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Tape Recording and Hi-Fi

FREDERICK OUGHTON



Tape Recording and Hi-Fi

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Tape Recording and Hi-Fi

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Tape Recording and Hi-Fi

FREDERICK OUGHTON

With Photographs and Diagrams



COLLINS
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PREFACE

The Slave under the Bed

Each year several thousand tape recorders are bought for prices ranging from ten to seventy guineas. Many of them barely record the sound of family chatter or baby's first words before being put under the bed and forgotten.

If you bought a slave in the market-place you would not tell him to wash the dishes and then order him to hide himself away. You would make full use of him all the time. But that is what people do with tape recorders. No sooner have they filled one spool with sound than they believe that they have reached the limit of what the machine will do for them.

The author of this book is slightly different. Ten years ago he paid £15 for a tape recorder. Instead of pushing it under the bed he made the wrong electrical connection and blew it up. As soon as the smoke and dust cleared he acquired another recorder and some extra equipment, then set off on a one-man expedition into the world of fine sound reproduction on tape and disc. Only a few years later he was producing recorded programmes for overseas distribution and is today regarded as an authority on tape recording.

Today, with every single facility available, perfect sound is within your reach. In a world of motor horns and pneumatic drills, it represents the kind of oasis needed by modern man.

There is, however, a knack to it. This book tells you how to get the most out of your tape recorder and hi-fi system. It is also an introduction to the adventure of sound.

1

MAGNETISED BY TAPE

Tape is like a slate. You can write on it, erase, then write again. It can capture and hold the magical atmosphere of a concert, the inflexion of a voice. When you hear a recording many months or even years after it was made, your memory is stimulated and the original pleasure is again with you.

If you are twenty now and you want to record something which you think you would like to hear when you are seventy, this can be done at the touch of a switch. Recording tape does not fade. It has been tested to the limit and it will last several lifetimes.

You can use it to create an exclusive library of jazz or symphonies, talks or debates. As a teacher it is in regular use in schools, colleges and in industry. If you are in business you can dictate your letters tonight and take tomorrow morning off, because your secretary will be able to type from the tape. Tape has so many uses that this book could be filled with a list of them.

What *is* this stuff called tape?

The majority of recorders now use a standard tape $\frac{1}{4}$ in. wide. It is polished on one side and dull on the other. The dull side is the important side. It wears an emulsion coating composed of an active material, known as an oxide. The underlying principle of all tape recording is magnetism, and it is this which acts on the oxide.

While magnetism is an invisible force, it is not very difficult to understand if you think of it as being a unit of energy. When you make a tape recording you are actually

MAGNETISED BY TAPE

placing units of energy on the tape in a variety of different patterns. These are “imprinted” on the oxide but still invisible to the naked eye.

When you play the tape back and hear the sounds you have recorded, all these units of energy locked in the oxide spring to life again. Aided by electronics, they make sounds.

The actual recording process is quite simple. Here it is in two steps: *Step One*: sound is changed into an electrical vibration when you use a microphone or other means of feed to the tape recorder. *Step Two*: vibrations are pushed through the recording head of your machine, and then pass on to the tape, creating the “pattern” which the recorder will “read” when you play the tape back again.

In other words, the feeding-in process is reversed in order to give you the sound which you originally recorded.

2

THE MAGIC BOX

These days tape recorders come in as many shapes and sizes as women's dresses, but, like dresses, they have one common function, to do a job of work. If dresses are meant to make the female form attractive, then a tape recorder should make beautiful sounds . . . but it depends on what you choose to record.

Here are the essentials of any recorder:

The Motor

There are three types, two-pole, four-pole and hysteresis. Two-pole motors are no good for hi-fi, and you should buy a recorder with a hysteresis-class motor if you want to obtain the finest results. It is the motor which drives the tape past the recording and erasing heads, so it must not suffer from any aberration in speed. In operation it should be completely silent.

Recording and Playback Heads

Although they are termed "heads", these small assemblies of metal, foil and wire are the heart of the machine. In some machines there are separate heads for recording, erasing and playback; in very many ordinary commercial models this is reduced to two heads, one for the erasing and one for the recording.

Erasing Head

This is for wiping off sound which is no longer wanted. One of the advantages of tape recording is that you need

not really erase old sounds. All you do is record *over* them, and this obliterates them completely. But later, when your interest in hi-fi blossoms, you will insist on having a "clean" tape, and this will guarantee against the possibility of "print-through" of the old sound track.

Amplifier

In every tape recorder the amplifier is a jack-of-all-trades and master of everything. Not only does it increase the incoming sound (or "signal" as it is called in technical jargon) to a level where it can be received by the tape, it also energises the erasing head and carries out all the work necessary for the playback of the recorded tape.

These four basic component parts of every tape recorder are segregated in two different sections: (1) *the tape deck*; (2) *the amplifier unit*.

Both are neatly enclosed in the same cabinet, or housing, but they can be bought separately. The reason for this is that many people design their own recording and hi-fi systems. One component may "match" any individual component made by another manufacturer, and constant testing and trying out is a habit to be encouraged if perfection is your ultimate aim.

Apart from testing different component parts, there is another reason for this division. Many people like to have a hi-fi console and speaker system to tone in with the decor of a lounge or study. It is possible to take a piece of antique furniture—a linen chest, for instance—and build into it the amplifier while the speaker is accommodated in a converted wardrobe, suitably modernised but without loss of eye appeal.

Like colour television receivers, tape recorders started off with a profusion of control knobs, buttons and switches, but over the years the manufacturers have reduced these to a minimum. Certain controls remain

CONTROLS

indispensable. The essentials are: a *brake* for the tape (quite a complicated piece of apparatus, because it must first slow down the tape, then bring it to a halt without breaking it); the *tape speed control*, usually with three positions, $1\frac{7}{8}$, $3\frac{3}{4}$ and $7\frac{1}{2}$ i.p.s. (inches per second), and on the more advanced semi-professional and professional models, 15 i.p.s. (for the top quality recording of music); *recording and playback control*, embodying a *fast-wind* position; the *tape transporter system*; the *recording and erasing heads*.

If all these component parts are working efficiently, then it should be practically impossible to make a bad recording, given a basic knowledge of how the machine is operated. But there are many degrees of good recording; enthusiasts cultivate very high standards, well up to professional level. When you use a tape recorder you are handling a piece of precision machinery. Mishandled, it will not give out anything like what it receives. It follows that you should understand the process of transferring sound to tape.

We have already mentioned the business of some recorders having separate recording and erasing heads. Other machines also have an arrangement of recording and playback heads which make it possible to listen almost simultaneously to the recording *as it is being made*. This is because the tape travels from the recording head to the playback head, and the latter "listens in" to the recording a split second after it has been put on tape. This is very useful when you are recording a "once only" event and need to check that the machine is doing its job.

In itself the recording head is perfectly simple. It is made from an iron alloy in the form of a ring, bent into a semi-circular shape. A wire coil is then wrapped around the two halves before they are placed together. This creates two very narrow gaps. In one of these is placed

THE MAGIC BOX

a piece of foil only .00025 in. thick, and it is across this narrow gap that the recording tape moves and picks up the sound impulses fed to it by the microphone and amplifier or the lead from an AM/FM tuner (see Chapter 8).

If the recording head is "dirty" (caused by minute particles of tape oxide adhering to the slot), or the motor-drive is slightly erratic, the playback suffers from what is graphically described as "wow and flutter." It is surprising how much a minute difference in pitch, caused by running speed or drag on the playback head, can irritate the listener, and while there is no precise measurement to gauge how much should be tolerated, it should not be more than three per cent. The majority of commercial machines made for amateurs have an inherent wow and flutter between two and three per cent, but in most cases this goes unnoticed. The real recording and hi-fi enthusiast seeks perfection, and for that reason keeps a constant check on such things.

A great deal depends upon the motor, which is the activator of the drive system as far as the tape is concerned. After the tape leaves the loaded spool on its journey to the tape-up spool on the other side of the deck, it passes through rubber-faced rollers, a capstan and a pinch-wheel. Acting in unison, these three should maintain a firm tension for the section of tape which is about to be recorded. Some recorders have three motors, one for each of the spools and a third for the capstan, but in cheaper recorders only one is used.

In the switching system the most important of all the controls from an operating point of view is the *fast-rewind*, which means that the tape can be moved very rapidly from one spool to the other. The fast-rewind should be reliable and trustworthy to prevent tape spillage.

SPEED CONTROL

Many mass-produced tape recorders have a single multiple-position switch for the recording, playback and fast-wind controls, and these positions and functions are defined by easily understood symbols.

Speed Control and Recording

One of the peculiarities of tape recording is that the slower the tape moves across the recording head, the lower the quality of the actual recording. In music recording, it is important to differentiate between these different qualities. The faster the tape moves, the higher the quality, hence the presence of the 15 i.p.s. position on the more expensive recorders.

When a tape recorder is used solely for speech recording, quality does not matter very much, but if you are recording an important symphony concert, a jazz festival or a recital of some kind, and you need to achieve as professional a tonal quality as possible, then speed *does* become a primary matter. The majority of recording and broadcasting companies use a tape speed of 15 or 30 i.p.s. for this very reason. One of the difficulties is that it is often impossible to record a lengthy symphony on one side of a reel of tape, because the tape is not long enough for the job. Unless you happen to be using two recorders to "bridge that gap" when spool number one runs out, you are likely to have breaks in the recording. However, a speed of $7\frac{1}{2}$ i.p.s. is good enough for most music, and with a little contrivance you can turn the spool over in between movements or during the interval.

The following table shows the most suitable speeds for the various types of recording:

VOICE RECORDING	(Grade One). For dictation and messages. $\frac{15}{8}$ i.p.s.
VOICE RECORDING	(Grade Two). Slightly better quality,

THE MAGIC BOX

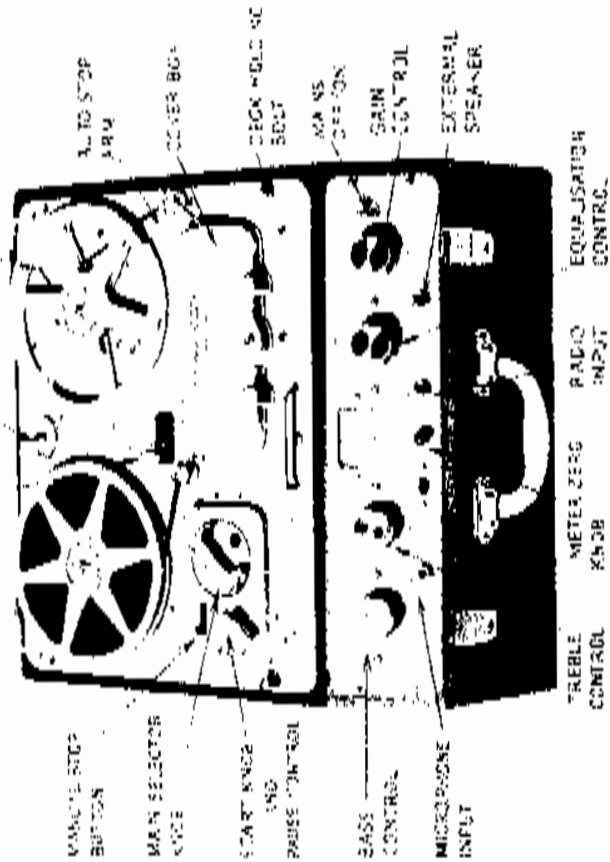
	suitable for taped messages to friends, etc. 1 $\frac{7}{8}$ i.p.s.
MUSIC AND SPEECH	Sub-standard but suitable for general uncritical listening; not adequate for hi-fi. 3 $\frac{3}{4}$ i.p.s.
MUSIC AND SPEECH	Hi-fi standard. 7 $\frac{1}{2}$ i.p.s.
MUSIC AND SPEECH	Professional quality. 15 i.p.s.
MUSIC AND SPEECH	Professional quality, also used for tape editing. 30 i.p.s.

When you are working with tape, particularly when you are editing, it is often necessary to locate a particular section of the recording for editing purposes or because you wish to hear a certain passage again. To help you find it, the tape recorder is fitted with a numerical mileage-type indicator or a digital-counter clock. Tape decks with neither device generally possess a graduated scale which is embossed on to the surface directly underneath the take-up or the feed spool. One of the drawbacks to the scale system is that when tape is wound on to the spool the tension may vary, and so it is often difficult to discover any given passage with precision.

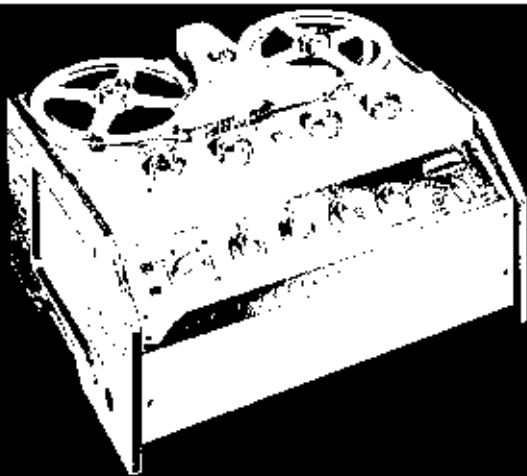
However accurate the indicator, it is not always absolutely "spot on", and so you have to play a little of the tape before finding the passage you want. To help you the majority of recorders now have a *pause* control, which enables you to halt the tape momentarily without the necessity of operating the main on-off switch. The pause control is usually incorporated in the dustproof cover which goes over the recording heads, and it is especially useful when you wish to record a passage from one tape and copy it on to another machine for the purposes of a compiled programme (for hospitals, dances, discussion groups, etc.).

It is unwise to operate the pause control for very long

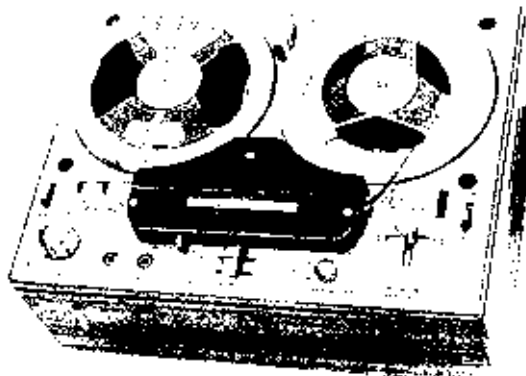
SPEED CHANGE KNOB TURNS COUNTER BRACE ADJUSTMENT SCREW



Robustly constructed, good utility tape recorder for house and amateur studio use.



Medium priced tape recorder, simple to use, streamlined in design and suitable for home use.



Stereo tape recorder in the upper price-range.

AMPLIFIERS

periods, because a frictional heat builds up quickly in the driving mechanism and this can cause a seize-up.

After lengthy technical development most of the tape recorder refinements have probably reached their zenith. The most recent is the automatic stop device, which cuts out the driving mechanism when the end of the tape is reached. These come in two varieties, the *automatic*, in which a lever rests on the tape and springs into action when the tape ends, and the *electrical*, which is activated by a length of foil on either end of the recording tape.

Not all recorders are equipped with an automatic stop device, and they are not found on the cheaper ones.

Amplifiers

Let's take a closer look at the amplifier, the second part of your tape recorder.

An ordinary conventional amplifier comprises the *on-off* switch, which controls the main power supply; a *signal level indicator*, known as a VU-meter (volume unit), to show the size of the load or "signal" reaching the tape and to safeguard against over- or under-recording; various *tone controls* to regulate the treble and bass response during playback; the *amplifier* itself, which regulates incoming signals and outgoing sound; a *distribution board* with sockets for leads used in a variety of ways, including hi-fi reproduction on extension speakers; a *selector switch* and a *volume control*.

Basically, then, the deck of the recorder is the *mechanical* section while the amplifier is the *electronic* section, the "brain" of the equipment. One depends upon the other, but of the two it is the deck which undergoes most of the wear, because it is here that friction occurs. In the well-built and well-ventilated machine the amplifier looks after itself to a considerable extent, and apart from the occasional circuit break or other disturbance caused usually

THE MAGIC BOX

by heat which builds up during use, the amplifier requires very little in the way of maintenance. Many modern recorders incorporate a small fan which keeps the air moving inside the machine, thereby avoiding the melting of wax and wires in the circuit. It is not unusual to be able to use a tape recorder several times a week for three, four or even five years before it is in need of servicing.

It has been said that anybody can make a recording by pressing a button and twiddling a few knobs.

It has also been said that the difference between *that* sort of recording and the high-quality one, obtained when you know how to get the best out of your machine, is all the difference between the photographer with the cheap box-camera and the artist with precision-built equipment.

After all, the difference is contained in one word: technique.

USING THE MACHINE

In spite of the *mystique* which now clouds tape recording, the machine is one of the simplest pieces of equipment to operate—simpler, in fact, than a car. The worst that can happen is an accidental erasure of the very recording you wanted to preserve, or the occasional snapping of the tape itself due to clumsy rewinding or braking. This latter minor accident should not happen after you have had a few hours practice with rewinding. Tape is strong stuff. Unless it is mishandled very severely, it will not break. It can be crumpled up, jumped or stamped on, tossed through a window (some recordings make you feel like doing just that), and still it will play. Normally, of course, you must take care to store it properly in its cardboard or metal container, well isolated from any strong magnetic field, (your television receiver, for instance) and away from heat which causes it to curl.

Just to show how durable tape really is one manufacturer passed a length of it through boiling water then over a block of ice, and still it played.

Now that you have bought your tape recorder, which generally comes with a free spool of tape and an empty take-up spool, and you have opened the lid, carefully checking the voltage, you stare at it . . . completely mystified.

Where do you start?

First of all, load the tape. You have two spools, one full and one empty. The full one is slipped over the *left-*

USING THE MACHINE

hand spindle. If you waggle it about, it will lock automatically on the base of the spindle.

