complete with doors, windows, external wiring and ventilation ducting, we can now discuss the various fittings and terminations to be applied to all internal surfaces as permanent fixtures.

These comprise: acoustic treatment; lighting and power terminations and fittings; technical ducting; technical wiring terminations; ventilation terminations; technical lighting units, ie signal lights, etc; cyclorama fittings; storage units; floor surfaces; and decoration.

Many of these require only brief description but all are important as they affect the final appearance and efficient working of the studio.

Acoustic treatment

This is obviously the most technically important item whose nature is still very much misunderstood, despite the fact that enough has been written on this subject to fill 50 issues of *Studio Sound.* Modern research has resulted in certain indisputable and basic facts briefly covered in this article with details of modern forms of modular acoustic treatment.

It is hoped to shed a little practical light on this very complex subject, and perhaps get rid of a few old-fashioned myths and misunderstandings. This is not really a 'do-it-yourself' subject and the employment of a competent acoustic consultant is a necessity if the result is to be successful.

So why is correct acoustic treatment so important? The quality and reproduction of speech or music is critically dependent on the shape of the reverberation time/frequency characteristic. Reverberation time is normally depicted by the symbol RT_{60}, or simply RT, and is the time taken for an initial sound to decrease by 60dB (or to one-millionth of its original intensity) when suddenly interrupted.

The frequency band to be covered is normally from 60Hz to 8kHz and the results are usually depicted graphically as the RT_{60} 'curve'.

Norman Bone (Shone Sound Ltd)

Ideally, the final RT_{60} curve should be flat, with measurements over the whole frequency band being as identical as possible, but in small studios this is rarely achieved and there is inevitably some rise in the low frequency band below 125Hz. Within limits this is permissible, but at 63Hz should not exceed 50% increase over the 250Hz figure, otherwise there will be severe colouration of speech and music clarity which will mask the reproduction of the middle frequency band, and result in the unwanted phenomenon known as bass boom. In studios of more than 300cu m (around 30ft square x 10ft high) there should be no bass rise at all from 250Hz downwards.

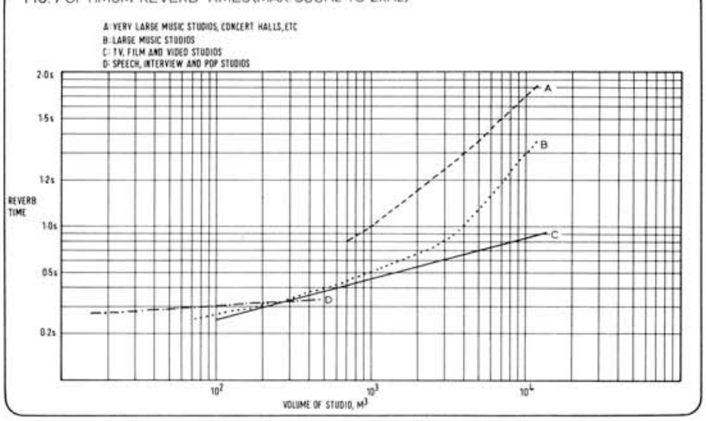
Deviations in the reverberation time of more than 10% are noticeable to the trained ear, and current IBA standards state that from 250Hz to 4kHz any deviation should not exceed that figure. Excess in this area can only result in sibilance on speech and a shrill quality to music.

In the case of small studios, because the wavelengths of sounds at the low frequency end of the spectrum will be equal to, or greater than, the dimensions of the studio, strong standing waves and colourations will inevitably occur which, if not dealt with, will severely distort speech quality. This problem is dealt with by reducing the reverb time and introducing selective acoustic absorbers as necessary. The optimum RT_{60} of studios up to 100cu m (18ft square x 9ft high) should not exceed 0.3s, particularly over the frequency band up to 2kHz, but this is quite difficult to achieve and usually results in all available ceiling and wall surfaces being covered by the appropriate absorbers.

Incidentally, it is interesting to note here that the now almost universally agreed RT_{60} figure for control rooms and listening rooms is about 0.4s, and that most well furnished domestic living rooms are normally about 0.5 down to 0.3s, so that there exists an extremely good chain of events right from studio to living room, provided always, of course, that the listener is not using a portable transistor set for listening!

Conversely, large studios have dimensions greater than most of the relevant sound wavelengths and exhibit longer reverb times. Since the users of large studios are normally orchestras and the like, which require a longer RT_{60} for natural reproduction, the correct figure is much easier to obtain. Typical reverb times for large studios would be between 0.6 and 0.8s for studios up to 1,000cu m and up to 1.2 to 1.5s for 10,000cu m. Times over 2.0s are likely to exhibit unwanted echoes. **Fig 7** is a graph indicating optimum reverb times for studios of different sizes and uses.

FIG. 7 OPTIMUM REVERB TIMES (MAX: 500Hz TO 2kHz)

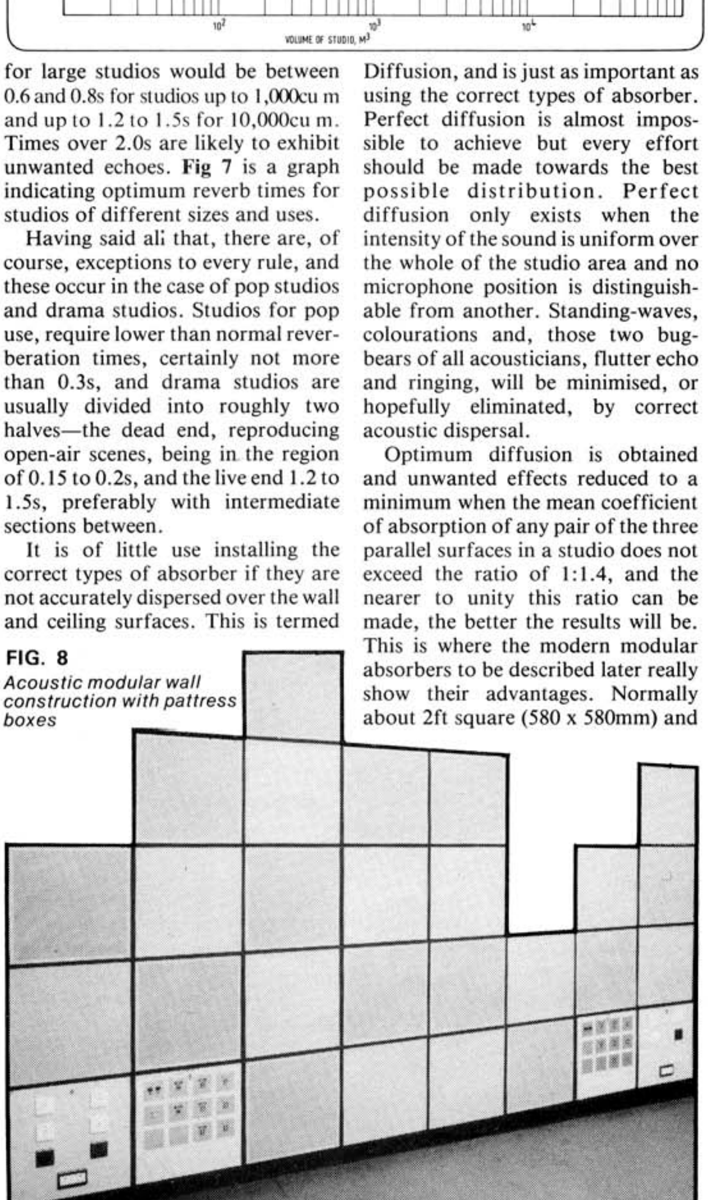


Having said all that, there are, of course, exceptions to every rule, and these occur in the case of pop studios and drama studios. Studios for pop use, require lower than normal reverberation times, certainly not more than 0.3s, and drama studios are usually divided into roughly two halves—the dead end, reproducing open-air scenes, being in the region of 0.15 to 0.2s, and the live end 1.2 to 1.5s, preferably with intermediate sections between.

It is of little use installing the correct types of absorber if they are not accurately dispersed over the wall and ceiling surfaces. This is termed Diffusion, and is just as important as using the correct types of absorber. Perfect diffusion is almost impossible to achieve but every effort should be made towards the best possible distribution. Perfect diffusion only exists when the intensity of the sound is uniform over the whole of the studio area and no microphone position is distinguishable from another. Standing-waves, colourations and, those two bugbears of all acousticians, flutter echo and ringing, will be minimised, or hopefully eliminated, by correct acoustic dispersal.

Optimum diffusion is obtained and unwanted effects reduced to a minimum when the mean coefficient of absorption of any pair of the three parallel surfaces in a studio does not exceed the ratio of 1:1.4, and the nearer to unity this ratio can be made, the better the results will be. This is where the modern modular absorbers to be described later really show their advantages. Normally about 2ft square (580 x 580mm) and basically of four types, each with its own particular absorptive characteristics, not only can the quantities of the various types be pre-determined, but the exact placing of each module can be arranged to provide a high degree of distribution on each wall, and the ceiling, and therefore on adjacent and parallel walls. If sufficient thought is given to the layout of these absorbers quite an attractive pattern can result. **Fig 8** shows a typical example. Most large broadcasting concerns now adopt this method.

FIG. 8
Acoustic modular wall construction with pattress boxes



It used to be thought that differences of wall angles, ie non-parallel walls, and/or deliberately designed wall projections, assisted in the elimination of colouration, flutter echo etc. In small studios, however, experiments carried out have failed to prove that these provide any significant improvement. Indeed, they sometimes cause new and unwanted resonances, and the idea has been largely abandoned. In large studios, however, wall and ceiling projections and coffering have proved effective, and almost necessary.

If any areas of wall surfaces remain untreated, and therefore exhibit reflective tendencies, ensure that there are no corresponding reflective areas on the opposite parallel wall as flutter echoes are bound to result.

Finally, do not be too disappointed if a perfect or even required result is not achieved at the first test. It must be realised that there are many factors involved, some probably unknown at the design stage, all of which tend to interact with each other, sometimes to the detriment of the final result, and, in small studios particularly, final adjustments may have to be carried out. This is where a competent acoustic consultant will really prove his worth.

We are now ready to consider acoustic materials and methods and their application.

All materials have some absorptive element, even brick walls and concrete, but the coefficient is usually so small that in most cases it can be ignored for all practical purposes, when compared with the high absorptive levels required.

Other examples in the chart in **Table 1** show that ⅛in hardboard or ½in wood panelling over 1in thick battens have a coefficient of 0.3 from 63Hz to 250Hz falling to 0.11 at 4kHz. Others rise to 0.7 and 0.8 at the

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higher frequencies but fail miserably at the lower frequencies. No material has an equally high absorptive level over the whole of the frequency band, so it is necessary to select different materials for different frequency bands and apply methods so they exhibit maximum efficiency.

It has long been known that two particular phenomena absorb energy to the highest degree—these are resonance and friction.

Research into acoustics since about 1950 has proved that a suitable vibrating (resonating) membrane over an enclosed air space is most effective for low frequency absorption and further, that the mass of the membrane vibrating with the compliance of the air in the enclosed space will determine the resonant point and also the amount of absorption. Alteration of the amount of air in the enclosed space has a similar effect.

Originally linoleum was used as the membrane, then later roofing felt, and currently a 2mm thick plastic sheet is used. It is also customary to place a porous pad behind, but not touching, the membrane and this has the effect of widening the bandwidth of the resonance. Since roofing felt or even plastic sheet does not present a very suitable appearance either perforated hardboard or a fine wire mesh is usually placed in front of the membrane.

For middle and high frequency absorption the friction method is employed. Very basically what happens is that the soundwave hits a porous pad, loses energy by traversing the thickness of the pad, is reflected back from the hard surface behind the pad, and again loses energy by traversing the porous pad in the reverse direction. The frequency band covered by this method depends on (a) the thickness and density of the porous pad; (b) the depth of the enclosed air-space behind the pad and (c) since, once again, a perforated cover is placed in front of the pad, the degree of perforation of the cover.