Unwind some of the tape until it reaches the right-hand spool, then drop the slack into the space *between* the recording and erasing heads and the small felt pads, which will hold it against the recording head when you switch on. It should fall quite naturally into position as far as the disengaged capstan and pinch-wheel are concerned. There is nothing very difficult about this. After a few attempts you will be able to do it in a jiffy.

At this stage the only thing you can do wrong is to have the tape "inside out"—that is to say, with the shiny side against the heads. If this happens you will be unable to record. It is the dull oxide-coated side which must face the recording head.

When you switch on, the switch itself should be at the *Record* position. As soon as the machine is ready for use the signal-level indicator will light up. This applies to the "magic-eye" variety. If the signal-level indicator is a meter-type, known as a *microammeter* or *VU-meter*, a pilot light situated on the deck or the distribution board of the amplifier will flicker to show that the circuit is now warmed up.

The microphone (see p. 38) should now be plugged into the appropriate socket on the deck or amplifier unit. You can now check the recording level by turning the appropriate knob (generally incorporated in the *Volume* control). Since you are probably making an experimental voice recording to try the new machine out, you can, by speaking into the microphone, test the level *before* the tape starts going round. This will give you some idea of the "balance" at which the recording should be made. Try various distances from the microphone, and always speak normally, do not shout or whisper.

From now on, until the recording is completed, the key

BALANCE

to it all is the signal-level indicator. As we have mentioned above, there are two main types: (1) the "magic eye" and (2) the microammeter.

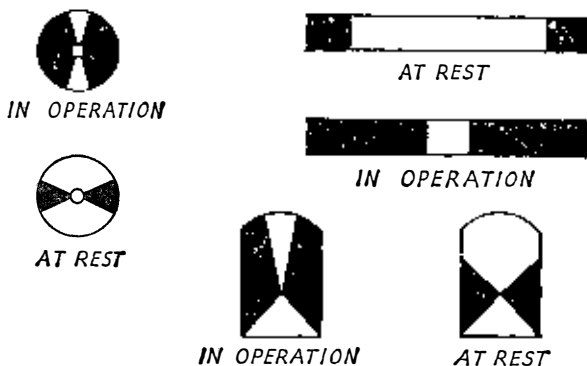


FIG. 1. Various types of "magic-eye" recording-level devices found on the majority of low priced tape recorders. The principle is the same in each case.

"Magic Eye" is a development of the tuning device found on many radio receivers. (See fig. 1.) When in use with a tape recorder the two halves of the "eye" should never quite meet. If they *do* meet and overlap the result will be an unpleasant and harsh distortion at peak levels of playback.

Microammeter consists of a dial and a needle, and by using this a more restrained and subtle recording is obtained, because it is possible to keep a very accurate check on the recording level. Most of the dials show a thin red line, beyond which the manufacturers do not recom-

USING THE MACHINE

mend recording, because this leads to overloading and distortion.

Of the two, the microammeter is preferable, because it has an acute sensitivity, whereas the "magic eye" is often difficult to watch with any accuracy, being comparatively small and often inset into the distribution panel of the amplifier. When you use a microammeter you are using a professional method which is in widespread use in broadcasting, television and in commercial recording studios.

Before making a recording you could do worse than experiment with the microphone, making varying degrees of sound. Keep an intent eye on the signal-level indicator and obtain the "feel" of the instrument.

When you do start to make your first recordings, always remember that it is much better to under-record than pile on all the strength you can find by turning the control to the maximum extent. The reason for this is that the amplifier will make up for any loss when you play the tape back. Over-recording leads to harshness and distortion, and far from "getting everything" on tape, you wind up with much which is undesirable from a hi-fi point of view. Ideally, the signal-level indicator should move to about half of the total capacity when the highest peak is reached.

Immediately before you start making your recording turn the signal level control down to zero. When a few inches of tape have passed over the recording head, gradually turn the level control up to the required position *before* you commence recording. This is simple enough if you have checked the level beforehand. The reason for allowing a few inches of tape to go through is that when a machine starts, there is inevitably a slight slackness in the tape tension. This automatically adjusts itself as the pinch-wheel and capstan come into action, and it avoids the possibility of a jerky start on the recording itself.

After you have finished making the recording, the same

RECORDING SPEECH

routine should be followed, but this time in reverse. The reason this time is to avoid putting an irritating "click" on the tape when you switch the machine off. The "off" switch generally transmits an audible click, which has to be erased if you wish to create an immaculate recording. It can happen that the click follows hard on the heels of the recording itself, with the result that you may delete some of the speech or music in your efforts at locating that irritating end-noise and removing it with the erasing head.

When you have made your first speech recording, play it back and listen with a critical ear. During the actual recording you may have experimented with the controls, resulting in nerve-wracking bursts of sound or else a fading away of the signal. In the case of ordinary speech tapes, the control can be left as it is once you have set it. When you record the speech of more than one person, and different people are at varying distances from the microphone, some manipulation may be necessary in order to create signal gain and pick up and equalise the words of those who are farther away from the microphone than others. Much, of course, depends upon the microphone used (see Chapter 4).

Although I hope that you will not stop at the purchase of a tape recorder, you may want to do some direct recording from a friend's gramophone or radio. Most of these have outlets for extension speakers and it is a simple matter to connect your recorder to these for non-specialist recording. It is however obvious that these recordings will not be satisfactory, and it is only through the acquisition of equipment discussed in the following chapters that you can hope to achieve hi-fi results.

Of course, the one obvious question is "How long will a tape play?" This is like asking "How long is a piece of string?" It depends upon the size of the spool, the running

PLAYING TIMES—DUAL TRACK

Tape Length	$1\frac{1}{8}$ i.p.s.	$3\frac{1}{2}$ i.p.s.	$7\frac{1}{2}$ i.p.s.	15 i.p.s.
600 ft.	128 min.	64 min.	32 min.	16 min.
900 ft.	192 min.	96 min.	48 min.	24 min.
1200 ft.	256 min.	128 min.	64 min.	32 min.

Single track times are obtained by halving the above figures.

TAPE ECONOMY

speed and other factors. Regardless of the length used and the job for which it is utilised, tape is still a most economical raw material, because you can use the same length over and over again, placing a new recording over one which is no longer required. It is, however, false economy to believe that you can "save" tape by recording certain things (music, for instance) at the slower speeds. This can lead only to disappointment.

Opposite is a convenient table to show the playing times of the standard spools of tape.

Among the latest technical developments is the four-track recorder, and this, of course, gives you *twice* as much recording and playback time as the standard twin-track machine. The four-tracker has a special switch to ensure that you remember to transfer the recording process to the new track. In practice it works out like this: you record tracks one and four (on the outer perimeters of the tape) in the normal way, as though you are using a twin-track machine. You then operate the special switch, which means that you will now record on tracks two and three. (See fig. 2.)

In time you will develop your own "tricks of the trade", but among the first to master is the fastening of the end of the tape to the take-up spool. Some enthusiasts favour a rather difficult slotting operation whereby the tape is anchored securely to the take-up spool, but this has the disadvantage of causing a tape breakage if you happen to be on a fast rewind and fail to act quickly and switch off at the right moment. Other users of recorders prefer to attach a short length of adhesive tape to the end of the tape. Perhaps the best and safest method is merely to give the end of the tape a few turns on to the core of the spool, and then let it grip under its own tension. This also disposes of the breakage hazard.

As you now know, tape is tough, resilient stuff; yet it is

USING THE MACHINE

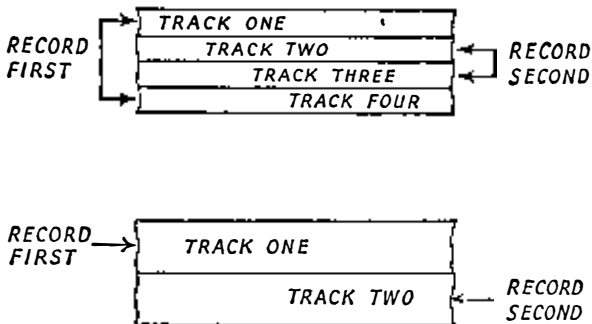


FIG. 2. Four-track recording tape is economical, and accepts twice as much material as twin-track. This diagram shows the recording sequence. Four-track recorders have special heads of fine tolerance. Twin-track (lower fig.) uses only the upper and lower halves of the tape.

still quite easy to cut and join together again. An accidental breakage can be repaired in a matter of seconds.

To join two ends of tape, whether as a repair or as part of an editing process, you have the choice of two methods. The first is by *splicing*, the second is by *welding*. Splicing is reckoned to be a more or less temporary measure, whereas welding is permanent.

But why should you want to cut tape at all? Primarily, for reasons of expediency when you are editing. This means that you can take one passage from one tape and add to it a recording from a second tape. Supposing you are sending a message tape to a friend overseas. After you have finished a passage from the message and you want him to hear some kind of recording which is currently on a different spool, you break off the message, remove the

SPLICING TAPE

first spool from the machine, and play the second one until you locate the required passage. You mark the beginning and the end of the desired passage with a crayon or a chinagraph pencil on the *polished* side of the tape. This tape is then lifted off the machine.

To splice one length of tape into another length you will need a sharp razor-blade (the single edged version is best for this job), or non-magnetic scissors (available from dealers who specialise in accessories) and a roll of splicing tape, which costs only a couple of shillings.

You now locate the exact position in your message tape where you wish to add the piece from your library tape, and cut straight through it. It is always a good idea to leave some "freeway" to accommodate the cutting. Now take the end of the library tape and the end of your message tape, ensuring that the polished sides face outwards and the ends overlap by about $1\frac{1}{2}$ in.

Put the ends together, allowing for overlap, with the dull side facing downwards on a perfectly flat surface (a small piece of glass or mirror comes in useful here). Cut off a short length of splicing tape and press it down over the severed ends. Make sure that you have been sufficiently generous with the splicing tape to allow for tension and a good firm grip.

One of the basic criteria of a good splice or joint of any kind when using magnetic tape is that it should be completely noiseless. You will quickly discover whether you have achieved this when you play the finished tape back. The beauty of using splicing tape, as against welding, is that a noisy join can soon be remedied by peeling the splicing tape off and re-doing the job. Once you get used to it, this takes only a few seconds.

Some novices believe that ordinary transparent adhesive tape will do as well for making joints, but it is completely unsatisfactory, and it can do great damage to the record-

USING THE MACHINE

ing and erasing heads of the machine. The trouble is that it often contains traces of adhesive on its non-sticky side, and these clog the heads as the tape passes over them, whereas splicing tape is made especially for the job with a "dry" adhesive. With its narrow aperture the recording head is one of the most delicate parts of the machine and it should be treated with care.

The more permanent method of joining two tapes together is by welding. Once this has been done properly the ends will never break, despite sudden stopping of the machine when on a fast-wind and other tensional strains.

Welding is done with one of two solutions, depending upon the type of recording tape you are using—P.V.C. (polyvinyl chloride, a plastic substance used as a base for some tapes) or cellulose acetate. It is advisable to take the tape to the dealer when you buy the solution just to be sure.

The welding operation is carried out on a special metal or plastic jig, obtainable as part of a kit in which both of the solutions mentioned above are included as a matter of course.

Assuming that the cuts have already been made in the tape, the two pieces are now placed in the wide groove of the jig. It is important to note that the dull side is uppermost, a reversal of the splicing procedure.

Using the cutter supplied with the jig, trim the tape ends to forty-five degrees. This is quite simple, because the jig has a marked graduation and it is impossible to make a mistake with the angle required.

The appropriate solution is now applied with an artist's brush to the end of the left-hand tape for approximately $\frac{1}{4}$ in.

Take a clean rag (one without lint), wipe the coated section of the tape, and you will find that the oxide coating will come away with the solution.

EDITING TAPE

Now put a second coating of the solution on the de-oxidised length of tape and lay the other tape over the end bearing the solution. Press it down very firmly for about one minute, after which the welded joint should be perfect.

Before putting the welded method into regular use, it is a good idea to practise with pieces of spare tape until you are quite sure of yourself, especially with regard to the distance between the join and the ending of one recording and the recording to be joined.

There is yet another rather more elaborate method of editing tapes, which does away with the physical cutting of the tapes themselves. This entails the use of a second recorder.

The editing is done electronically; that is to say, by creating the edited tape on the second machine and operating the "slave" machine as a feed, taking whatever is required from the original recording. It has the advantage over the other two methods in that you can fade in and fade out the required passages, and if this is done skilfully and with proper timing the finished tape has a professional sound to it.

As far as connections between the two machines are concerned, all you need is an ordinary screen lead with a jack-plug on either end, one connected to the output of the "slave" machine, the other to the input of the machine on which the edited tape is being created.

When this method is used, the balance of the second machine must equate exactly with that of the "slave" machine. This level is quite simple to find if you monitor a dummy run on headphones before actually making the recording copy. Superior to the headphone monitor method is the tapping into the circuit of a loudspeaker unit, because this gives a better idea of the strength of the signal as it flows from one machine to the other.

USING THE MACHINE

Editing tape recordings on two machines is, however, an advanced form, and one which demands some skill, though it should be within the scope of the amateur who wishes to create recordings suitable for hi-fi reproduction.

When you buy a spool of tape you will find differently coloured transparent tapes, one on either end. These are known as *leader tapes*, and they are non-magnetic, serving much the same purpose as the "margin" of a gramophone record to indicate the point at which the recording commences.

Leader tapes can be bought separately for splicing on to or into your own tapes. They can be utilised for library coding or to separate associated recordings on the same spool.

On commercial pre-recorded tapes opaque *marker tapes* are used on which the title is printed, and these are also available to the amateur for the purpose of titling recordings you want to keep. A ballpoint pen is the best way of writing on them. Another use for marker tape is as an indicator of a particular passage in a recording, and it shows up better than crayon or a chinagraph pencil when the tape is in motion. You can stick a short length of it to the polished side of the tape, where it can be immediately seen. The only drawback to this is that it thickens the tape for the duration of its length and sometimes creates a slight aberration in the playback. However, as a purely temporary measure when you are editing, it is very useful.

Keeping your tapes tidy in their own individual containers is a good habit to cultivate. As your collection of recordings grows, a card index or else a tabulated list should be maintained, because nothing is more irritating than trying to locate a certain tape in a hurry, and not knowing quite where it is until you have played them all.

CLEANING THE TAPE

It has been said that dust is non-injurious when it is in contact with magnetic tape, but this is partly wrong, because microscopic particles do work their way into the coil regardless of how tightly wound it happens to be on the spool, and in due course they can reach the recording, playback and erasing heads, ultimately creating a distortion which has a curious habit of building up. When this happens the dirty heads should be lightly brushed with methylated spirit or carbon tetrachloride. The latter is best, because methylated spirit has a habit of melting the shellac used by some manufacturers when the heads are finished off. Make sure that no surplus fluid is left on the heads and allow a few minutes to dry. There is on the market a preparation known as "Klenzatape", comprising a specially-prepared tape with a soft surface and a bottle of special solution, which is sprinkled on the tape. The tape is then run through in the usual way, and it removes any dust particles or oxide deposit.

The hi-fi hobby has during the past few years been enhanced by the introduction of pre-recorded tapes. While expensive in comparison with an LP disc, they are, nevertheless, first-rate value for money, because you often receive a longer playing time. They are made direct from the edited master-tape of the actual recording session. Stereo tapes are also available, and here again they are technically more perfect than their counterparts on disc.

One important thing to bear in mind about recorders and tapes is that while any recorder will make a recording, not every machine will make a *good* recording, despite the fact that manufacturing standards are high.

Like the machines which use them, tapes vary in quality, but "cheap tape" never interests the really knowledgeable amateur. Cheap tape crinkles and snaps easily, and is more trouble than it is worth. The standard brand makes are the best, and any dealer will show you the complete

USING THE MACHINE

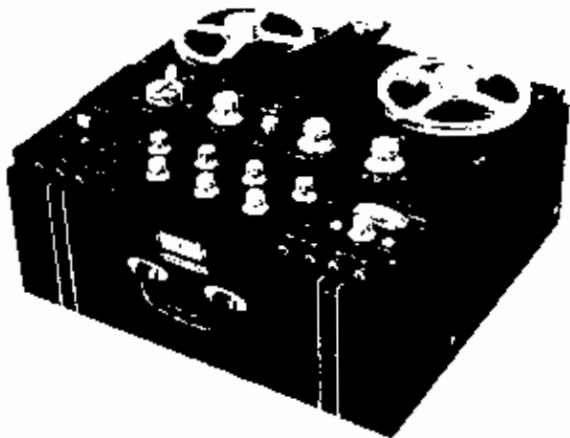
range. Some are American, others come from Germany and many are now made in Britain.

When buying a tape recorder you must first of all define your precise requirements. Do you want it only for speech? Or music? Or as the precision-built heart of a hi-fi installation? Do you want a portable or a standard model? What, in fact, do you expect it to do for you?

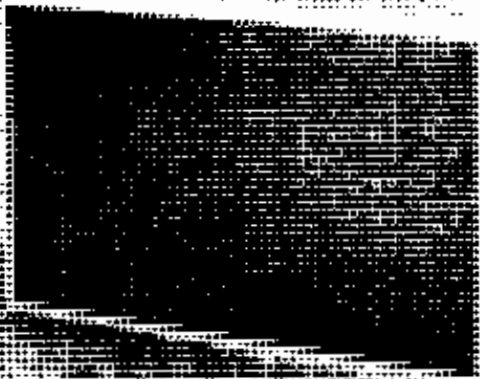
The answers are often difficult to find, and if you are an absolute beginner you should lose no time in getting on talking terms with the kind of dealer who really *knows* about recorders, and does not sell everything from washing machines to electric razors on the side. The odds are against such a jack-of-all-trades having the kind of know-how you need in making your choice of a machine. Avoid the shop which is full of cheap plastic-case recorders, but hunt out the smaller place which is half workshop and half shop, because it is likely that here you will find a man who not only sells recorders but uses them and knows their various idiosyncrasies.