In both cases it has been found that absorption is most efficient when constructed in the form of modules. These modules usually take the form of airtight wooden boxes, about 2ft square and from 7 to 10in in depth containing all the materials mentioned. Such modules normally have the air space behind the membrane or porous pad divided into about 25 separate compartments as this greatly increases the efficiency of the modules by preventing transverse air flow in the enclosed air space.

TABLE 1 A SELECTION OF VARIOUS ABSORPTION COEFFICIENTS

	FREQUENCY IN Hz								
MATERIAL OR PRODUCT	62	88	125	250	500	1k	2k	4k	8k
Brick wall	.02	—	.02	.02	.03	.04	.05	.07	.10
Celotex building board (½in unpainted)	.04	—	.06	.10	.15	.21	.26	.26	.29
⅛in hardboard on 1in battens	.30	—	.32	.43	.12	.07	.07	.11	.18
½in wood panelling on 1in battens	.33	—	.31	.33	.14	.10	.10	.12	.15
Average woolcord carpet with underfelt	.02	—	.04	.13	.36	.60	.69	.62	.52
Average haircord carpet with underfelt	.05	—	.13	.17	.24	.29	.30	.30	.37
Wilton carpet with underfelt	.04	—	.08	.22	.51	.64	.69	.71	.70
Curtains: Velour draped	.05	—	.06	.31	.44	.80	.75	.65	.60
Lightweight over 2in air space	.00	—	.04	.10	.20	.50	.60	.50	.40
Heavyweight over 2in air space	.00	—	.06	.16	.30	.55	.65	.65	.65
Full Concert Hall audience with Orchestra	.39	—	.54	.66	.78	.85	.83	.75	.71
Membrane Absorbers: (typical figures) High-density mineral wool backing 12in air space	.81	1.15	.87	.47	.30	.15	.15	.15	.15
Porous Absorbers: 0.5% perforated front 6in air space	.60	.95	.77	.52	.38	.22	.18	.17	.15
25.0% perforated front 6in air space	.40	.80	1.10	1.05	1.00	.98	.95	.80	.60
Wire-mesh front 6in air space	.40	.80	1.10	1.05	1.00	.98	.98	.97	.95
Typical "Acoustic" Tile on 1in air space	.10	—	.14	.52	.52	.61	.61	.65	.65

NOTE The above results are from single samples of materials and absorbers, and on occasion are higher than unity due to diffraction at edges of samples. Where quantities of materials or absorbers are used in large unbroken areas lower absorption values will result.

These modules are commercially produced in large quantities. The cost is about £3 to £4/sq ft and while, admittedly, a few could probably be made in a small workshop, the cost and availability of the materials, plus the time and labour involved and the space required for the manufacture of several hundred modules, does not warrant the effort involved against the precision jig-built commercial products.

It is, of course, possible to build-in these types of treatment, but this is more costly, usually two to three times the cost of *separate* modular treatment. Also if the studio ever decided to move, individual modules could be transferred since they do not normally deteriorate in use.

Any colourations or resonances remaining after full acoustic treatment has been carried out are usually nullified by the use of special Helmholtz absorbers specifically tuned to deal with particular frequencies and bandwidths.

Brief mention should be made of certain other materials used in acoustic treatment. As an instance, the use of excessive amounts of perforated hardboard over porous mats may result in an unwanted rise of reverb time at the top of the hf band, and in this case the use of stretched or pleated fabric in front of the absorbers is employed to counteract this effect. Reference to **Table 1** will show that such fabrics are effective from about 2kHz upwards.

Most small studios, particularly speech and interview studies, usually have carpet-covered floors with an underfelt. The chart again shows that this provides a degree of mid and high frequency absorption and this must be taken into account when estimating the total amount of absorption in these bandwidths.

Finally, in the case of some of the membrane and porous absorbers, the absorption coefficient is shown rising to more than unity. This is theoretically impossible since the maximum coefficient—that of open air—*is* unity. This is not a mistake, but is due to the fact that the figures quoted are those measured for small samples of materials or a few modules, in which case the radiation resistance is less than a wavelength and diffraction effects round the edges of the samples tested give rise to this effect. In practice, larger areas of acoustic materials, or quantities of modules, exhibit lower absorption coefficients and should be taken into account.

Lighting and power

The description of the lighting system required for a TV, film or video studio of anything more than about 1,500sq ft floor area is outside the scope of this article and the services of a competent firm of film or television contractors should be employed. Such a system is highly complex and is likely to cost anything from £15,000 upwards, requiring as it does the inclusion of motorised tracking, winches, dimmers and racks, and a comprehensive lighting console.

For the smaller studio however, much can be achieved by a simpler system utilising a fixed grid of single or double construction composed of tubing akin to scaffold-pole dimensions.

A basic or primary grid would comprise a line of tubes around the perimeter of the studio about 1ft away from each wall, with intermediate tubes at about 4ft intervals

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FIG. 9

crossing the studio in both directions thus forming a complete cross grid suspended about 2ft down from the ceiling over the whole area. The lighting units would be suspended from this grid by means of simple metal hangers hooked over the tubing in the positions required. This makes for a simple but flexible arrangement and, of course, the lights would have to be manually adjusted for each set, but this form of grid is relatively cheap to install.

An improvement on this basic system would be a secondary grid suspended about 1ft down from the primary, with the tubing in the primary running in, say, the east/west direction and the secondary north/south.

This has the advantage that the lighting hangers can be slid along the tubes of the lower grid over the whole width or length of the studio, according to the direction of the lower tubes, to provide more precise location of the lighting fittings.

Single or double grids require very secure fixing to the studio ceiling as the combined weight of grid and lighting fittings can be considerable—easily up to one ton in an average studio. Sometimes H-section girders are built into the studio walls crossing the width of the studio, and suspending the grid from these girders avoids weight on the ceiling.

The height of the lighting units above the floor level can be adjusted by the use of hangers of different lengths or by the use of commercially available pantographs.

A variety of lighting units will be required, ie spots, floods and soft lights, and the numbers required will obviously depend on the type and complexity of the productions envisaged, but sufficient should be available to produce a lighting intensity of not less than 1,000Lux at a colour temperature of 2,550°Kelvin.

In the section headed Structural Items it was suggested that the mains supply for this lighting should enter the studio at high level just below the ceiling. This is because the last thing we want in a studio is masses of lighting cable draping over the working area and this can be completely avoided by the installation of a standard 4in square metal trunking installed on the studio walls about 3ft below the ceiling, preferably on all four walls. This would contain all the lighting wiring and the circuits should be terminated on single or double standard 13 amp switched outlet sockets inset into the front cover of the trunking at roughly 2ft intervals, particularly over the production area.

Between 20 and 30 outlets will probably be required, each one controlling one lighting unit, and the whole can be controlled either on an all-on/all-off basis by one or more mains isolators situated in the control room, or individually by a simple switching console also situated in the control room. Lighting switching is very rarely carried out in the actual studio as the programme producer will wish to have the variation or alteration of the lighting under his immediate control.

General lighting for sound studios presents no problem and is catered for by a standard electrical installation with ceiling fittings and wall switching. Once again, the wall switching is usually installed in the control room, often by the use of miniature circuit breakers (MCBs) contained in a special unit. **Fig 9** shows an example of this type of unit contained in a special pattress box.

Lighting can be of the normal tungsten type, with fittings suspended from the ceiling, or recessed into boxes to match the ceiling acoustic modules, or by the use of standard fluorescent fittings with diffusers.

There is, however, one proviso to be observed if fluorescent fittings are used. The majority hum or buzz albeit to a small degree, accentuated by the metal body of the fitting acting as a resonator. In a studio with a noise rating of NR20 and a number of such fittings, the resultant noise is unacceptable. It is standard practice, therefore, to mount all chokes, ballasts and starters outside the studio, leaving only the actual tube in its fitting in the studio.

A third successful lighting system is by the use of tungsten/halogen units, and the availability and use of them could well be investigated.

Whichever system is used, a fairly high and even intensity, without glare, will be required. In orchestral studios where music scores have to be read, a good standard of intensity has been stated as "15ft/lamberts on a script or score when inclined at an angle of 60° from the horizontal". Pedantic maybe, but very precise.

Drama studios follow normal procedure as above, but "pop" studios usually require a special treatment of their own. Good general lighting will be required for other uses, but for reasons unknown to the writer, most pop groups seem to prefer to work in a cave-like atmosphere, with only coloured spotlights for illumination. Most groups work without a music score so the intensity does not have to be particularly high, and is usually achieved by the installation of a number of spotlight tracks suitably positioned, with adjustable spotlight units and coloured lamps, some of which will often be angled to reflect off the studio wall surfaces.

Domestic lighting only requires a very simple standard installation, consisting very probably of two or three standard tungsten fittings with 100W lamps, sufficient only for general cleaning and tidying of the studio or certain maintenance work, thus saving the cost of the main lighting and the generation of unwanted heat.

There will be a necessity in any studio for mains power supplies for loudspeakers, television monitors, electrical musical instruments, mic power units, etc, and quite often the outlet sockets for these are installed around the studio in a rather haphazard manner. When these are added to the domestic outlets and technical outlets a most untidy appearance results.

The use of pattress boxes provides a very neat and efficient method of tidying up the whole system and is strongly recommended. The term pattress box is really only a technical term for a stout wooden box with a door. If modular absorbers are employed, the box should be of identical external dimensions, and examples are illustrated in **Figs 8** and **9.** They could also form part of built-in acoustic treatment where this is employed. Basically they are of very simple construction and comprise a strong wooden box with back and sides of at least ¾in timber with a door of similar thickness hinged with a piano-hinge for reliability and fitted with a lock or carriage bolt for security. They should be very securely fixed to the wall.

The power wiring is brought down the wall, usually in conduits, from the ceiling level, taken into the pattress box and terminated on the back of the box by suitable terminal blocks with covers. Flexible connections are then taken from the terminal blocks to the mains outlet sockets which are inset into the door. Sufficient lengths of flexible cable should be allowed so that the door can be opened for maintenance.

Three or four such boxes, each accommodating up to six individual 13 amp mains outlet sockets, sited around the studio, should satisfy most requirements. The same boxes will also accommodate the separate domestic power outlet sockets, which should be of a different type or colour to distinguish domestic from technical. The mains isolator controlling all these outlets will normally be situated in the control room.

Camera power sockets are usually of a special and heavier type than the standard 13 amp socket, and it is doubtful whether the wooden pattress box would be strong enough to withstand the constant plugging and unplugging of the camera cables. In this case the pattress box is constructed of 16 gauge steel with a cover which screws on instead of a door. The camera power sockets are inset into the cover as before.

To be continued

Interior design

Part three

The final part of Norman Bone's insight into interior design continues his coverage of structural fittings with technical ducting and concludes with an overview of ancillary fittings.

Between 12 and 50 technical (audio) circuits will have to be installed between studio and control room for loudspeaker feeds, talkback, foldback, mics, ring main and similar facilities and it is essential that these be kept as far removed from the power circuits as possible. They are usually run in a special cable duct and in new studios this is often built into the floor so that the removable cover is flush with the finished floor surface.

Since this is frequently not possible where old buildings are being converted another solution has to be found. This takes the form of a hollow skirting built into the angle between the walls and the floor and normally running right round the studio, distributing the various circuits where required. The cable runs are thus unobtrusive, safe from damage, and additions can be made when required. **Fig 10** shows a simple section of this form of skirting and is almost self-explanatory.

The internal dimensions should not be less than 3⅞in (100mm) square, and if it is not convenient to let the bars supporting the top actually into the wall as shown, alternative L-shaped brackets can be used. There are no supporting uprights so that when the front covers are let down there is an unobstructed cable run right around the studio for maintenance purposes and the addition of any future circuits. The front let-down covers are not more than 4ft in length and held by magnetic catches.