The tape recorder is not an erratic instrument. Its performance can be measured quite easily with a test tape made specially for the job. This contains a series of electronically-produced sounds throughout the scale of human hearing. Test tapes can be purchased at the usual price of pre-recorded tapes, and they are a worthwhile investment if you contemplate tinkering or giving your hi-fi installation a rigorous testing.

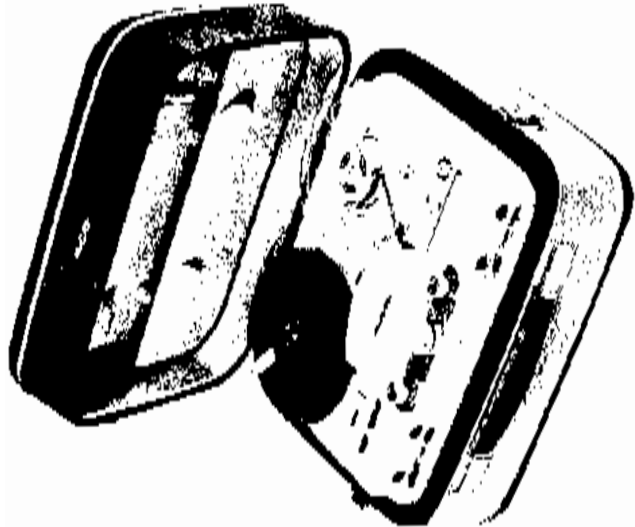
While a test tape is intended to measure the capabilities of a recorder, you should still nevertheless make certain allowances, because the recorder is fitted only with what is known as a "monitor" speaker—that is to say, an internal loudspeaker which is there merely to give an indication of what is on the tape. It is not there to enrich the recording, and for a full performance the same tape and the same recorder should really be incorporated in a hi-fi



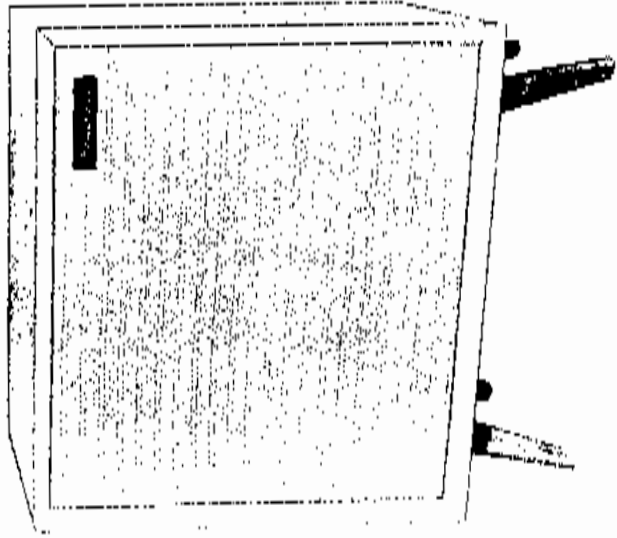
New look in tape recorder design. An expensive machine giving a lifetime of service.



Slim loudspeaker and enclosure.



Useful, compact tape recorder—medium price-range.



This type of loudspeaker and enclosure can be bought in parts and assembled at home.

TAPE RECORDER SPECIFICATIONS

system. This should be borne in mind when you are listening to a machine which may have an excellent line-up of recording, erasing and playback heads plus a first-class motor and electronic system, yet still sound tinny. The same machine and the same tape will probably be head and shoulders above itself, once it has the extra boost which makes hi-fi what it is.

Every reputable tape recorder has a specification. This is generally shown in the instructional booklet or else on a separate pamphlet. This is the manufacturer's listing of all the qualities he claims for his product, and while some undoubtedly exaggerate for the sake of impressing the absolute beginner, there is now a tendency to be a little more honest about such claims.

You should know how to read a specification, otherwise you have no standards from which to work. The ultimate criterion is still your own ear, but at the same time your ear can deceive you, especially if you are listening to a demonstration in the retailer's own studio, where the acoustics are quite different from those of your home, where the machine will be used. Treat the specification sheet as a starting point, therefore, and then listen to the recorder in action. Listen to a test tape, listen to pre-recorded tapes, and then record your own voice at varying degrees and distance from the microphone. The investment may be a sizeable one as far as you are concerned, and unless you buy a machine which pleases you (as distinct from the one which may please the retailer), you are heading for trouble.

Here are the main headings used in a specification-sheet with an explanation of their meaning:

Frequency Response

This concerns the range of signals which can be reproduced by the recorder, from treble to bass. The majority of

USING THE MACHINE

manufacturers publish a graph in which the input and the output from 40 cycles to 15,000 is shown. Ideally, this statement should concern the recorder's performance without benefit of auxiliary aides such as hi-fi amplifiers, special speakers, etc.

dB: This means "decibel" and it is a sound-measuring unit. It has been established that one dB is the smallest variation which can be heard by the ear.

Harmonic Distortion

Regardless of the excellence of your recorder, there is always a certain amount of distortion somewhere in the quality of the output as it emerges from the speaker. A distortion of 0.1 per cent spread over the amplifier in its lowest to highest performance is considered satisfactory.

Power Output

Not all the electrical energy passing from the amplifier to the speaker is used. This is included in the specification as watts, and the majority of recorders have an output of something between two to four watts.

Signal-to-Noise Ratio

Even the very best recorders display a certain amount of noise when you play a "blank" tape at maximum volume and minimum volume. However, this should not exceed a certain level. Manufacturers express this in terms of dB, and if a specification states that the signal-to-noise ratio is 20 dB, this implies that the background noise has to increase by 20 dB before it rivals the signal. Manufacturers have made great efforts to lessen the ratio, and this has been accomplished in recent years, showing an improvement on the older type of machine.

HUM, WOW AND FLUTTER

Wow and flutter

In the specification this is expressed in the following terms (figures vary from make to make). "Better than 0.15 per cent." Some manufacturers attempt to conceal this aberration under another heading. The best test is a pianoforte recording of a work in which single notes are struck and held. An advanced method of testing wow and flutter is by means of an oscilloscope, which presents the aberration on a cathode ray screen as a wavering line, but during demonstration the prospective buyer should rely upon the human ear.

Hum

This is created by the alternating current system, and because of this it cannot be banished completely, although a well-designed circuit and the correct valve line-up in the amplifier can reduce it. Manufacturers sometimes conceal the true hum level by including it with other factors. Basically, the presence of hum with the recorder volume control at zero is one reason for avoiding that particular model. Hum should not become noticeable until the volume is turned to maximum, and even then should be negligible.

The application of the specification claims to actual performance is simple enough, especially when a retailer agrees to leave a model with you in your own home for a few days, in order that you can satisfy yourself that it meets with your requirements.

But even when you are inspecting machines in a shop or a showroom, certain easy tests can be carried out. These are as follows:

Using a pre-recorded tape, turn the volume control as far as it will go and listen for distortion. This is likely to be a deafening process and the dealer should be warned to stand clear!

USING THE MACHINE

Turn the control to fast-rewind with a tape running over the heads, allow it to run at maximum speed for a moment or two, then apply the brakes. If the tape spills from the spool and creates general chaos, you should inspect another machine, because this one is definitely not for you.

Glancing at the instruction book regarding the fixing of the spool on the spindle and the threading of the tape, attempt to do it correctly first time. If it seems to be unnecessarily complicated, start looking at other machines. Some manufacturers attempt to "baffle with science" when it comes to these smaller points. Professional machines used by broadcasting companies are exceptionally simple in operation, and fancy bits and pieces are scorned—and rightly so.

Persuade the dealer to record his voice via the microphone with you operating the machine, and then play it back at maximum volume to check for distortion. This test is quite different from the one with the pre-recorded tape, because it enables you to check the recording level device in actual operation.

With the volume control set at maximum, play an unrecorded tape and listen for hiss and hum. If this is very noticeable, then ask to see other machines.

One last word about this game of "Picking a Recorder": do not buy the first one that satisfies you. Today there are 150 different models on the market, and they all have varying characteristics. If you studied the specifications and claims made by manufacturers you would be inclined to think that all of them were suitable, but in actual use your critical faculties will tell you differently. It comes down to deciding why you want a recorder and what you intend using it for. In the last resort, the motto should be: only the best is good enough.

Finding the best takes a little time, but it is great fun

USING THE MACHINE

trying out the different machines and engaging in “shop talk” with the dealer. Some dealers will try and baffle you with science, others will go to great pains to help you. The last judge is stuck on the side of your own head. It is your Ear.

4

MICROPHONES

When you buy one of the popular makes of tape recorder it comes complete with microphone. Paradoxically, when you go into the upper price range you do *not* get a microphone thrown in.

There are various opinions concerning the quality of these “giveaway” microphones. Some experts consider them to be junk, others say they are just about—but only just—adequate for general home recording purposes and quite unsuitable for high-grade recording.

It all boils down to one thing: what do you want to use the microphone *for*? If it is merely a question of general utility for recording conversation, making message tapes for friends at home and abroad, for party use (because the microphone can also be used as part of a public address system), then this little plastic gadget will probably serve its purpose.

But a few comparison tests between a proper microphone and its plastic counterpart will quickly demonstrate the basic differences, and even a person who is hard of hearing would notice it.

Why do manufacturers supply these poor quality microphones with their machines? Apart from the fact that they can advertise the machine “complete with microphone”, there is the economic reason; a really good microphone can cost as much as the machine itself. Of course, there are many moderately priced microphones which are quite suitable for near-professional use.

CRYSTAL AND RIBBON MICROPHONES

It is, therefore, wise to regard the microphone which is supplied with your recorder as a *starting point* rather than the ultimate, especially if you intend to obtain the maximum amount of benefit from your equipment by adding to it as and when your bank manager will allow.

Sooner or later, let's face it, you will want a better quality microphone and you will not be satisfied until you have reached your goal.

There are three main types of microphone from which to choose, CRYSTAL, RIBBON, MOVING COIL.

Crystal

These are generally lightweight with an element made from an asymmetric crystal called Rochelle Salt, which converts sound into electricity. Temperamental to a certain degree, they are nevertheless excellent for voice recording, and as far as price is concerned can be obtained for a modest sum.

Ribbon

The professional definition is *pressure gradient*. The active element is a piece of aluminium ribbon held between two magnetic poles. In use the ribbon microphone can be relied upon to pick up relatively distant sounds, while in home use they should be carefully situated in relation to the sound source. They have a habit of picking up bass sounds and exaggerating them, but this can be rectified in some makes by the adjustment of the internal felt pads. The sound area in which they are most sensitive can be likened to a figure-of-eight with the microphone located at the centre crossover. This means that the area of acute sensitivity is directly to the front on either end of the figure-of-eight, and generally lessening at the sides. A good ribbon microphone can cost in the region of £12.

Moving Coil

This consists of a diaphragm linked with the coil, which is situated in a permanent magnetic field. Sound waves cause the diaphragm to move or vibrate, and this is converted into electrical impulses. Thanks to technical developments, moving coil microphones are now largely mass-produced, varying tremendously in price range, but an average cost would be about £10.

Of the three main types, the moving coil is probably the most reliable general-purpose microphone.

When you buy a microphone you make your purchase on the basis of certain standards stated by the manufacturer. These are set under two headings: *sensitivity* and *impedance*.

Sensitivity means the amount of electrical output for any given sound input. It follows that if you have a high-priced recorder, a low-priced microphone with unmatching characteristics will be unsuitable, because the two are probably incompatible.

Impedance is the main governing factor. Before buying your microphone you should check with your tape recorder instruction book and specification to discover what the impedance is. For instance, a low-impedance microphone will work badly, perhaps not at all, with a high-impedance tape recorder.

Low-impedance microphones have many advantages, and are in general use in professional recording studios, because they can be used with a much longer lead than is possible with high-impedance. In home recording the length of your microphone lead should be ten to twelve feet on a high-impedance machine, but much longer on a low-impedance one.

The following table shows what happens when you oper-

PROBLEMS OF ACOUSTICS

ate a microphone on various lead lengths. The loss in terms of decibels is marked and constant.

LOSS OF STRENGTH IN CABLE LENGTH

<i>Cable (in feet)</i>	<i>dB Loss in Level</i>
20	.8
40	1.4
60	2.0
100	3.2
150	4.4
200	5.6

Before you can hope to get used to working with a microphone you should experiment with it. Recording engineers claim that every microphone is different. This is complicated by the fact that the same microphone, used in two contrasting rooms, will react differently. This is due not so much to the microphone as to the acoustics of the actual room in which the recording is made. For instance, an empty room will often give back an echo, which makes it necessary to record close to the microphone. A heavily-furnished room, on the other hand, will absorb sound waves. On playback the different results obtainable will be very noticeable.

Part of the fun of making a recording derives from this basic difference in every situation. It takes time to find out how a microphone's sensibilities may be wooed.

Microphones come equipped with several different types of stands, so that you can use them on a table or in the middle of a room. There are few considerations to bear in mind about the stand, except that it is always a good idea to buy one which has a heavy base, not one of the lightweight tripods, because they tend to fall over if you stare hard at them for a moment or two. This often means buying a new microphone.

MICROPHONES

Most of the standard stands have a screw-sleeve arrangement, enabling you to fix the shank of the microphone to the stand in a matter of seconds.

Until you clamber to the higher slopes of hi-fi recording you are likely to use a hand-microphone, but here care must be exercised, otherwise you will pick up an acoustic ragbag of unwanted sounds, such as the tap of your thumbnail on the casing, the movements of your own body and the creaking of your bones. A hand-microphone should be handled very delicately, especially when you are moving about in a room.

When the microphone is not in use, it should be placed in a polythene bag, the neck tied tightly, and then stored away from any risk of accidental knocks and bumps, because this is one of your most sensitive ancillary instruments, and it will pay you to look after it.

Naturally, you would like to get down to some serious experiments with the microphone in order to discover what it can do.

First of all, the human voice—*your* voice. It is better to carry out the first experiments in conditions of privacy, otherwise the family will only take a morbid interest in the results and assume that your brain has cracked under the strain of owning a recorder. Even when you are quite alone, you may *still* feel somewhat self-conscious. Never mind. You will not be the first tyro recordist to blush under the impact of his own personality. All this is quickly overcome as you discover the fascination of your own voice. If this is the very first time you have ever recorded your voice, or heard it reproduced, you will be amazed to notice inflexions which you never thought were there, a certain roughness or even a pleasing smoothness in delivery . . . or a most peculiar way of speaking. Do not disown yourself. The sound you hear is as true as your own reflection in the mirror.

TESTING THE MICROPHONE ,

Let the recorder warm up, and then operate the controls in the drill described in an earlier chapter. Connect the microphone, using the marked socket, and then position the microphone twelve to twenty-four inches away from your mouth. Now read a page from a book in a normal non-declamatory tone, paying due attention to the balance at which you are recording.

Stop and play the recording, listening to it critically. Try the same experiment at a different speed next time. If you recorded at $1\frac{7}{8}$ i.p.s., switch over to $7\frac{1}{2}$ i.p.s. This is a positive way of demonstrating the different qualities of recording in relation to running speeds.

Repeat this procedure several times until you are confident that you know how to use a microphone and recorder in conjunction. During playback watch out for accentuated sibilants, the snake-like hissing when you pronounce a word like "sausage" or "shyster". This can be corrected not by operating the level control of the recorder but by moving slightly "off-mike", and trying it again at the new angle.

Assuming that a member of the family or a friend is ready to co-operate, try out some "second-voice" recording. The most usual method is the interview, and while you may feel rather silly, interviewing your own wife or husband, it can be a revealing experience for both parties. As long as your victim is well-known to you, there is no need to feel uncertain of yourself, because the majority of people will put up with practically anything for the sake of hearing themselves on tape.

Place the microphone on the table between you, ensuring that it is slightly to one side so that the sound of your voices "sprays" down towards it. It is a good idea to try it at different angles before making the final recording. Alternatively, you can always move the microphone about during the actual interview, explaining what you are

MICROPHONES

doing so that when you listen to the playback you will be able to note any improvements.

You may be one of those recorder users who intends using the new machine solely for voice recording. In that case you are advised to get in plenty of practise with microphone positioning. This varies from one place to another, and it is always affected by environment. For instance, these machines are now used to record both routine and important meetings in industry, the deliberations of different bodies and societies, and so forth.

Let's assume that you are going to record a meeting with twelve people present. What you actually have is not twelve people but twelve interesting problems. There is no need to mention this fact to them.

Your twelve problems are going to meet in a room which has a high ceiling, long curtain drapes and a thick pile carpet. You can expect some of the sound to rise towards the ceiling, bounce and come down again. When the microphone finally catches the sound as it reverberates, the playback will enhance it. On the other hand, the person who almost whispers will also be caught very readily . . . and we hope that he, too, will be suitably enhanced. You will, of course, have to be constantly monitoring the level of recording, so that even the person who may be virtually inaudible at the meeting can be clearly heard on playback.

It is always a good idea to try and arrange the positioning in such a way that the main speakers will obtain the full benefit of the active microphone field. This happens to be governed by the type of microphone you are using. The crystal—and moving coil microphones—have a circular hearing area.

Another method of recording a meeting is to use two or even more microphones, linked to a *mixer*. This is a multi-channelled device which will accept and feed different

CANDIDS AND TAPESPONDENCE

sound sources into the recorder at the same or varying levels. Recording a meeting obviously calls for the setting of the same level all round. Simple four or six-channel mixers are not very expensive, and they are useful gadgets to have in your kit.

If the notes of the meeting are to be typed by an audiotypist, working direct from the tape, then a mixer is certainly useful, because it reduces the risk of mistakes since she can hear all the speakers equally well. But if the tape is being recorded for reference only, then a mixer is often unnecessary.

Another use of the microphone and recorder is to make *candid*s. This means that you make a tape of people talking when they are unaware of the presence of the microphone, because it is hidden from view, while the recorder may be in the next room. Obviously, some long and well-hidden leads are necessary. In many quarters the making of candid*s* is frowned upon, because it can produce unexpected results. However, if you play the results back to the victim at the end of this innocent (?) joke and he does not object, then who is to worry about it? It rather depends upon your victim. . . .