This form of skirting can be seen in several of the photographs and being sited immediately under the bottom row of absorbers and the aforementioned pattress boxes it only remains to drill holes in the top of the skirting and in the bottom of the pattress box for the distribution of the circuits to take place as required.

Technical wiring terminations

The technical cabling having been run and distributed into the various pattress boxes, which will, of course, be separate boxes from those containing the mains power supplies, the various cables can be taken directly to their individual sockets inset into the door, or terminated on the back of the box as before and flexibly connected to the sockets. Do not forget to leave sufficient loop for the door to be opened.

It is now almost standard practice to use an *XLR* or similar type of socket for terminating technical cables and these can be obtained in many types and pin connections sufficient to cater for almost any requirement. The type with the locking catch is recommended to avoid cables being pulled out of their sockets accidentally. This usually happens in the middle of a programme or recording!

Ventilation terminations

The termination of the ventilation ducts inside the studio will be by some form of grille. The normal type has adjustable slats so that the incoming air can be directed as required, but a newer type has a foam pad behind a coarse metal mesh which acts as a filter. If a flush surface treatment is desired this can be achieved by use of a pattress box (remember!) with the ducting terminated on the back of the box, and the grille mounted in the door, but in this case the door will have to be made airtight or even replaced by a cover screwed to the box. There are two minor advantages in this method. The box acts as a small plenum chamber and helps to reduce airflow noise, and the cover is easily removable for cleaning the grille and removing any dirt or fluff which might collect in the end of the ducts.

Technical lighting units

Most studios utilise some form of signal lights both inside and outside the studio to indicate that the studio is rehearsing, on transmission or recording, and for cueing the artistes. They can take the form of metal boxes, either surface or flush-mounted, on the front plate of which are mounted coloured light units. Commercially produced units are readily available in single, double or triple units, with up to five different coloured lenses—red, blue, green, amber and white. Standard practice has been to use red for transmission or recording, blue for rehearsal, green for cueing artistes, white for telephone and amber for any other purpose. The lamps illuminating the units are normally 240V, 15W pigmy bulbs, and can be operated directly from the mains supply, or by means of a 24 or 50V relay contained within the unit. **Fig 11** illustrates a typical commercially produced unit.

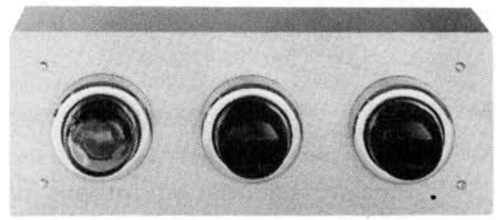


FIG. 11

FIG. 12

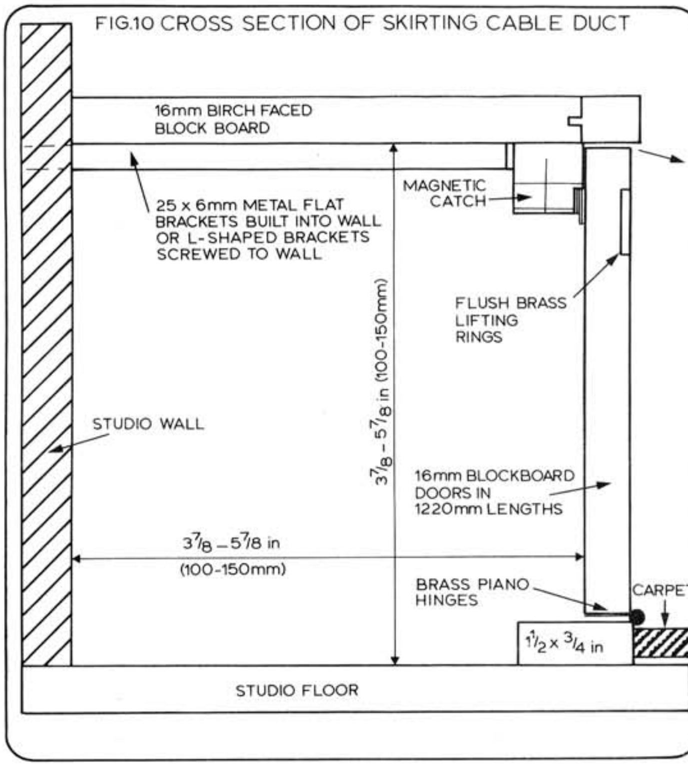
Some studios prefer to use an illuminated sign. These also are commercially produced in the form of a metal box similar to that mentioned above but with a cut-out in the front panel behind which is fixed a coloured perspex panel back-printed with the legend required. Normally these signs are blind until illuminated, usually by a 30W tubular lamp. **Fig 12** shows an example of this type of sign. They are available in single, double and triple units with different coloured perspex panels.

Both types are permanently mounted on the walls of the studios at a height of 6 to 8ft above floor level, and wiring from the units is taken back to the control desk in the control room. Similar types but with larger lenses are available for use in television studios where the level of lighting is higher than that in sound studios.

Two other light units must be mentioned. The first is a 'Fire' sign usually of the second type mentioned above and with an all-red panel with the wording 'Fire' in either black or white lettering. A flashing sign operated by a flasher unit inside the box can indicate that there is a fire in the proximity, and a steady red calls for immediate evacuation of the studio.

Where members of the public are present in the studios or theatre,

FIG.10 CROSS SECTION OF SKIRTING CABLE DUCT



special 'Exit' signs are required, and these have to be individually powered and permanently lit when the studio is occupied so that they remain illuminated should the mains supply fail. This is achieved by means of a small mains battery charger unit and battery contained within each unit with a changeover relay.

Cyclorama fittings

In all television, film and video studios some form of background will be required and this is normally provided by scenery flats or sets, or by means of a cyclorama.

Scenery flats will be erected or dismantled in the studio as productions demand but a cyclorama is a permanent feature of the studio. It can be constructed of hardboard or plywood and extends round two or three walls of the studio, curving round the corners to present an unbroken line of background with no apparent angles, on which various scenes can be painted or applied according to the production requirement.