Tape recording has given birth to what is known as *tapespondence*, and people throughout the world are able to chatter away to one another at length without worrying about the telephone bill. In Britain alone several thousand people cultivate this hobby, and many of the lonely ones have made new friends with the aid of a cheap recorder and a spool of tape. Medical specialists, engineers, writers and people in the professions use tape to compare technical notes, and in some hospitals a surgeon dictates the stages of a critical operation into a microphone while performing the operation. Of the uses of tape there is no end!

Recording home music-making is slightly more difficult

MICROPHONES

than putting the human voice on tape, due to the larger and more dynamic range of almost every instrument.

It is best to commence with piano experiments. Assuming that you have a pianist in the family, try the microphone at a distance of between seven and ten feet from the instrument, then reduce to two feet and listen to the difference. By using this kind of test you should very quickly discover the best distance at which to record.

Musical instruments operate over a wider spectrum of sound than the human voice, (see fig. 3), and perhaps the easiest sound of all to record is a brass band, where the individual sounds of the instruments are clumped together.

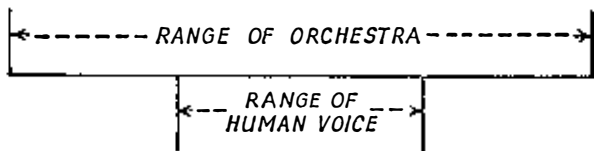


FIG. 3. Hi-fi recording embraces a very wide range of tone. This diagram illustrates the scope in comparison with the human voice.

The most difficult sound of all is the full symphony orchestra where, in many works, the different groups of instruments state a theme which is taken up and elaborated upon by the remainder of the orchestra. We will discuss orchestral music more fully when we reach the hi-fi section of this book. It is unlikely that the home recordist will have the opportunity of putting a full orchestra on tape, although opportunities may exist with amateur orchestras in the neighbourhood.

Recording choirs is simpler than an orchestra, unless the work happens to feature a soloist, in which case it may be possible to use a mixer and place one microphone for

MICROPHONES

the choir and a second for the soloist. Again, there may be an amateur choir or choral group in your neighbourhood able to help you as you plod your way along the tape road.

As with all tape recording, confidence comes with use. Do not feel too ambitious at the start, otherwise you may easily disappoint others, who tend to worship their kind of perfection. On the other hand, if you do have the opportunity of testing your capabilities on choirs and orchestras, etc., then accept with a good heart and on the strict understanding that you are "only an amateur".

5

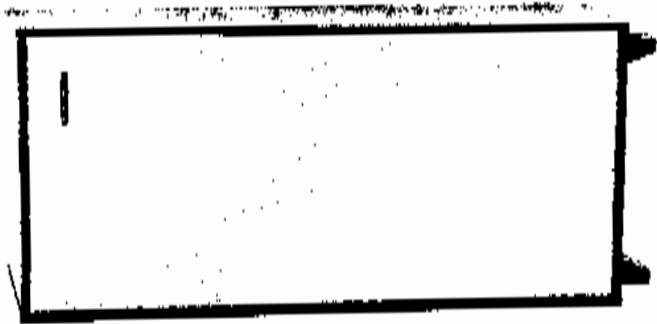
PRE-RECORDED TAPES

Pre-recorded tapes are only just coming into their own. The distributors have widened the entire repertoire, so that it is now possible to buy practically any sound you like and want on tape, recorded to high studio standards. The advantage is that when you buy a pre-recorded tape you also buy something which can be used again and again after you tire of the original recording—the tape itself. All you have to do is erase it, and you are still getting value for money.

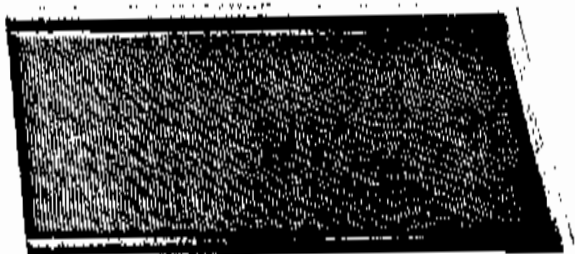
For testing your equipment and getting to know more about what hi-fi is, and what it can do, you are recommended to buy *Sound Adventure* (Esoteric), which covers among other things frequency, pitch, intensity, the Doppler Effect, echo and reverberation, delay distortion, fundamentals, overtones, etc.

A tape which represents a comprehensive course in the principles of audio, with actual tests for frequency response, intermodulation and resonance is *This is High Fidelity* (Vox-Esoteric), with the plush-and-cream voice of Art Hannes making it all sound simple—as it is once you have mastered the basics. This one has the advantage of using actual musical examples to illustrate frequency range, the Fletcher-Munson effect, peaked transmissions and the very nature of sound.

In the sphere of music itself, the majority of pre-recorded tapes are copied from the actual master-tape made during the original recording session, and with the skilled supervision of engineers they generally represent a



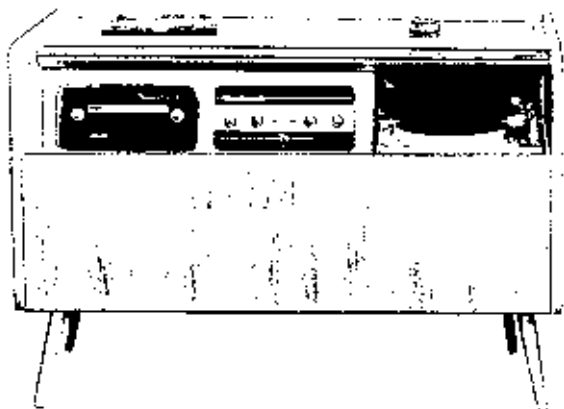
Rectangular loudspeaker and enclosure.



Loudspeaker enclosure suitable for placing on bookshelves and room dividers.



Matching stereo loudspeaker enclosures for all types of room decor.



Home-made cabinet containing complete set of hi-fi equipment.
The tape recorder is recessed into the lidded top.

EXAMPLES OF PRE-RECORDED TAPES

greater degree of clarity than is obtained even on the best LPs.

In classics, Christopher Wood playing two of the Bach harpsichord concerti (No. 1 in D minor and No. 5 in F minor) with the Goldsbrough Orchestra (Saga) are among the technical triumphs.

Another intriguing technical accomplishment is *Collaboration!* (Saga) with the Johnny Dankworth Band and the London Philharmonic performing together the Salzedo-Lindup *Rendezvous* and other works for jazz band and symphony orchestra, including the seldom-heard *Ebony Concerto* by Stravinsky. This one contains many of the most exciting sounds and rhythms ever placed on tape.

For "big sound" you should buy the tape of the Vienna Symphony Orchestra and Choir of the Vienna State Opera in performances of Tchaikovsky's *1812 Overture* and Borodin's *Polovtsian Dances* (Esoteric). In the *Dances* the choral and orchestral recording is particularly lucid.

Another major scale work is Lalo's *Symphonie Espagnole* (Saga) with the Orchestra Pasdeloup and Salvatore Accardo as soloist.

A great deal of light music is now on tape. Two which can be recommended are *Continental Holiday* with Pepe de Santa Cruz (Recotape-Esoteric), and George Fayer's piano entertainment, *Echoes of Paris* (Esoteric).

Pre-recorded tapes for children still lack a certain amount of imagination, but one which represents good value is *The Red Shoes*, played and sung by the London Philharmonic Orchestra and Choir (Saga).

Some tapes are ideal for giving your equipment a work-out and providing good listening at the same time. The tapes, *Living Percussion* Vol. 1 and 2, with the New York Percussion Trio (Esoteric) are in this category. They are technically interesting, because they utilise over-dubbing,

PRE-RECORDED TAPES

the same method being used by Les Paul with his one-man multiple-guitar arrangements.

Many tape people love collecting interesting sounds. For nostalgia and historic interest at the same time there is the series, *Sounds of A Passing Age* and *Sounds of A Dying Age* (Esoteric), the individual titles including *Merry-Go-Round* (fifteen famous tunes played on an authentic caliope), *The Sound of The Mammoth Fair Organ* and *The Sound of The Steam Organ*. These are all well worth keeping for their intrinsic value alone.

6

WHAT MAKES FI HI?

The tape recorder may be the heart of a hi-fi system, but several other “organs” which are just as important in their own way are needed before ordinary sound becomes “presence sound”. We shall be considering these in detail a little later on, but in the meantime we have to appreciate the realities of high fidelity.

The simplest way of understanding hi-fi is by listening to the end product, the actual sounds reproduced with the aid of special equipment designed for the purpose.

There is absolutely no comparison between the quality of a disc or a tape played through the speakers built into the recorder or record player and the same sound when it has been dealt with by high fidelity equipment. Hi-fi is the reality without the artificiality. It is the difference between poor-quality calico and the finest satin or brocade. Once heard, it is never forgotten.

In a nutshell, hi-fi is “natural” sound, and it becomes possible only through systematic planning, both economic and aesthetic, and the skilled operation of a variety of separate units working together in unison.

These units include the *amplifier* (as distinct from the tape recorder amplifier) and the *loudspeaker enclosures*, including “tweeters” and “woofers” for the true-life reproduction of a wide range of tones.

To obtain true versatility you also require a *radio tuner* (for radio and television programmes whether you tape record them or not), and a transcription unit (for disc

WHAT MAKES HI FI ?

reproduction). All these are sold separately in a wide price range. Buy the very best you can afford.

The myth that hi-fi is an expensive proposition is still quite prevalent, although a large number of firms offer "budget buying" of equipment and the drawing up of a hire purchase schedule which does **not** harm your pocket while giving you the full range of equipment of the best quality. Many insurance firms offer policies to guard against unemployment and perhaps the failure to meet your commitments. Nowadays it is practically respectable to take advantage of such facilities and nobody thinks any the worse of you.

But if you are anti-hire purchase, you can still get together a first class hi-fi installation, bought piece by piece over a period and to a strict budget.

Financially speaking, the decision is up to you, but when you realise that **any** of the best AM/FM tuners can be bought for as little as £2 down and interest-free instalments over a year (for longer periods a shilling in the pound is charged as a rule), then it is obvious that hi-fi is within the grasp of practically everybody.

Another factor to bear in mind is that hi-fi can cost far less than many standard radiograms, yet give much more pleasure plus a vastly superior range of acoustic reproduction. Where a radiogram is limited to radio programmes and records, the growing hi-fi installation is still capable of infinite expansion coupled with a never decreasing interest.

For instance, it is only a short step from the hi-fi reproduction of radio programmes to the taped compilation of your own library of music—jazz or classics—talks, plays and radio documentaries.

It is an even shorter step from monaural sound reproduction to binaural (otherwise stereophony or "stereo" for short).

THE VERSATILITY OF HI-FI

Hi-fi offers opportunities for constant change and improvement. If you use tapes, they can be utilised again and again and they will not deteriorate. You can also make tape-recorded copies of expensive long-playing discs (loaned, we hope, by friends who can afford them!).

If you are interested in adding top-quality soundtracks to your home movies, this can be done, and the hi-fi reproduction of them will increase your enjoyment many times over.

Hi-fi is limitless not only in its possibilities but also in the spectrum of sound reproduction. The equipment gives so many nuances of tone, timbre and colour that its sound will never cease to fascinate you. They say that until you have heard good hi-fi you have not heard sound and this is quite true.

Hi-fi commences with a tape recorder or a disc transcription unit, but it *really* starts with a power amplifier and, perhaps, a pre-amplifier.

Amplifiers are classified in terms of *power output*.

In small amplifiers the output ranges from five watts to the ten and twenty watt models.

In this context "power" means the amount of vol me which can be supplied by the amplifier without distortion. This is referred to as the *dynamic range*. A single instrument (e.g. a flute), requires something less than one-tenth of a watt for adequate audible reproduction, whereas a complete symphony orchestra or military band will draw up to ten watts.

If it is to deal with high peaks of sound (as is the case with the symphony orchestra), an amplifier needs power reserves which help to reduce harmonic and intermodular distortion. For instance, a specification may show that the amplifier is laboratory-tested, saying that there is a three per cent distortion at ten watts, the efficient peak power being fifteen watts.

WHAT MAKES FI HI ?

This figure does not mean much to the amateur. It is not clear even to the expert, because the specification does not mention what *kind* of distortion is caused. It could be harmonic, it could be intermodular. One fact is clear, however; distortion increases proportionately as the power output is increased.

Distortion is, of course, easily recognised. It is one of the major bogies of hi-fi. There are two main types, *intermodular* and *harmonic*.

Intermodular makes tones which are discordant in comparison to the recording, assuming that the recording is a faithful one in the first place.

Harmonic, caused in the vacuum tubes of the amplifier, is additional to the actual recording.

Both types of distortion are quite easily identified. The best way of finding out whether they are present in any particular amplifier is to actually test it to the utmost limit of its capacity. Do not hesitate to "punish" an amplifier. It is supposed to handle a comparatively massive load, and if it cannot do so when pushed to the limit, then the flaw will at once show. But when you conduct such a test, whether in the home or in the showroom of your dealer, always make sure that a suitable speaker is used. If you connect a modest little speaker to a high-output amplifier, you will not be able to use either unit properly. With loudspeaker development, however, many of the smaller ones can deal with quite large amplifier output.

Practical aural testing does not mean that you should completely ignore the maker's specification. It is a good idea to remember that in the field of amplifiers, makers' claims are apt to vary quite widely. For some years there has been an enthusiasts' lobby to try and prevent manufacturers from using such terms as *push-pull* and *feedback* in regard to amplifier circuits and systems. This is like a car manufacturer stating that his latest model runs on

FREQUENCY RESPONSE

petrol. Of course it does . . . and the majority of amplifiers include push-pull and feedback!

Among the main headings in the specification you will find two words, **Frequency Response**. This means the range of frequencies in relation to the amplification. If the amplifier is any good at all—and most of them are within the limits of their own price range—it should give what is called an *even* performance. In the trade they use another word for it, and this may mislead you. They call it a *flat* performance.

When you discuss the technical characteristics of an amplifier with a dealer, never be afraid to ask him to clarify terms. Some of the older generation do not stick to standard terms and phrases, but make up their own (often on the spur of the moment!). Younger men in the trade tend to be more reliable, because they treat hi-fi as a subject and a science apart, and try to give as objective a picture as possible. Some dealers may even stock equipment which they do not especially recommend, but the entirely reputable people will sell equipment only after it has passed their own tests. This is especially true of hi-fi.

But above all, pay attention to the frequency response of the amplifier when you listen to several of them in a demonstration, and always bear in mind the quality of equipment you already have.

Hi-fi equipment falls into a series of definite price ranges. A lower priced amplifier will have a frequency response of 30 to 15,000 c.p.s. (a unit of measurement meaning “cycles per second”) within 1 dB. A more expensive and elaborate amplifier will have a frequency response of 20-20,000 c.p.s. *flat* within 0.1 dB.

In other words, the more you pay the better the ultimate performance. It is a good idea to regard performance characteristics as a series of steps with price tags attached to them. The more you pay the better the view from your

WHAT MAKES FI HI ?

position on the ladder. If you stick to the standard ~~makes~~ you will not go far wrong. Many of these are not necessarily known at a national or detergent level, but because they seem to be only modest-sized companies, this ~~does~~ not mean that they turn out a technically inferior model. Far from it! In the ~~past~~ it has been the bigger firms, with their sub-contracting methods, that have been the culprits. Today standards are higher. The manufacturers know that a complaint from a knowledgeable hi-fi addict is something to be dealt with, not ignored.

The manufacturing standards of amplifiers in particular are now encouragingly ~~high~~. As a rule the detailed specification which should come with every instrument is rather more accurate than the one which is supplied with the tape recorder.

We have referred to the tape recorder as the "heart" of a hi-fi system. This being so, the amplifier can be regarded as the "brain". It is also the strongest link, because you cannot hope to achieve anything like true hi-fi without using an amplifier, ~~the~~ controls of which are designed to ~~give~~ you the purest possible tones and reproduction within the limitations of your equipment.

Amplifier controls comprise *volume*, *bass* and *treble* and certain other devices, such as the *filter*, which removes a percentage of unwanted noise and interference.

The *volume control* is in charge of the power output. In some amplifiers it is combined with the on/off switch, in others it is separate. The volume dial is generally calibrated 0-10.

Bass and treble controls have calibrated dials marked in the following style: -5, -4, -3, -2, -1; +5, +4, +3, +2, +1. In use these either accentuate or de-accentuate bass and treble, as heard through the loudspeaker.

The *selector* dial will indicate as many positions as there are inputs embodied in the amplifier. These are generally

THE PERFECTION OF HI-FI

found at the rear with special plugs. Thus: *tape* ("T"), *radio* ("R"), and about three other positions for pickups, etc.

Also at the rear will be the *hum balance* and the *damper*, both of which are useful when a fine reproduction is sought after. In many instances the *hum balance* will not be needed, especially when good equipment is being used, since any hum will exist below the threshold of human hearing.

Very often the new hi-fi enthusiast will seriously query the use of an amplifier. After all, they say, VHF broadcasting is "true to life", so are pre-recorded tapes and long-playing discs in which every artifice of electronic engineering is applied. If the basic sound is perfect, why tamper with it?

In the world of hi-fi a sound is never *quite* perfect. The ultimate search is for perfect sound, but we still have a long way to travel before we finally hear it. This explains why in this hobby the enthusiast is forever tinkering or changing his component parts. A valve gets tired, a connection needs resoldering, a new circuit needs trying out. All these may be interfering with what he is trying to do, therefore he learns how to rectify faults which may not be discernible to the ordinary human ear.