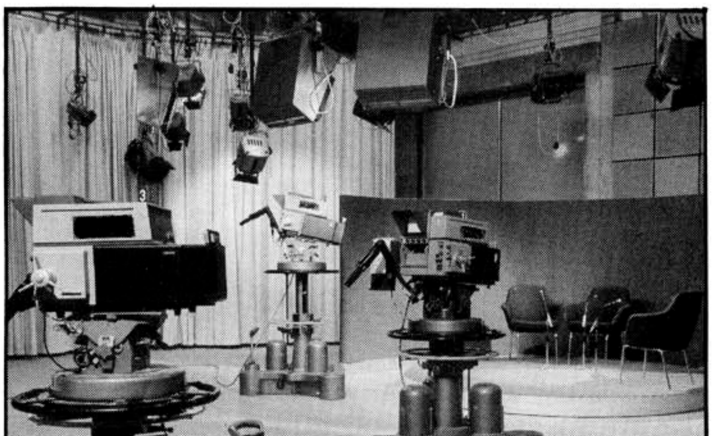
Such a construction will, however, cause serious reflections and give rise to many unwanted echoes which may even destroy the atmosphere of an intimate production, and a much better solution, where possible, is to use a curtain of suitable fabric. A curtain of this type would be suspended by a track attached to the lighting grid, and the curtain either fixed at intervals of about 9in or attached to runners on the track so that it would appear stretched or draped as required. Lightweight fabrics reflect inefficiently, even absorbing over some frequencies, and being more or less acoustically transparent, will not seriously affect the basic reverberation time of the studio as a whole.

It is quite possible to use back or front-projection on to such materials to present the scenic background required.

Storage units

In small and medium sound studios a very useful provision is that of a small storage cupboard situated on one of the studio walls. A typical size would be about 4ft square and 9in deep. If modules are being used as the acoustic treatment it could take the place of four modules and thus maintain the flush appearance of the treatment.

A shelf or two would house spare microphones and other small items of equipment, and a number of pegs could also enable the spare microphone cables to be coiled up and



Typical TV studio

housed inside the cabinet. Nothing is more detrimental to the appearance of a studio than spare microphones and cables lying on chairs and tables. They are also subject to damage or even theft.

Floor surfaces

Television studios require different floor surfaces to sound studios since a hard and absolutely level surface is necessary for the cameras to track upon, as they do not easily track on carpet. Most studio floors these days have a concrete base, and for television use these are normally covered with a ½in or ¾in thick layer of material known as a self-levelling screed. Specialist contractors are employed to lay this screed, which flows, rather in the manner of a liquid, and sets to form a hard and perfectly level surface devoid of all bumps and hollows. In most cases this is again covered with heavy duty vinyl sheet again laid by specialist contractors who carefully weld all joints where they occur and thus provide a perfect tracking surface for the cameras.

Most speech studios are carpet covered and this is normally laid on an underfelt. Various types of carpet such as haircord, woolcord or *Wilton* are employed, and as each type has a different absorbent coefficient the type will have to be decided at an early stage so that the acoustic consultant can take this into account.

Small music studios can be partially or wholly carpet covered, or part of a whole carpet can be made removable to achieve different reverb times. Large music studios usually have a floor surface of parquet, wood-block or strip as less absorption and a higher reverb time is required.

Drama studios are usually carpet covered over the dead end, and have a wood, vinyl or linoleum covering at the live end. Small sections of stone or cement are often inset to provide the various effects.

Self-adhesive carpet tiles are sometimes now used particularly as they have the advantage of being replaceable in sections where extra wear takes place, thus avoiding the cost of replacing the whole carpet. Regarding colour, it is advisable to choose a reasonably dark colour which will not show stains and dirt. A busy studio entails a great amount of wear and tear on the carpet and nothing looks worse than a light-coloured carpet which has become grubby and stained.

Decoration

And to the last item in this section, and probably the most controversial—that of decoration, or more correctly—final appearance.

The question "What is the best form of decoration?" is almost analogous to asking "What is the best loudspeaker?". The answer in both cases is "It all depends on what you want."

Every studio owner will most certainly have his or her own ideas on this subject, varying from the clean but perhaps rather clinical appearance of painted modular absorbers through the mock Texas ranch house design to that resembling a forest glade complete with a ceiling with twinkling stars which, incidentally, was requested not so long ago.

What then are the requirements? Firstly, the final appearance must be restful and unobtrusive since the artistes and users must not be distracted in any way; it must be clean and not fussy; it must be complementary to the type of production envisaged so that the users feel comfortable and at ease, and finally it must be easy to maintain.

When Broadcasting House, London, was first built two studios on the third floor were designed for specific purposes. One was in the form of a library complete with book-lined shelves and a type of Adam fireplace, which was used for talks, and the second was designed in the form of a chapel complete with altar on the back of which was projected a lighted cross, from which the morning service was always broadcast. This was the studio in which, during one broadcast, the studio door was thrown open and one of the BBC charladies announced in stentorian tones, the famous Tommy Handley phrase "Can I do yer now, Sir", for all the world to hear. Sadly, both have now disappeared and have been replaced by the modern form of painted modular absorbers. They were both eminently suitable for their purpose.

It is not, in these times of financial restriction, economically possible to restrict studios to such individual use, and all that can be done is to lay down certain guidelines which may assist in agreement being reached on a final design acceptable to all concerned.

Small studios, suitable for use by four to six persons, for talks, interviews and discussions should tend to be rather intimate. If modular treatment is used for the acoustic response these can be wholly or partially covered by the use of lightweight fabrics either stretched on frames positioned 2 to 3in in front of the modules, or in the form of drapes suspended from battens mounted at ceiling level. Suitable colours can be introduced by the choice of fabrics now available, or vision-net will provide a very attractive material if draped.

In larger studios, hessian can be utilised in a similar manner and a pattern or even a mural applied to the surface, hand-painted or by use of a spray-gun, and, if executed professionally, can result in a most attractive appearance—a forest glade perhaps?