In the ordinary way, hi-fi sets out to correct certain aberrations. VHF broadcasting is as close to perfection as we can hope to get—when it leaves the studio by way of the microphone and, ultimately, the transmitter. But what happens at the other end, where the listener sits? Every single room where VHF programmes are heard is different. Some people over-furnish, others under-furnish. Some people go in for heavy velvet curtains, others prefer a light chintz or nylon net. Heard in different environments even the perfection of VHF becomes imperfect.

Again, one has only to read reviews of newly-released

WHAT MAKES FI HI?

long-playing gramophone records to realise that inconsistencies do exist. Remarkably few are considered first rate by the reviewers. The performance might be top rank but the recording can be slightly off beam.

The same goes for many pre-recorded tapes, the latest contestant for the major sales achieved by discs, although they remain more expensive since magnetic tape is more costly than disc material.

Hi-fi is a renovator, an improver. It can give a "wash and brush up" to the most inferior recording ever made and, if the installation is a good one, increase enjoyment a thousandfold. It can give more bass to bass, more treble to treble, it can throw more "light" on sound. It can *create* living sound.

We mentioned discs just now. In this field hi-fi is unsurpassed. Of course, many ordinary record players are launched on the market wearing the hi-fi label, but these are usually scorned by the enthusiast, since the resultant reproduction is generally inferior to the sound produced by the balanced installation of separate components.

Amplifiers come equipped to deal with all types of gramophone pickups, or "arms" as they are often called. This is to your advantage, because it enables you to equip your hi-fi system with a separate record player, known as a *disc transcriber* (this is considered in detail in Chapter 10). It is possible that the best results can be obtained by using a turntable of one make and a pickup arm of another. But that is the fun of hi-fi, looking for the best results through a variety of combinations of equipment.

You will find that your amplifier is fitted to deal with the output of the majority of standard pickups, and this is done by means of two calibrated dials, usually situated at the rear of the instrument. The conjunction of these makes it possible for the amplifier to accommodate a wide range of pickups—like this:

ADJUSTING THE PICKUP

DIAL ONE 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0.

DIAL TWO A, B, C, D, E, F, G, H, I, J, K.

The eleven positions on each of the dials provide countless permutations, of course, but each type of pickup has only one correct position. You will find the correct adjustments for your particular pickup detailed in the specification as follows: C8; B3; D5, and so on.

Pickup compensation is necessary because of the vibration of the pickup needle in the groove of the disc. In the bass the needle has a pronounced lateral (directed towards the side) movement. In the higher frequencies (treble) this movement becomes smaller.

Since the advent of scientifically-designed hi-fi equipment, recording engineers working on disc development have successfully modified the frequency response, and succeeded in reducing the lateral movement and increasing the small lateral movements. Perfection has not yet, however, been achieved. It is quite possible that the next revolutionary development will be a scanning beam which will do away with the principle of the needle or stylus. In the meantime, it falls to hi-fi equipment to add the finishing touches. The pickup compensator is just one example of how this can be achieved.

If you choose to use a magnetic pickup on the disc transcriptor, you will require greater amplification. This is achieved by adding a *preamplifier*. The reason for this "extra" is that the magnetic pickup generates considerably less voltage than the more usual crystal pickup. The separate preamplifier is therefore connected to the magnetic pickup which, in turn, is connected to the amplifier itself. This enables you to go into action with the required amount of amplification. As with a crystal pickup you will still require a compensator coding, but if this is not available and you are unable to obtain it from the manu-

WHAT MAKES FI HI?

facturer, then a maximum bass and treble control operation on the amplifier will give much the same effect.

Many amplifiers embody a preamplifier in their construction, and it is therefore unnecessary to buy a separate one.

Obviously, your first problem is to reach a decision concerning the type of amplifier required in relation to your needs and to the rest of your equipment. In this case the standards are quite different from choosing a tape recorder, and more affiliated to the selection of a loudspeaker. They are linked with the room in which you intend having your installation. If you have an ordinary-sized lounge, then ten watts output will be ample. If you intend putting your hi-fi equipment in a study or a room which is considerably smaller than a lounge in cubic-capacity, then you need a smaller one. The old rule, "You don't take a steamhammer to crack a walnut", is especially applicable in such a case. Obviously, it is useless having an amplifier suitable for a public hall in the home, but you will find that you have a choice of many amplifiers, all of them suitable, but some more suitable than others.

Faced with this array, what do you look for? How do you finally and, we hope, exactly decide on the best one for the job?

This is a matter for practical demonstration and often prolonged experiment. Wives are not too keen on it, nor are neighbours, because you sometimes send out shockwaves of sound which shake up human sensibilities. But persist. It is your money at stake! Although any amplifier can be connected to a tape recorder, it is worthwhile remembering that if the recorder is of poor quality, the amplifier will do little more than increase faults which were previously suppressed by the inadequacy of the recorder's own amplification and loudspeaker systems. If you already have a recorder it may prove necessary to sell

BUYING AND TESTING EQUIPMENT

this, and obtain a more suitable model before you start exploring the world of hi-fi.

The majority of dealers are themselves enthusiasts, and you will find them very helpful as far as home demonstrations are concerned. In the last resort it is a good idea to talk the man of your choice into bringing a selection of amplifiers to the home so that the *actual room* can be tested. It is no use making the selection in one of those special glassed-in studios so beloved by many dealers where the hi-fi jungle grows profusely and a choice is difficult. Far better to narrow it down there, and then to have half a dozen of the most probable ones brought to your house. Once they see how serious you are about it, most dealers will agree. It is possible that your dealer will come along and rig up the amplifiers, so all you have to do is persuade your wife to go and see some friends and then administer sedatives to the children in their cots upstairs.

We will assume that you now have three or four amplifiers for test purposes and, having connected what seems to be the best one with your tape recorder, you play a test recording through, this automatically cutting out the recorder's own amplifier. It is a good idea to use a pre-recorded tape which has a wide variation in sound and tone for testing purposes.

What do you listen *for*?

As we know, the governing factor is *frequency response*. This was discussed in relation to tape recorders earlier in the book. In this instance, the emphasis is upon the amplifier. By taking it from one extreme to the other as far as bass and treble are concerned you should very quickly detect any glaring faults in the reproduction, assuming that your tape recorder is in first-class condition, without more than the minimal wow and flutter, and you also have a good loudspeaker.

Noise and *hum* are just two irritating faults which can be

WHAT MAKES FI HI ?

caused by an inefficient amplifier. Most amplifiers are built to deal with this, and two controls are available to suppress it. But noise and hum are never totally eliminated.

Every amplifier should have a complete manufacturer's specification. Some of the more expensive ones have test reports made by independent authorities. Among the significant features, is the *signal-to-noise ratio*, given for each of the several amplifier inputs. For instance, *Tuner—50 dB* and *tape recorder and disc transcripator 45 dB*.

As you now know, the amplifier is the computer-like brain of the hi-fi system. When first you unpack it you will subject it to a thorough inspection (this is a good idea anyway, because manufacturers now and then forget to include the guarantee card and that important little packet of screws so that you can fix the amplifier into a larger installation). You will notice that the amplifier is fitted with a number of inputs, designed to take different signal sources. There is also a preselector switch to match the inputs. This means that the same amplifier can handle the signal input from the radio tuner, from the tape recorder, from the disc transcripator and so on. Once you have settled the instrument down, it is a good idea to solder all these connections and leave them rather than go in for too much chopping and changing. After all, an input is an input, and it is unlikely that you want to fumble yourself into the innocent error of feeding the radio tuner through the disc transcripator input and vice versa. Another good reason for arranging your input leads at the beginning is that each of the inputs carries its own set of individual compensating characteristics.

These characteristics will become more apparent during actual operation. For instance, you may choose to feed the amplifier with signals from an inferior source—perhaps a badly scratched disc. By using the different amplifier controls you can eliminate many of these scratches and

ELIMINATING SCRATCHES

other odd noises, thereby improving the quality of the sound. Your amplifier is also fitted with a graduated filter (calibrated 4, 7, 12, OUT, as a rule), and the operation of this, together with the adjustment of treble and bass, "washes" the incoming signals and provides a vastly improved reproduction.

Many hi-fi addicts "wash" old 78 r.p.m. discs and then dub them on to tape. In this way you can preserve records which are considered to be collectors' pieces. Some experts re-record the dubbed sound and gradually improve it beyond all recognition. There is quite an art to this, and it is a fascinating one which gives long-term satisfaction. Through experiments like these many so-called amateurs are, in fact, experts and operate their equipment well up to professional level.

But however good an amplifier happens to be, it can never remove *completely* all unwanted noise such as cracks on the disc. True, it can minimise the noise to a point where it becomes practically inaudible.

Despite such minor drawbacks, hi-fi does bestow the improvement of richer tones on old recordings. Quite apart from that, it consistently gives the "living presence" reproduction of new sound, originating from radio tuner, from LP records and from tape.

SPEAKERS, LOUD AND OTHERWISE

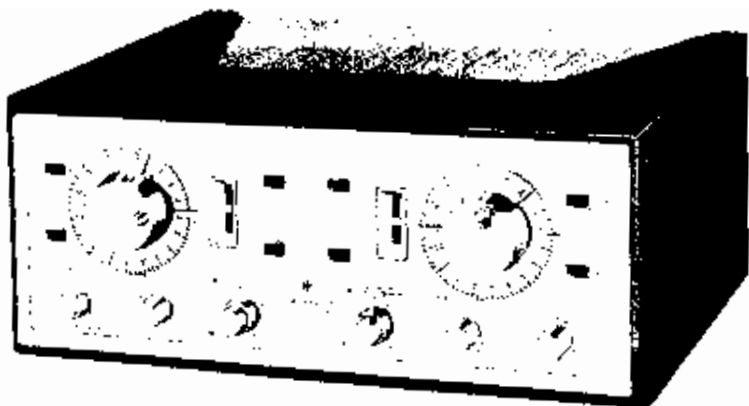
Without any doubt at all, the loudspeaker is the real of the entire hi-fi system.

With a good speaker you can probably get by with an amplifier, tape recorder and record transcripator which between them share quite a few little faults. But if you have a poor loudspeaker, the act of listening will probably become excruciating. If you are audio-sensitive, as the majority of hi-fi addicts duly become, then you will want to scrap the whole lot and take up hamster breeding or stamp collecting. Nothing is worse than a faulty sound, which explains why many hi-fi people cannot bear to listen to certain television receivers with their very high-pitched transformer whistles. Once you have heard top quality sound, anything less annoys you.

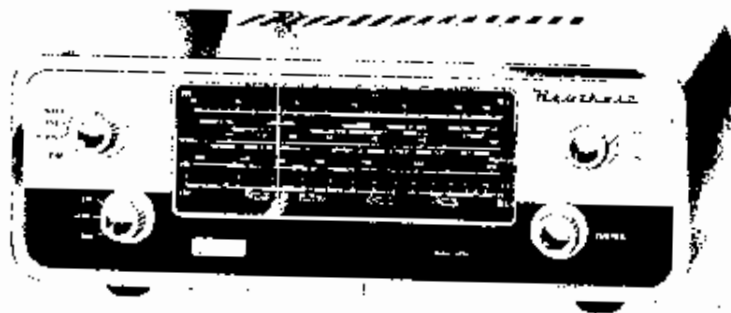
Of course, like every other piece of your hi-fi setup, a really good loudspeaker does cost money. You cannot economise on this item, because it is absolutely essential to good reproduction. But, like everything else, they can be obtained on reasonable hire purchase terms. It is a case of "listen now, pay later".

The consoling fact about a good loudspeaker is that it will last for many years and still continue to give excellent service long after you have worn out your original tape recorder and amplifier and replaced them.

Yet contrary to what many people may believe, the loudspeaker does have to withstand a considerable onslaught of vibration, a veritable barrage of shaking up every time it is used. It is by no means the passive thing it



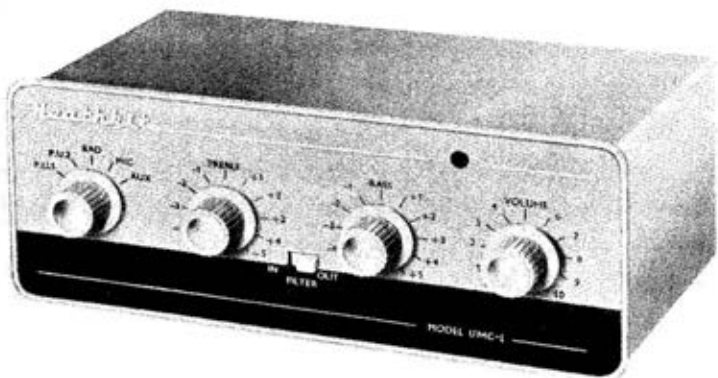
Top quality stereo amplifier.



One of the make-it-yourself radio tuners available in component form.



An AM/FM tuner—one of a matching series of hi-fi components.



This amplifier, built with a component-part kit, is suitable for general utility purposes.

PRINCIPLES OF THE LOUDSPEAKER

looks. This explains why an inferior loudspeaker can easily develop one of those irritating rattles, which are practically impossible to trace. Even a very slight fault can aggravate you, while a first-class model made by any of the names well-known to hi-fi addicts will go on working year after year, requiring very little attention beyond the courtesy check-up and perhaps a tightening of the odd screw which happens to have worked loose, and the cleaning of a thin layer of dust on the cone and magnet. It takes only a moment or two. With the almost totally enclosed loudspeaker even this may not be needed.

The principle of the loudspeaker is very simple to understand. (See fig. 4.)

The cone is clamped by the base to the framework in which a permanent magnet is fastened. Round the apex of the cone the speaker voice coil is wound, enclosing the pole of the magnet.

This is what happens when the loudspeaker is in action.

Audio voltage variations reach the voice coil. This creates a changing electro-magnetic field, and the coil is attracted or repulsed by the magnetic field. The voice coil and the cone of the loudspeaker now move on the line of the axis. This, in turn, leads to a movement of the air, which creates sound.

In a more detailed consideration of the working of the loudspeaker we find that apart from its basic function, outlined above, it must also displace larger quantities of air for low notes using the same mechanism for the high notes.

Ideally, a large-cone loudspeaker is necessary to handle the wide range fed to it by the keen-edged hi-fi system. Manufacturers have solved many of the old problems associated with performance, and it is now possible to buy very reasonably indeed, models which can handle frequencies from 20 to 16,000 cycles per second.

SPEAKERS, LOUD AND OTHERWISE

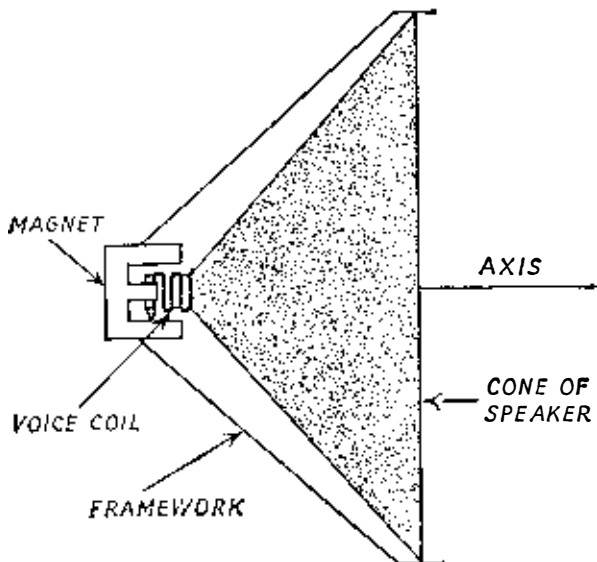


FIG. 4. A conventional loudspeaker in which the cone is suspended in the framework.

In hi-fi circles no greater bone of contention exists than the loudspeaker. From time to time each of the three different types comes under fire or is treated to the sort of adulation which comes only from the technically minded. The reason for this is that the different speakers all have widely differing qualities.

The three types are SINGLE-CONE, COAXIAL and MULTIPLE-SPEAKER SYSTEM.

Let's take a closer look at each of them. It is important

THE CONVENTIONAL LOUDSPEAKER

for you to be on familiar terms with their qualities before you try them out in your own home.

Single Cone

This is probably the most popular speaker on the modern market. The basic construction is that shown in fig. 4, and the development has been such that a reasonably-priced one will give a wide range of tones from 45 to 12,000 cycles per second.

In hi-fi it is necessary to ask the dealer to let you hear the special single-cone speakers made for the job, otherwise you might accidentally acquire an ordinary single-cone job intended for ordinary humdrum sound reproduction. Single-cone speakers intended for hi-fi have a number of modifications which make all the difference. For instance, they are as much as twelve inches bigger so that they can handle the "lower than low" notes which typify hi-fi. As far as the high notes are concerned, the cone material is specially selected with these in mind.

This does not mean that you will end up with a huge speaker just because you happen to need it for a hi-fi installation. Many of the ten-inch speakers are perfectly adequate, but they do of course have disadvantages.

The first important thing against the single-cone speaker is that the higher frequencies "squirt" out along the axis. What this means basically is a reduction in the effective listening area or even an overall loss. It rather depends upon the room in which you, your equipment and the single-cone loudspeaker are located. At the same time we should remember that the fault is not quite as serious as it may appear, because many of the best single-cone loudspeakers contain contrivances for the wider diffusion of the sound.

Of course, purchase of this and other loudspeakers is governed by your purse, although determination to have

SPEAKERS, LOUD AND OTHERWISE

only the best often over-rules other considerations. The single-cone loudspeaker is recommended to beginners in hi-fi, however, because it is an untemperamental instrument, it will provide a fairly satisfactory level of reproduction, and it is always a very helpful adjunct and standby in later years when you wish to include a speaker in a circuit for monitoring purposes.

Coaxial

The deceptive thing about the coaxial speaker is its size. At first glance it looks very small, and indeed it operates on the principle of having to displace much less air than the other types.

But it is not quite as simple as that, because coaxial speakers go in pairs and include a "tweeter" to handle the high notes. In construction it is not unlike the single-cone loudspeaker except for a diaphragm, which is connected to the voice coil. Acting in conjunction with the tweeter is a kind of horn to scatter the sound.

The second section of the coaxial speaker is the *crossover* network—an electrical circuit which acts as a filter, sorting out the high notes and the low notes. At this stage, of course, they are not notes at all, merely frequencies.

The third section of the coaxial loudspeaker is the large speaker itself for the purpose of handling the low notes. This is the "woofer". Any hi-fi enthusiast will verify that these speakers give a first rate account of themselves.

What is against them, then? Generally, initial cost. They are an altogether more complex instrument than the single-cone speaker. But as part of a hi-fi system they are worth their weight in gold, and give many years of the finest service with their superb dynamic range. In one word, they are an *investment*.

TWEETERS AND WOOFERS

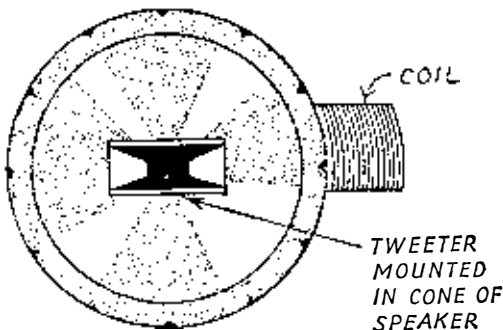


FIG. 5. Special loudspeakers containing a tweeter are available, and are useful when compact construction of a unit is important.

Multiple-Speaker System

This is a fairly straightforward separation-of-sound system, which has made us familiar with the twins, "tweeter" and "woofer".

In many ways it is a blend of the other two types of speaker, because it embodies the two types of speaker construction in differing forms, and also an electrical crossover network which is almost the same as the one found in the co-axial speaker.

Over the years there have been a number of refinements. For instance, there are *two-way* and *three-way* systems.

Two-way embodies a tweeter, woofer and crossover, which comes into operation from 400 to 3,500 cycles per second. (See fig. 6.)

It is the point at which the crossover comes into opera-

SPEAKERS, LOUD AND OTHERWISE

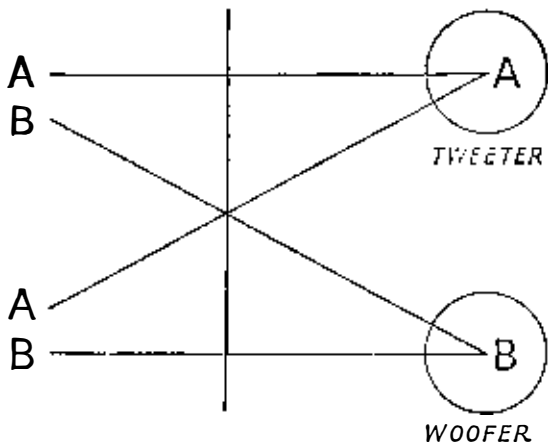


FIG. 6. Crossover network in which there is no need to use a mid-range speaker, because the entire frequency is handled by tweeter and woofer.

tion that makes the multiple speaker system comparatively expensive, because here, as nowhere else in hi-fi, precision engineering is called for. But if there is any compensation as far as price is concerned, it is that you can always add more tweeters or woofers and thereby enhance the sound reproduced, despite the fact that it may already be close to first class. In hi-fi there is always room for improvement, and the use of the multiple-speaker system is one way of getting it.

The story goes that one enthusiast became so engrossed with his loudspeaker system that he eventually built one

THREE-WAY LOUDSPEAKER SYSTEM

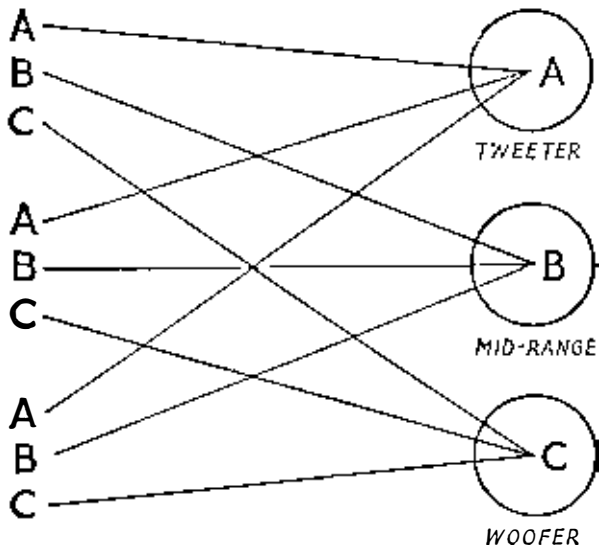


FIG. 7. Crossover network in which a three-way multiple loudspeaker system is used. Diagram shows the distribution of frequencies. A-treble; B-mid-range; C-bass. Distribution is handled by a crossover.

big enough to live in! That is how hi-fi possesses you in the end—or the beginning.

Three-way is probably the ultimate in sound reproduction, and while you may not be able to dwell within it, the installation will soon start encroaching upon what is left of your lounge, study or sound workshop.

SPEAKERS, LOUD AND OTHERWISE

The basic essentials comprise the woofer, the mid-range speaker, the tweeter and a pair of crossover networks.

In operation these would handle the following frequencies: *woofer* 30 to 600 cycles per second; *mid-range speaker* 600 to 4,000 cycles per second; *tweeter* 4,000 to 20,000 cycles per second. As far as the crossover networks are concerned, they would have crossover points at 600 and 4,000 cycles per second. (See fig. 7.)

It should go without saying that the dynamic range of such equipment is exceptional and often beyond all acoustical reproach.

Regardless of the system used, the ultimate target is the full reproduction in as faithful a fashion as possible of all sounds originally recorded. This is not always as easy as it may at first appear, but in the solution of the problems that arise lies the joy of designing hi-fi equipment.

8

SPEAKERS IN THEIR BOXES

A speaker will not give of its best unless it is incorporated in a box, referred to in the hi-fi world as an *enclosure*.

People have been making different kinds of enclosures ever since the loudspeaker was invented, but basically it has stuck at the rather conventional box shape, despite the many elongations, stretchings, the variations in positioning of the speaker itself and other refinements that have been evolved. They have even tried *round* enclosures, which look like squashed footballs and rest on the floor as though punted there by the children, but these were never much good, because they throw sound out like a shower of rain, and all the tonal values are dissipated and lost.

Of course, if you want to go the whole hog, you can build a brick enclosure in the corner of the room, but it is possible that when friends look in for a drink and a chat they will take a look at this nicely-finished edifice and ask when the builders are coming in to complete the fireplace. In hi-fi, however, appearance is not everything. It is the finished sound that counts.

If you do not fancy bricklaying, then an ordinary cone loudspeaker can be placed inside an ordinary pre-cast concrete drainpipe. Many hi-fi people have done just this, and experimented with varying lengths of pipe. It can have exciting results, especially as far as stereo reproduction is concerned.

The ordinary enthusiast generally sticks to the wooden

SPEAKERS IN THEIR BOXES

box-like structure, and so long as it contains two cubic feet of air or more, progress can be made.

In hi-fi it is a mistake to say that one enclosure is much the same as another merely because they look almost identical. This is far from being the case when you take a look at the "innards". Many variations are possible. Here are the names of only a few of them: *air coupler, bass reflex, Karlson, Lee Catenoid, Brociner, back-loaded folded horn, Klipschorn, acoustic labyrinth, infinite baffle.*

There is another type of speaker which calls for a special type of enclosure. This is called an *electrostatic*, and unlike the other types, it generally arrives complete, so there is no scope here for the tinkering type of addict. It works on the principle of a plastic diaphragm covered with metallic powder, and this is connected to the mains electricity. The outer plates are connected to the tape recorder or disc transcriptor. Parts of the diaphragm are pushed away from the positive and move towards the negative. The result is that the sound issues from this long, narrow "wafer". At the present time electrostatic speakers are generally used in tweeters to handle the upper frequencies.

To return to the enclosure itself, this is generally free-standing and away from the source of the sound. This means you should place the speaker enclosure on one side of the room and have your tape recorder, amplifier, disc transcriptor and all the rest of the equipment on the other. There is an added advantage in doing this, because it enables you to judge the quality of the sound from a distance. If you are right on top of it, there will be a certain amount of distortion.

I do not propose entering into too much technical detail concerning enclosures. This chapter is intended to acquaint you with the possibilities rather than the individual peculiarities and performances of specific types.

LOUDSPEAKER ENCLOSURES

If you place an ordinary cone speaker in a kitchen basin you will hear sound—of a sort. You will notice that it is somewhat louder than the sound which comes out of the cone when you hold it in your hand. As soon as you place a loudspeaker in a receptacle of any kind you create an exit for the sound waves, but more important you enclose the air on which the speaker actually works, and give the reverberating air something against which to bounce. As you vary the cubic capacity and the nature of the “sound-ing-board” so you vary the quality of the sound.

Enclosures, therefore, come in different types. These are the *direct radiator*, the *resonator* and the *horn*. To a great extent the terms explain themselves, but here are some helpful notes to gain a fuller comprehension.

Direct Radiator. In this the backward wave of sound from the speaker cone does not come into contact with the forward wave.

Resonator. In this one the backward and the forward waves do join, but under controlled conditions.

Horn. In this the loudspeaker enclosure includes a frontal opening and the control is over the amount of air on which the cone loudspeaker works.

Each of these is mounted in a slightly different way. The direct radiator has a simple board, which can be of a size which is equitable with the needs of the user, and the cone loudspeaker is mounted in a circular hole in the centre. This means that the sound shoots straight out into the room, and so there is no sound action from the back of the cone. It is called an *infinite baffle*.

Another form of mounting is the *acoustic labyrinth*, and in this one the sound waves which are thrown back from the cone pass through a maze, finally emerging through a variable-sized slot cut into the front board, directly underneath the circular orifice in which the loudspeaker is mounted.

SPEAKERS IN THEIR BOXES

But in hi-fi the most favoured of all the enclosures is the *bass reflex*. The box is internally padded with felt or other material, and it embodies an orifice for the speaker and a lower vent for the escape of the sound waves. The waves issue directly from the loudspeaker proper while a percentage strike the back wall of the enclosure and issue from the lower vent.

Apparently simple enough as far as design is concerned, the majority of enclosures are really quite complex from an acoustics point of view. Every dimension must be carefully measured, every scrap of wood or other material examined for flaws.

All reputable loudspeaker manufacturers are prepared to give advice on the best instruments for mounting, and some may even supply, free of charge, a drawing to show how it can be done. Drawings are usually for a bass reflex enclosure.

The idea of building your own corner enclosure is interesting (see fig. 8), because it gives the finishing touch to the installation, but *please* keep to straight lines and planes, and do not attempt any form of ornamentation, because this can affect the tone. Instead, give the enclosure a plain painted or polished finish and leave it at that, otherwise you will soon have a knotty problem on your hands.

Of course, speakers mounted in suitable enclosures, designed and built by experts at the job, can be bought ready made. In this field the standards are exceptionally high, and all enclosures are scientifically tested before leaving the works.

As with other hi-fi equipment, it is a good idea to have a selection of speakers in the home for demonstration purposes. You will find that a great deal depends upon the decor of the room, the way your wife has hung the curtains, distributed the rugs on the floor, even hung a

CORNER ENCLOSURES

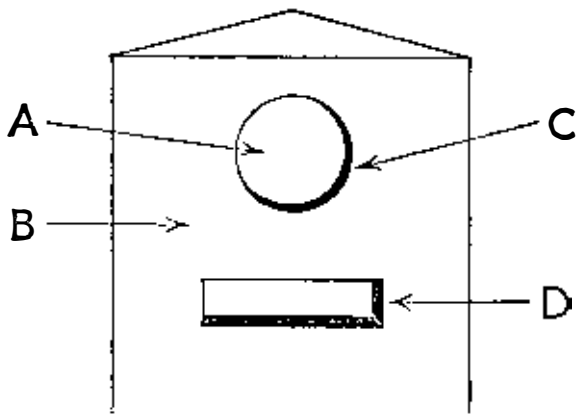


FIG. 8. Corner enclosure for speaker. Walls and floor are utilised, and the inner wall should be insulated with a damping material (e.g. beaver-board). A: loudspeaker mounting; C: mounting diameters—15 in. loudspeaker—13 in.; 12 in.—10½ in.; 8 in.—6¾ in.; D: vent in direct proportion to loudspeaker orifice; B: ¾ in.—1 in. pine board.

large picture on the wall with its sheet of polished glass. This same glass—or a mirror, of course—can start bouncing sound waves about willy-nilly. Nothing is more irritating.

Enclosures for loudspeakers now come in a variety of shapes and sizes, including the pillar type, which can stand in a corner and not look out of place. Women generally adore them. Another type of enclosure is squat and huddles on the floor, practically out of sight.

Get used to the idea that the enclosure and the speaker which lives inside it is going to cost money. Do not be put

SPEAKERS IN THEIR BOXES

off by prices. It is vital that you buy the best you can afford, because it will be in use just as much as the rest of your hi-fi installation.

Do not go in for an unnecessarily complicated enclosure, especially if all you have as fodder for its appetite is a simple tape recorder, disc transcripator and radio tuner. The all-purpose speaker will suit you for the time being. Just because an enclosure looks complicated in the accompanying diagrams, there is no reason to suppose that you must buy it. It is a fact that many of the simpler cone speakers mounted in an infinite baffle will give as much satisfaction as the more expensive ones, which occupy twice the space.

Always brush aside the claim that "this loudspeaker will solve all your hi-fi problems". No such loudspeaker/enclosure—or, for that matter, any other piece of technical equipment—can do anything like that, since every problem is a unique one, and while certain of the common headaches which are shared by all hi-fi enthusiasts are practically identical (how to get rid of hum, etc.), the solution is not always the same, because hi-fi systems comprise matching units made by different firms, some old established, some new.

Hi-fi tends to fall into two different camps where the design and appearance of equipment is concerned. In the first one the addict wants equipment to look like equipment. In the second, where there may be a certain amount of wifely pressure—"Don't litter up the lounge, *darling!*"—there is no alternative but to disguise it if possible. A number of firms will design a suitable console to house the tape recorder, disc transcripator, tuner and amplifier, and this is a job which the home carpenter can also tackle. In the design of a console you should allow as much room as possible for the component parts. The standard idea is to have a desk-like structure with cupboards for tape and tool storage underneath. Ventilation is something to

PLACING THE LOUDSPEAKER

bear in mind, because any electrical equipment tends to generate a great deal of heat. However, a few disguised vents, etc. should attend to that problem quite adequately.

Now that the speaker is installed, you should apply a rough rule of thumb to see just how adequate it is for your needs. It is reckoned that in order to reproduce a low-frequency sound, the room must be as long as the wavelengths before it will properly reproduce. This means that a 50-cycle note is heard to advantage only in a room which is 24 feet long. For hi-fi families a 12 foot room is generally ideal.

After the dealer has departed and your wife has gone to the pictures "to get a bit of peace and quiet", you have a chance to experiment with the placing of the loudspeaker. Sound can be bounced off the wall (neighbours permitting in a semi-detached) with surprisingly good results in many instances. Of course, if you have an ordinary straight-walled room, it is quite possible that the best listening point will be down at the far end. Try it and see. Then reverse the procedure, especially if the sound waves have to bounce against the windows.

For such tests use the same recording over and over again, otherwise your attention may wander from the aim of the experiment to the music, and you will lose track of what you are doing.

9

AM/FM TUNERS

Radio tuners tend to be the hard-working Cinderellas of the hi-fi world, taken for granted and often not used to advantage, although they have tremendous range when it comes to working at the compilation of a library of recorded sound, providing pleasure through the VHF (Very High Frequency) facilities introduced in the last few years by broadcasting stations. Quite apart from providing a steady stream of sound of the highest imaginable quality (dependent, of course, upon the standard of the rest of your hi-fi installation), many tuners can also bring you the television sound channel; for many programmes comprise talks, discussions, orchestral concerts and other odd snippets which are in themselves interesting without the visual element.

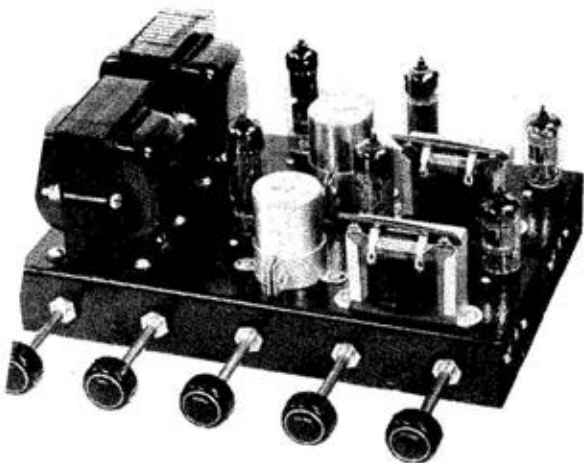
Like everything else in hi-fi, there is much to be said both for and against the acquisition of a radio tuner.

You may already have a perfectly good VHF radio receiver. By connecting it to your tape recorder from the outlets at the rear of the set, you are able to make perfectly good recordings. Or *are* they as good as you think they are?

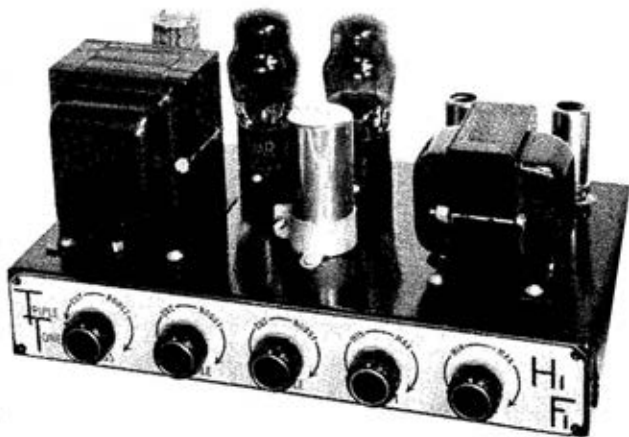
Of course, if all you want to do is to create a library of broadcast talks or plays, you can get along on this system. The only criterion is that you should be able to distinguish what people are saying.