In music studios, where the wall surfaces tend to be farther away from the performers, it is quite normal to leave the modular absorbers uncovered and merely paint the front surfaces in a suitable colour. Pastel shades of green, cream or grey are quite popular—not blue which always presents a cold appearance—and the paint should always be applied by roller or paint-pad, never by brush, which will fill up the small

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holes of the perforated panels and thus destroy the acoustic response.

Drama studios are veritable workshops, and the users under constant pressure, so that nothing must distract them, and the more unobtrusive the surroundings the better they will perform. In any case the dead end of the studio will normally be occupied by the various effects items such as staircases, water tanks, effects doors, etc, so that there will be very little wall surface remaining.

Pop studios have already been mentioned, and the final appearance can vary from straight modular treatment lit by coloured lights to hessian coverings with painted murals.

Television studios seldom require any decorative treatment whatever, other than the cyclorama already described. Generally so much of the floor is occupied by studio sets with scenery flats that virtually none of the wall surfaces are visible anyway. The acoustic treatment is functional only and is not there to provide a decorative surface.

So throughout the various types of studio, there is plenty of choice, and the final decision must be a personal one. The only criterion is that it must not upset the acoustic response and agreed reverb time.

Just one word of warning. Do not use large areas of *slotted* hardboard, particularly with fluorescent lighting. This combination produces a most peculiar spectroscopic effect which is most disturbing and distracting to the users.

Ancillary fittings

The studio now being structurally complete and all services installed, it only remains to provide the various technical fittings and items of furniture to make it a working entity. Most of these are produced commercially in various forms and the final choice will depend on the particular studio usage.

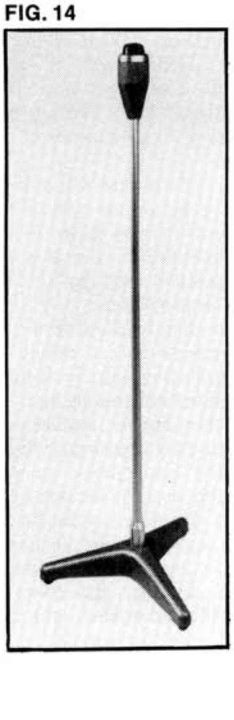
Talks tables

All studios designed for speech, talks, discussions, interviews etc, will require a correctly designed table. Tables with a hard top surface are not suitable since they reflect speech sound waves. These will reach the microphone momentarily later than the direct sound wave resulting in echo, and marring of the speech quality. Even a felt or cloth cover will not entirely remove this defect.

FIG. 13

Correctly designed tables are known as 'acoustic tables' and the top is designed to be as acoustically transparent as possible commensurate with rigidity, to allow the sound waves hitting it to percolate through without reflection so that only the direct wave is picked up by the microphone. They are usually rectangular, nominally 48 x 36in or hexagonal, thus allowing up to six persons to sit around the table at the optimum distance of 2ft from the microphone. A centre hole in the top will allow the use of a floor stand isolating the mic from the table thus avoiding any knocks or vibrations being transmitted from the table. A cardioid type mic will serve up to six persons equally and the table top should be absorbent but firm enough to permit alterations to scripts, and above all the whole table must be rigid and free from squeaks or rocking. Timber construction is preferable to metal which tends to 'ring' if kicked, and a typical commercial design is illustrated in **Fig 13.** Headphone jacks can be fitted into the rim of the table.

FIG. 14



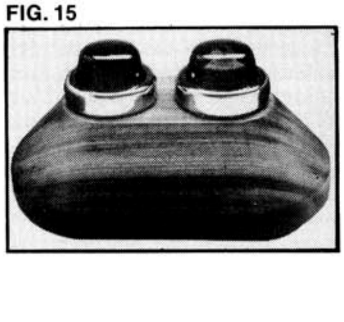
Chairs

The correct design and type of chair is most important. They should also be of wooden construction, free from squeaks or rocking, and both seat and back should be padded as they may be used for long periods. Chairs without arms are normally used by musicians and can be of the stacking variety, but when used in conjunction with acoustic tables, chairs with arms or better still the 'tub' type of chair, with an upright back will seat the speaker comfortably but firmly in the correct position and prevent him leaning back too far during the course of a transmission with consequent loss of speech quality or volume.

Clocks

Two or three clocks will be required in any but the smallest studio and these should have a face diameter of at least 12in for smaller studios or 18in for larger music or drama studios. One clock is normally sited on the studio wall over the observation window to the control room so that it can be observed while talking to the producer prior to the transmission. Many programmes are commenced on a time cue, ie, "Go ahead in 10 seconds from now" and any studio personnel should be able to see at least one clock without turning round and thus changing microphone position.

FIG. 15



The clocks can be of the synchronous type with a 'seconds' hand, or the 'slave' type driven from a master clock with a 1 or 2 second impulse. The latter type is preferable since ideally all the clocks should remain in step at all times. Quartz controlled clocks, either digital or analogue, are now coming into use but these also can vary one from another.

Whichever type is used clocks should have a clear and unfussy face for quick and easy observation. Black hands on a white face or the reverse are best since it is the correct time that is required not an example of the clock designers art. The clocks should be mounted at a height of 6ft in smaller studios and 8ft in larger studios.

Cue and signal lights

Additionally to the wall mounted signal lights described under structural fittings, table cue lights will be required for talks purposes and floor-mounted lights for drama and music usage. Examples of standard commercial types are shown in **Figs 14** and **15.**

Usually only a single light unit is required for table use and it is placed on the table adjacent to the microphone as a visual 'go-ahead'. In drama studios the floor-stand light is similarly placed alongside the microphone stand and the cast grouped around in a circle. For music purposes where light cues are required the floor-stand light is placed near to the orchestral leader or conductor. There can, of course, be several individual cue lights for different sections of cast or performers or one master cue connected in parallel with the wall mounted signal lights.

In many broadcasting concerns a standard method of signalling is for the desk operator to 'flash' the cue-light for 'silence' or 'stand-by' and then give a steady light for 'go-ahead'.

Microphone stands

Three types of mic stand are available commercially and the varieties are legion. Table stands, floor stands and the 'boom' type may all be required according to the studio usage.

The table type should be reasonably small but sufficiently heavy or weighted so that it is not pulled off the table by the weight of the cable during the middle of a broadcast or recording **(Fig 16)** as has

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happened on more than one occasion, and a floor-stand should be adjustable in height to suit the user but essentially firm and steady. A floor-stand with a heavy flat base is preferable to a stand with tripod legs as these often present a hazard to performers but sadly the former have tended to die out in favour of the latter.

Boom stands are available in all sizes with boom lengths of from 6ft up to 12ft for large music productions.

Acoustic screens

These items are very useful for separating groups of performers or musicians—usually the drummers, singers or solo artistes—so that a better mic balance may be obtained. Full height 2m high x 1m wide or half height 1.3m x 1m are available and these can be obtained absorptive on both sides or with one side reflective, with or without windows or observation panels which should be of thick perspex and not glass for obvious reasons.

Most of these screens are fitted with castors or small wheels for ease of movement and are designed to be stackable, so that when not in use they can be pushed together against a studio wall and not take up valuable studio floor area.

Transmission loss can be up to 20dB particularly at middle and higher frequencies, and several screens can be placed together to form an enclosure with a roof as a temporary isolation booth. In music studios a permanent booth with a transmission loss of up to 35dB is often incorporated in the studio design.

Rostra

In large music studios it is quite normal to tier the orchestra on a full or half set of rostra so that a better musical balance may be obtained and to give all the orchestra a better view of the conductor. These are very stout wooden boxes, ie a top and four sides, about 4ft square and of varying height from 9in to 36in, which are pushed together to form the desired configuration.

The timber tops of these rostra must be very solid and of at least 1 or 1¼in thick timber as they have to withstand a very considerable weight, even grand pianos, and must not flex or bend under the weight. Crossbracing of the top will help to prevent this.

Safety transformers

The use of electrically powered musical instruments is becoming

FIG. 16

much more popular of recent years. Regrettably, either by bad design or misuse, some of these are almost lethal in use and present a severe hazard to the user, of which he is sometimes unaware. Many accidents and even deaths have occurred and it is the duty of the studio owner to see that such accidents do not occur on his premises. Should such an accident take place the least he can expect is much unwanted publicity. Indeed most professional studios now exhibit warning notices that such instruments must not be plugged into the studio mains sockets without reference to the engineer in charge.

Such accidents may be eliminated by the use of a safety transformer which is a specially designed unit with double windings, ie the separate secondary winding is entirely isolated from the primary and with an earthed shield between the two windings which will safely earth any fault destroying either primary or secondary insulation, and blow the protective fuse. Note that an 'auto transformer' is *not* a safety transformer and secondly that only one instrument should be fitted to each transformer. The transformers are interposed between the musical instrument and the studio mains sockets.

Miscellaneous items

To complete the studio the following items will be necessary:

Ash trays if smoking is permitted; water jug with clean glasses and fresh water; fire extinguishers, carbon-dioxide or inert gas is necessary for electrical fires; wastepaper buckets; headphones for talkback during transmission or recording; script racks for use on the studio table which incline the script at a suitable angle allowing the speaker to address the mic directly; piano stool; padded bass stools for bass and cello players as normal chairs are too low for their comfort; and bass blocks to accommodate the spikes fitted to basses, cellos, etc, to prevent them from damaging the floor, a 12in square of wood or blockboard or even *Celotex* should be provided so the spike can be dug into that instead of the floor.

External areas

The studio is now complete and with the addition of the technical apparatus and microphones, ready to go to work, but perhaps a little thought might be given to ancillary areas outside the actual studio which are necessary if not essential to a well-run concern.

Rest rooms which can be separate rooms or an area where performers can sit, rest, enjoy a quiet smoke or perhaps a cup of tea or coffee when not performing in the studio. Some easy chairs and a few occasional tables are all that is necessary. Further recreational facilities can be provided in the form of a coffee bar or canteen. Not many studios will require a canteen, but the provision of a tea or coffee making machine, perhaps in the rest room, is almost an essential. Many performers will have travelled long distances to the studios, and have breaks between recordings. Nothing is more comforting than a cup of tea or coffee, albeit from one of the many machines on the market today.

Make provision for a public telephone, possibly coin-operated, adjacent to the studio. Nothing is more frustrating to a producer than to have one of the performers disappearing for some time just before the recording or transmission to find out whether the expected new arrival has indeed arrived and that mother and baby are both doing well.

Toilet facilities with wash basins and towels should also be sited near to the studio and not at the other end of the building and should be well signposted for obvious reasons.

Where there are two or more studios, a practice room is helpful in which singers and solo artistes can rehearse in privacy and comfort. A well-lighted mirror and shelf is much appreciated for final make-up and hair-tidying purposes. Where public are admitted the performers may even wish to change their clothes for the actual recording or transmission. Do make provision for the safe storage of hats, coats and handbags and brief cases etc. These should not be brought into the studio and hung onto microphone stands, cue-lights etc. It does not do the microphone or cue light, or even the coat any good at all, particularly if the cue light is switched on accidentally.

A workshop, maintenance room, storage area, and, in television studios, scenery storage facilities, also need to be provided and all of these should be reasonably adjacent to the studio(s) for quick action should a studio fault develop.

Conclusion

In the course of this series an attempt has been made to throw some light on the very many requirements and complexities inherent in the successful design of a modern studio. A studio can be used for so many purposes that many problems will invariably arise during the construction, but with common sense and a little patience these can always be overcome. It is of as much advantage to the design consultant as to the studio owner to produce a satisfactory result and if this article has brought to light or even jogged the memory of anyone concerned with the design of a new studio then its object will have been achieved. Undeniably, every design consultant will have his own ideas as to what constitutes a perfect studio and equally many designers will undoubtedly disagree with one or more of the items discussed in this article. However just remember 'one cannot please all of the people all of the time'. If this series results in some small way in better studios being built then it will have served its purpose. ■

Thanks to CTVC Studios at Bushey, Herts, UK, for the provision of studio photographs featured in this series.