What it boils down to is one simple question: "Do you want *real* high fidelity perfection or don't you?"

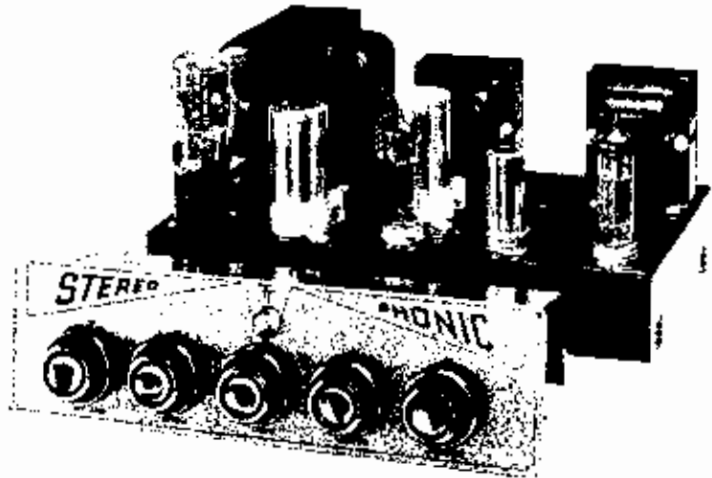
What a tuner can give is "presence sound", the you-are-



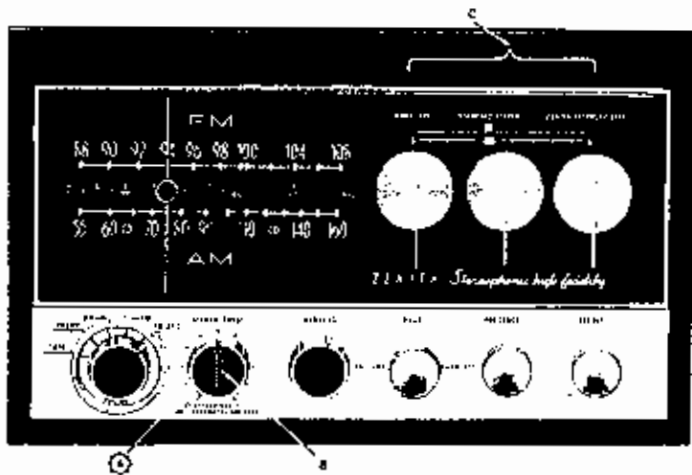
Two amplifiers coupled together for stereo.



Utility amplifier without casing.



General utility stereo amplifier.



Stereo amplifier and tuner in one enclosure. A: Stereo/Mono control; B: Automatic balance control; C: Indicator.

there touch which characterises high-fidelity. It is no use spoiling this particular vessel for want of a few dabs of tar. A tuner which can cost a fraction less than a medium-priced radio receiver is going to be integrated with the rest of your hi-fi system and it will be much more reliable than any ordinary radio, giving years of trouble-free service. In the last resort it is the quality of the reception that matters.

Tuners do not come equipped with a loudspeaker system. The signal must be fed through an amplifier and a separate speaker system. Your first reaction during an initial hearing when it is all quite new to you, is that you are hearing the sound as it is heard at source, in the broadcasting studio. This is, of course, quite correct. No ordinary commercial radio receiver can provide such presence.

Tuners arrive in two types, AM and FM (*Amplitude Modulated* and *Frequency Modulated*).

One of the major advantages of FM is that it is completely free from all kinds of oscillation and the irritation of "atmospherics". Regardless of broadcasting conditions, what you get is a sound which is entirely true to life.

But what is a tuner? It can be simply defined as a radio receiver without a sound reproduction system, and its two chief characteristics are *selectivity* and *sensitivity*.

The design and construction of a tuner should be such that sensitivity, selectivity and true fidelity are the prerequisites. As a result, special component parts have had to be developed by the industry so that the quality of the programme is retained intact right up to the moment when it comes out of your loudspeaker. In contrast, the ordinary commercial radio receiver coarsens the quality, often due to mass-production methods. A tuner is hand-built, individually tested, so that what you buy is a first-class precision instrument, not just an ordinary receiver.

AM/FM TUNERS

The AM detector is at the heart of the AM/FM tuner. This can be a diode, grid or plate type. The detector itself comes in one of two different types, the *phase discriminator* (also known as an *Armstrong circuit*) and the *ratio detector*. Apart from a few of the usual technical quibbles, there is not a great deal to choose between them when it comes to operating the tuner.

To gain a slightly better understanding of what this is all about we must take a quick trip over the surface of electronic theory in relation to tuners. Even if you know absolutely nothing about electronics, you should be able to make sense of what follows.

AM (Amplitude Modulation) is able to vary according to the frequency of the radio signal. This means that if you have an AM tuner, all radio signals are taken in by the aerial. The tuner then uses its special preselector apparatus (like a computer with a predigested memory unit), and tunes in to the station required to extract the audio voltage. This is then presented to your ear by means of the loudspeaker.

FM (Frequency Modulation) does exactly the same, but with a slight difference. The FM transmitter modulates by means of the frequency of the actual radio signal, which explains why it is free of atmospherics.

What does all this mean? It means that in AM the tuner does its own filtering while in FM the signal is pre-filtered and reaches the tuner in a "pure" state.

There is a vast range of tuners on the market, and it is often difficult to know which of these is best for your particular hi-fi needs. Basically, the choice is governed by price. Price range tends to set the trend of all your hi-fi equipment. It is pointless buying a powerful and elaborate tuner for a hi-fi system of only moderate strength. Buy prudently and do not be overawed by a profusion of knobs, dials and other controls. It is often the simple, almost

THE TUNER AND THE HI-FI SYSTEM

elementary-looking tuner which does the best job. Typical of transatlantic technical development is the large number of tuners which look like pieces removed from a spaceship.

The ordinary tuner looks rather like a car radio, compact and well-designed, functional in line, and very practical to handle. The average weight is between seven and ten pounds, and the majority are already fitted with an output for a multiplex adaptor against the day when stereophonic broadcasting becomes general.

Tuners are quite easy to mount in a hi-fi control console. Some are supplied with special metal brackets and screws for the purpose, although you can, of course, have them free-standing if you are one of those people who enjoy re-arranging your equipment from time to time. Another idea is to mount the tuner in its own box, allowing for ample ventilation, since the circuits do generate heat and to totally enclose them is to invite disaster of a melting kind.

Tuners in the medium-price range are quite easy to operate and use. It is one of the paradoxes that the more you pay, the greater the complexity, especially in regard to tuning procedure.

It is very important to check your existing amplifier against the tuner on which you have set your sights. Do not just go out and listen to a few in a showroom. Take along the specification of your amplifier and make sure that the tuner will be able to live happily with it. In certain instances—rare, admittedly, but still worth keeping in mind—the two components may be quite incompatible. Others may just about perform together harmoniously, but you will not obtain the finest performance from this uneasy partnership. Your dealer will be glad to advise you, providing you supply enough information about your amplifier.

Many manufacturers of AM/FM tuners also market

AM/FM TUNERS

matching amplifiers. This can represent considerable additional expense. You should really give early thought to this whole question of matching components. It may well be that you will decide to buy all the necessary items in one particular range, so you will have no worries (and, incidentally, very little fun in finding perfection!) As a general rule, hi-fi does not work like that. You may first see and hear one particular make of amplifier which you like and buy. Later, you see a tuner of another make, a horse out of another stable, so to speak, and so you buy that too. This, incidentally, explains the crowds of apparently absent-minded professors who crowd into the component shops, fingering the bits and pieces offered for sale.

Tuners are among the simplest pieces of equipment to operate. They normally have a tuning knob and a volume control and that is about all.

FM is not quite as expensive as AM/FM, and it performs best when in reasonably close proximity to the transmitter (within about one hundred miles). Although the country is effectively blanketed with the VHF waveband, in certain parts the reception is weakened by freak geography, but this can be overcome by using the aerial in fig. 9.

Naturally, you should arrange to try out the tuner you have almost decided to buy under home conditions. Some dealers agree to this, some don't. Go to one who does. It shows that he knows his job.

Remember that an AM tuner does not provide absolutely true hi-fi sound, but it is still the next best thing to it. The question is: should you carry out home tests with AM or FM tuners—or both? It depends upon the amount of co-operation your dealer offers. But in any case you should know more about AM as such and FM as such.

THE USES OF AM AND FM TUNERS

Tuners fall into categories. They are FM (only); AM (only); AM or FM, and AM and FM.

We have already discussed FM (only) and AM (only). What about AM or FM and AM and FM? Here are the basic differences:

AM or FM handles only one signal at a time.

AM and FM can be used for the reception of stereophonic broadcasts. If needs be, they can be used to service two entirely different radio programmes into two entirely separate recording or listening systems at one and the same time.

There are certain differences in the AM tuner which should be understood. They fall into two different types, *Tuned Radio Frequency* and *Superheterodyne*.

Tuned Radio Frequency tunes in to stations on a broad band and gives a complete modulation of tone.

Superheterodyne (or "Superhet") tunes in on a narrow band and does not give as full a modulation as the **Tuned Radio Frequency**.

For most purposes AM tuners possessing tuned radio frequency characteristics are the most satisfactory.

Basically, the tuner is built to the principles we have outlined, and location of stations is by means of a calibrated numerical scale and "magic-eye" or meter tuning for achieving spot-on tuning. Others in the tuned radio frequency range are fitted with marked positions and no dial. There is an indicator knob which can be turned to the titles of the transmitters, and this simple action brings in the station loud and clear without any further attention. This type of tuner must be adjusted to your particular region, or area, by the manufacturer.

Any method of preselector tuning has much to commend it, because it obviates the need for knob-twiddling to find a particular station. It can be most useful when you are in a hurry to make a recording and do not happen

AM/FM TUNERS

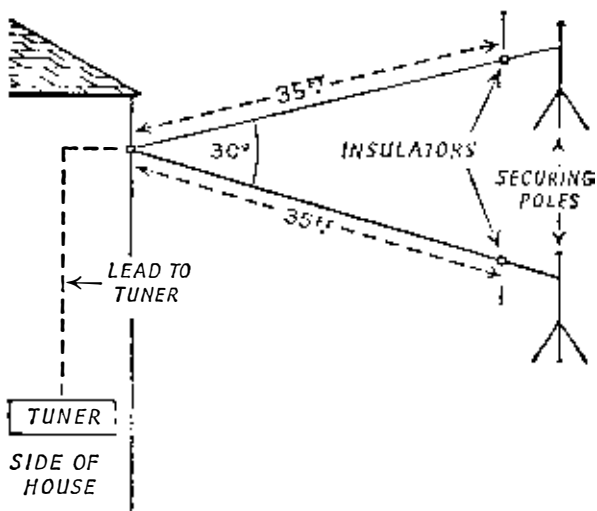


FIG. 9. Rigging an external AM-FM aerial for maximum results. The 30° arc is only approximate depending upon geographical location and proximity of transmitter. The same type of aerial can be modified for use in a loft, but the open-ended triangle should be retained. In exterior use (e.g. garden) the best operating height is between twelve and fourteen feet.

to have time in hand to find the station and tune in.

While we are considering the tuner as part of the hi-fi system, it should not be forgotten that it replaces the ordinary radio receiver for casual or leisure-time listening.

The tuner is designed to get the best out of a comparatively young development in broadcasting, but like any other receiver it benefits considerably from a good

INSTALLING THE AM/FM AERIAL

aerial, and while any odd length of wire may be connected and hopefully laid along the picture-rail, it should be remembered that subtle distortion, similar to "ghosts" in television images, can occur when too little attention is paid to this aspect of reception. If a television aerial is incorrectly orientated, a ghost image appears on the screen. Similarly, with AM/FM the signal can move slightly off-beam and the result is acoustic distortion, which makes it sub-standard as far as making a recording is concerned.

Mr. R. S. Roberts of Wolsey Electronics Limited, Kent, is one of the authorities on the subject of FM aerials. Here are his thoughts on the subject.

"The aerial should be sited in the clear as high as possible, in just the same manner as one would site a television aerial, and with the same object, namely, to extract the greatest possible signal from the arriving wave for transfer to the receiver. (See fig. 9.)

"The bandwidth of the aerial must be adequate to ensure that the frequencies on which the Home, Light and Third programmes are transmitted are received equally well and without undue attention to one of them."

DISC TRANSCRIPTORS AND PICKUPS

One thing about creating your own hi-fi system, you will always hanker after something else with the idea of improving the quality of the sound or else generally enhancing your pleasurable investment. You may acquire an amplifier, tape recorder, speakers galore, a tuner and all the rest of it, but you will eventually want to hear some of those superb commercial recordings made with hi-fi in mind. Step into any record shop and you will be dazzled by the vast array of disc sleeves, in themselves a temptation to new listening horizons. And, of course, you will fall for it, hook, line and sinker. There will be nothing else for it but to add a disc transcriptor to your hi-fi setup.

Like everything else in hi-fi, a transcription unit has other uses. For instance, you can acquire one of the test recordings made by acoustical laboratories for the testing of home hi-fi units. With their tremendous range of electronically produced pure sounds, they are ideal if you want to find out the standard of your handiwork.

You can buy the same sounds on tape, of course, but it is better to use a disc transcriptor if only because speed for speed the turntable is more reliable than the tape recorder.

A disc transcriptor also enables you to make tape recorded copies of favourite discs, many of which can be borrowed from one or other of the postal lending libraries at a very reasonable fees. The copyright laws are very stringent about this copying habit, but as long as "performances" (as the Copyright Act puts it) are confined to the home and you do not charge your friends a fee to

RECORD COLLECTING AND HI-FI

listen to your wizardry, you are quite safe. Nor should you lend the taped copies to the vicar to play at the fete, otherwise an agent of the Performing Rights Society may knock at your door and demand a fee. Ignorance of the Copyright Act is no excuse¹. They can sue you!

Many skilled home hi-fi technicians now have vast libraries of music and the spoken word, painstakingly collected over the years, and their collectors' instinct can be likened to that of the millionaire who owns a dozen masterpieces.

There is also the sheer entertainment of playing the discs through your hi-fi installation, which is a never-ending source of pleasure and one which brings out all the highlights of sound unheard when the same disc is played on an ordinary record-player. One of the anomalies of this business is that many cheap record-players are blatantly labelled HI-FI when they do not comply with the accepted high fidelity standards. In comparison with true hi-fi, the tin-box record-player is an atrocity to be abolished.

In the realm of true hi-fi you do not, of course, buy a record-player any more than you buy an ordinary radio and attempt to introduce it into your setup. What you do is buy a special transcriber which is designed to do one job and one job only.

Some transcription units are already mounted in wooden cases when you buy them, but others require mounting, which is a fairly easy job if you intend building them into a specially-designed hi-fi installation. In the latter case you will be supplied with a simple working drawing by the manufacturer.

Disc transcribers come in two sections, the *arm* and the *turntable*. You can, of course, buy them as a single unit. If you are only just starting out and do not know the technical ropes very well, it is advisable to settle for a

¹ See Appendix.

DISC TRANSCRIPTORS AND PICKUPS

complete unit, and reserve pickup and stylus experiment until later.

Before you even start thinking about what kind of transcription unit you would like to buy, remember this one thing: *you cannot beat a good quality turntable and pickup.*

Whereas in other component fields you may be able to save a little money here and there by buying pieces which are not quite as expensive as you set your heart on in the first place, you will always regret the day when you bought a cheap turntable and pickup. Second-hand ones offered by some dealers are useless, because they have secret flaws which will not become apparent until you use them—and then it is too late. “Surplus stock” turntables generally have bad bearings or something else wrong with them. Settle for one with a well-known name on it and pay the full price. You will never regret it.

You may think that you can convert your old record-player into a transcription unit. This is not really possible. The record-player is not designed for the job. In hi-fi you start with near-perfection and you work towards perfection. Maintain your standards.

The reason why you cannot hope to succeed with a makeshift turntable becomes obvious as soon as you introduce this sub-standard equipment. With the full amplification made possible by your equipment, even the most minute flaws in the disc-playing end of it will be immediately magnified many hundreds of times. If the turntable is a fraction “out” you will hear it. If the pickup arm is faulty, you will hear peculiar noises coming out of the loudspeaker. It will become more agonising as time goes on.

There is another excellent reason—really, the most important one of all—why you should invest in the best. In a word, *discs!* LPs are far from cheap. They operate

THE TURNTABLE AND PICKUP

on the microgroove principle, which makes them more vulnerable than their grandfathers, the old-style 78 r.p.m. record. LPs do need looking after. By using an inferior turntable and an even more inferior pickup, you can easily ruin the microgrooves. The arm may "skate" or jump about or the stylus will plough merrily along, enlarging the groove. You will not notice it for a time, but then comes the shock when you realise what has happened. Even if you do not actually lay any money out on LPs and manage to borrow them from friends or through a postal lending library, nobody will love you for the desecration of their cherished recordings. You cannot blame them for becoming so irate, but for a professed hi-fi enthusiast to be barred from borrowing LPs is akin to being drummed out of the Guards.

While one part of the turntable and the pickup is quite as important as the next, the really vital part of the setup is the *stylus* (in old-fashioned language, the "needle" which no longer exists as such). Today the stylus forms part of the *cartridge*, which is the end section of the pickup arm. As a rule the cartridge can be detached by pulling it out in the same way that an electric plug is pulled out. This enables you to take it to your dealer for examination without having to take half your hi-fi installation along with you.

There are two different types of pickups, the *crystal* and the *magnetic*.

Crystal

This works through the piezo-electric principle. It means that the stylus gathers vibrations from the disc groove, and these are transmitted to the crystal which, in turn, generates electricity on a sort of push-pull basis, similar to the crystal microphone. Crystal pickups compensate automatically for the bass and the treble response, but they

DISC TRANSCRIPTORS AND PICKUPS

happen to have one serious drawback, being temperamental in wet or dry atmospheres. For instance, a crystal pickup may operate quite well in a certain room during a warm afternoon, but then give an inferior performance the same evening if there is rain in the air and the room is not air-conditioned to maintain a steady temperature. In hi-fi circles crystal pickups are not generally accepted.

Magnetic

This pickup works in much the same way as an electrical generator. After the stylus has picked up the vibrations, these move across magnetic lines and create electricity in a wire coil enclosing a magnet. A magnetic pickup requires the use of a preamplifier because it gives a "flat" response. It is the job of the preamplifier to give tonal "colour" to the bass and treble responses. If played flat a magnetic pickup supplies a sound in which the treble is shrill and the bass practically non-existent. This explains the need for accentuation throughout the hearing range. What the preamplifier does is to supply the tonal values, as a painter touches up a picture which is almost completed.

Many amplifiers already contain a built-in preamplifier for just this purpose of compensating the magnetic pickup. It means that you must obtain the correct coding for your pickup, adjust two controls, and then the preamplifier automatically handles the output of the pickup.

Styli

As an important part of the hi-fi system the stylus merits special consideration.

There are two different types, *sapphire* and *diamond*. In the last few years a number of substitutes have been put on the market, but none of them begin to compare with sapphire or diamond because they are "soft" and lack the

CHOOSING THE STYLUS

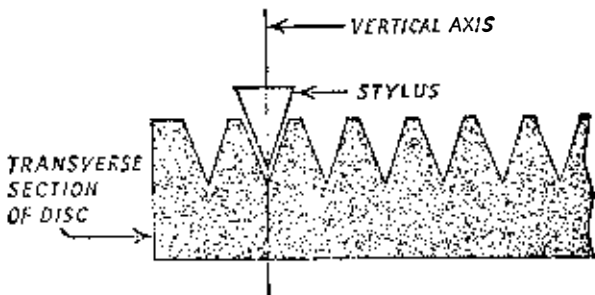


FIG. 10. The correct angle for the stylus in relation to the LP disc for obtaining maximum results.

staying power of the two standard types. Never go by the claims of manufacturers, who are always inclined to rhapsodise about their products. Only by constant use can you hope to gauge the quality of any particular stylus.

What are the requirements of a stylus? Obviously, when you are playing LPs you require one which is accurately made to a very fine tolerance and in such a way that the point of it has little or no contact with the depth of the groove. In the LP the "sound" is on the side of the groove.

A stylus will take on the shape of the disc groove, not vice versa as might be thought. What happens in such a case is that the stylus embarks on a destructive orgy if it is not correctly aligned to the vertical (see fig. 10). In the end it manages to coarsen the entire reproduction by means of hisses and other noises. You will probably think that the disc is "wearing out," but this is not really the case. It is the stylus which is merrily chewing chunks out of the grooves. Given a harmonious marriage, disc

DISC TRANSCRIPTORS AND PICKUPS

and stylus should live happily together for many years.

So what is it to be, sapphire or diamond? Obviously, it *should* be diamond. The drawback is, of course, your own pocket, because diamonds are expensive. As compensation, you can get something like 1,500 playing hours out of one, and even then it will not show much wear.

In comparison, the sapphire is much softer. It may manage to beat the 1,500 hours of the diamond, but only if used solely for LPs, which are made from resilient materials like polystyrene or vinylite.

Sapphires wear out over ninety times quicker than diamonds, they chip five or six times more easily, and they generate twice as much dangerous friction-heat when they are moving in the groove of the disc. When you realise that the stylus operates in the microgroove of a disc which is only 0.0025 in. *across the top*, you will see how important these facts become.

To understand the meaning of stylus wear, try out a worn one on a newly-purchased disc. It will not hurt the disc—just this once! But the quality of the sound will be impaired from the start.

As an investment which will pay a sound dividend, it is a good idea to obtain a pickup head with a cartridge containing a sapphire for old-style discs (78s) and a diamond for the LPs. Dual-purpose heads are common, and special stylus fittings available to meet individual needs.

The stylus represents a smaller investment than any other part of the hi-fi installation, but it is still a vital one. You are advised to give just as much care and study to this as to the purchase of any other equipment.

Turntables are divided into two types, belt-driven and rim-driven.

The *belt-driven* turntable relies upon an endless friction

TURNTABLES AND AUTO-CHANGERS

belt which goes from the motor to the main shaft. There is something to be said for this type, because it is divorced from the actual motor and as such not subjected to any motor vibration, which can infect the pickup with palsy. However, so much depends upon the compactness and general design of your installation, because a belt-driven turntable can occupy considerably more room than the rim-driven model.

Rim-driven turntables are driven directly by the motor, the touching point being the rim. In inferior models there is a great deal of vibration, but recently many precision-built ones have come on to the market and they are well up to professional standards.

If you have been using an ordinary record-player for a few years, you may be surprised to discover that a disc transcriptor unit does not as a rule boast an auto-changer. This is for the very good reason that the majority of auto-changers rely for their operation upon a short drop in which the disc falls down on to the surface of the previous recording. Others incorporate a sliding motion from the side-stack of discs. Of course, the inevitable must happen and a certain amount of surface deterioration is unavoidable. Granted, some hi-fi enthusiasts prefer an auto-changer, but this is not at all desirable when you are copying discs on to tape, since the lightweight LP must be "bedded down" very firmly prior to making the tape recording. In some auto-changers there may be a thin film of air between the disc which has been played and the one about to be played. As this is gradually expelled by pressure exerted by the revolving top disc, a certain amount of aberration may be caused. This, in turn, is transferred to the tape recording and is destined to become a source of constant irritation as far as the perfectionist is concerned.

One other valid objection to auto-changers is that the centre-hole of the disc becomes more worn by this mech-

DISC TRANSCRIPTORS AND PICKUPS

anical handling than if the disc is placed manually on the turntable.

When you start to consider the various makes you will be struck by the fact that a good pickup arm can cost a great deal of money—perhaps just as much as an amplifier. The reason for this is that the best arms are hand-fashioned, only human skill being able to keep the weight down to a minimum. Weight reduction obviously improves performance. Some amazing arms have been made which are only slightly heavier than a large feather.

Hi-fi enthusiasts are preoccupied with the weight factor. It is of primary importance and must be equitable with the rotation rate and motor vibration, any fault in which can make the arm jump or skate across the grooves.

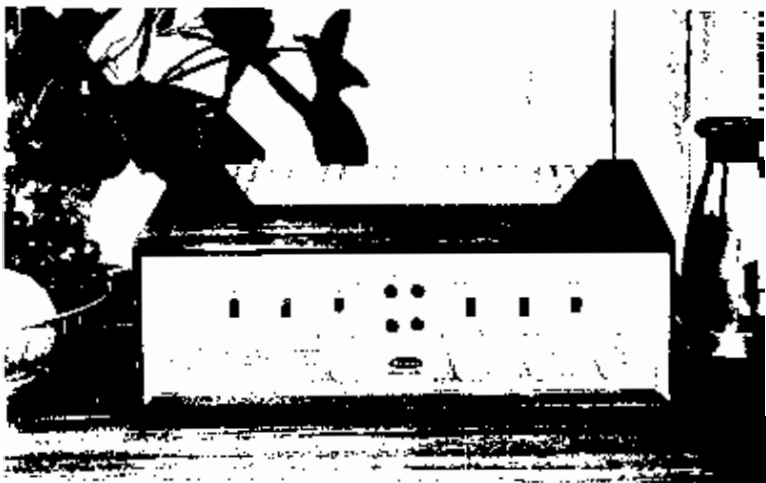
Rotation rate starts with the speed of the motor. This is simple enough to measure with the aid of a *stroboscope*. It usually takes the form of a disc of paper or thin card on which are printed a series of broken circles, one series for each of the standard speeds. Viewed under certain lights the broken line should appear to be “standing still” at the desired speed. Regulation is within a hair’s-breadth, but still easy to achieve because your turntable comes equipped with a plus-and-minus speed regulator. Speed checking should be carried out regularly if you have the turntable in frequent use. Many people use a “strobe” every time they play a disc. It is a good idea.

The turntable itself should be heavy and surfaced with a rubber mat. Some have felt mats, but these impart a certain amount of dust, and dust is the enemy of the microgroove. If your turntable arrives with a felt surface you can always buy a rubber mat separately and lay it over the felt.

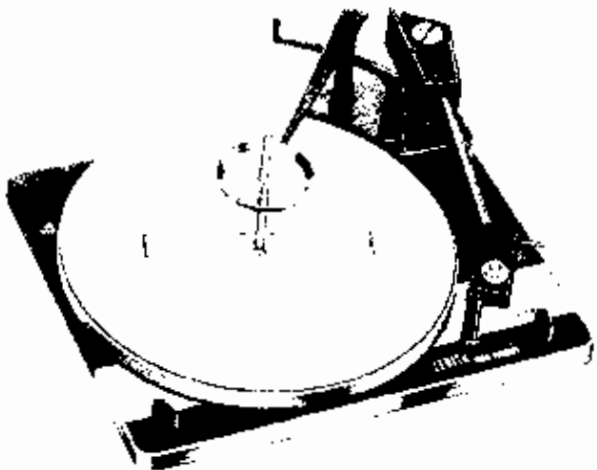
Turntables rotate as a result of being driven by a motor in which a flywheel is incorporated. There are two types of motor, *synchronous* and *induction*. Of the two you



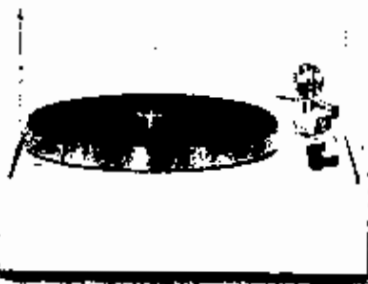
The new look in component design. A German hi-fi stereo amplifier.



An American stereo amplifier which contains every possible utility for the hi-fi enthusiast.



Precision-made disc player suitable for mounting and transcription use by the amateur.



German disc transcriptor, free-standing or for mounting in a console.

THE TURNTABLE MOTOR

would do best to choose a synchronous, because it is linked direct to the power supply, and since this seldom if ever varies, there is little chance of the playing rate becoming affected. The one drawback is that synchronous motors are generally much more expensive. Most of the turntable motors on the general market are of the induction type. In this type the crucial factor is the voltage, which does vary from area to area, although the hazard can be practically eliminated by asking for a *four-pole* motor, which is infinitely more reliable than the two-pole version. Make sure that your dealer understands the difference.

A turntable should be a turntable, plain and simple. While it is a mistake to go for the one with the most gadgets attached to it, there is still something to be said for buying a model with *auto* and *non-auto* controls. This means that you can choose between having the motor switch itself off at the conclusion of a recording or lifting the arm off yourself while the turntable is still rotating. It is especially useful when you wish to copy only one part of a disc on to tape.

In conclusion, a few words about installation. . . .

Installing a disc transcription unit calls for compliance with certain rules if you want to avoid such bogies as vibration and acoustic feedback. Acoustic feedback is a cumulative build-up, due to air vibration from the speaker colliding with itself after rebounding off the turntable. It can be in the bass, in the treble or in both simultaneously. The actual sound may scare you out of your wits if you do not know what is wrong, because it builds up to a crescendo. Unless it is choked at birth, it can wreak havoc in your delicate amplifier. Acoustic feedback is not uncommon, especially where the installation is in a small room. The cure is simple—the individual mounting and separation of the speaker and the rest of the equipment.

DISC TRANSCRIPTORS AND PICKUPS

Several things need to be kept in mind when mounting a turntable. You should make sure there is a very firm connection between the pickup and the turntable. The motor should be comparatively isolated from the baseboard. This can be done by means of springs and rubber blocks, usually supplied with the equipment by the manufacturer. Lastly, ensure that the motor is free to vibrate *separately* from the baseboard and cannot transmit its movements to the turntable.

There is an excellent test to see whether a mounting is effective and while it may be disconcerting to those who are not used to hi-fi, it should still be used. It is perhaps better carried out when wives, children and other lodgers are out for an hour or two.

You simply stand in the middle of the room where the turntable is mounted, start playing a disc about which you care little, and then jump up and down on the floor, taking little jumps at first but with increasing force. Increase the volume until you can hear it distinctly above the sound of your thudding feet. If at any stage the arm skips the grooves, then an adjustment is required. This may consist of longer springs under the baseboard, a fatter rubber block or general insulation. But make sure that you punish the floorboards. If they withstand the onslaught and your turntable does not shudder, you can be sure that the mounting is correct.

11

YOUR OWN SOUND STUDIO

After you have been buying your hi-fi components separately for a time, the moment of truth must arrive sooner or later, and you will want to build your own installation.

True, the decision is often precipitated by a wife who objects to the lounge and/or the living-room looking like an electronics laboratory. Women as a general rule take little notice of the splendid sounds reproduced—they will refer to them as “nice”—unless the gear that makes the sound can be looked at with an aesthetic eye.

After the wife has made her little speech there are two things you can do, (1) make the equipment more presentable in its present location, or (2) take over the spare room and convert it into a sound studio.

The second choice is probably the better one because here you will be able to turn up the volume rather higher than in the lounge, especially when testing your equipment. One does not always want to work with a pair of headphones clapped over the ears.

The spare room must first be insulated so as to contain the sound and to provide that extra something as far as enjoyment is concerned. Insulation is simple to carry out because acoustic tiles are now available in a fibrous material or polystyrene. The first is slightly more expensive, but in any case the cost should not run to more than a shilling a tile, and as these are large in area the whole job need not be very expensive.

However, if you have spent all available money on equip-

YOUR OWN SOUND STUDIO

ment and still need to insulate the room, you can go and see your grocer and ask him to save all the dividing partitions from his egg boxes. Just to make doubly sure of a supply, call on several grocers and ask all of them to save the partitions. Tacked or stuck on to the wall, these make an excellent baffle. If you are colour conscious they can be painted with a matt colour.

The first job is the ceiling, which should be fully covered with acoustic tiles or egg box partitions. It is probably best to use an adhesive for this, because when you have to wield a hammer over your head there is a strain on muscles seldom used, and the aftermath is unpleasant.

Now, what about the walls? They constitute a different problem. While you *can* cover all the main surfaces if you wish, it may easily be that only certain sections require treatment. It all depends upon the location of the loudspeaker installation and the way the sound bounces. Also, a carpet makes a lot of difference, depending upon its texture. A bare floor is often best with a few rugs. It is a good idea to experiment with wall insulation, giving first one area a covering of acoustic material and then another. This should be temporary until you are satisfied with the results, and you can then arrange it permanently.

Another method of containing sound and getting the best out of your loudspeaker is by using heavy drapes on the walls. But this does not mean that the ceiling can go untreated. It will still need the tiles. When you use wall drapes there is a considerable advantage in that they can also look quite decorative. Secondhand materials can be found in junk shops, velvet being the best.

Everything depends upon the dimensions and the shape of the room. No modern home contains a room shaped like a concert hall, and the best one can do is to approximate the conditions and hope for the best. By mounting acoustic tiles on an old screen it is possible to make the

FURNISHING THE SOUND STUDIO

room smaller in the sound sense of the word, but this is often difficult because sound waves have a habit of wandering.

The furnishing of the room is up to you. It is, however, pointless installing large quantities of heavy furniture which soak up sound and kill it. Rather, one or two easy chairs and/or a settee. A simple sound studio is preferable to a crowded one. There is also a possibility of installing the television set in the studio if you intend having the television sound on the hi-fi channel. The only drawback here is that if the family wants to watch a programme and you want to make recordings of a radio programme there is likely to be strife. On the whole, it is perhaps better to confine the sound studio to sound and leave it at that.

Apart from the foregoing you will require a workbench on which you can carry out maintenance work, conduct various experiments, etc. This should be close to the control console, and you should for the sake of convenience have a multi-point extension board installed by an electrician so that you can feed your equipment without grovelling on the floor with an adaptor in search of the power point.

The control console is quite another proposition and one which warrants deep and calculated thought. Basically, it should follow a straight-line design without any fancy bits and pieces as far as the actual bodywork is concerned. It may contain one or two deep and shallow drawers to hold tapes, discs, tools, etc.

Tastes differ as far as the top of the control console is concerned. Some like them flat, others prefer them on the slope. You can take your choice here, but remember that into this surface will be sunk items of equipment like the tape deck and amplifier, the disc transcriptor, tuner and amplifier. (See figs. 11, 12, 13.)

YOUR OWN SOUND STUDIO

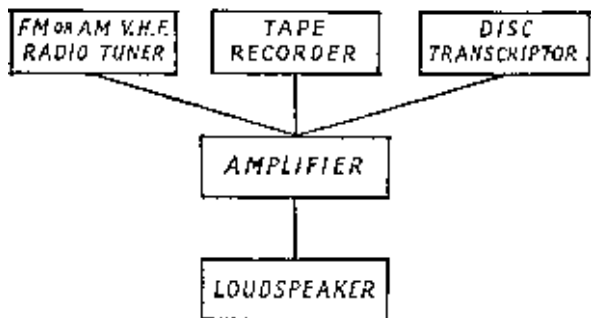


FIG. 11. Schematic layout of a preliminary monaural hi-fi system. Tuner, recorder, disc transcriptor and amplifier can be free-standing or mounted in a control console.

Everything should be quickly detachable so that you have immediate access to the connections. It is not advisable to make rigid and permanent connections, especially in the case of the amplifier which is equipped with a multi-channel pre-selector, because the chances are that you will soon want to experiment with an interesting new combination of equipment. If the equipment is all securely bolted down, it will probably mean undoing all your previous work. Tuners and amplifiers come with a simple metal frame and screws, and it is quite easy to adapt these to your own wants as far as fixing is concerned.

There is no particular technique when it comes to woodworking, except that in a control console all the joints should be firm and permanent to avoid rock and rattle during operation. Thin hardboard is not the best stuff

THE HI-FI CONSOLE

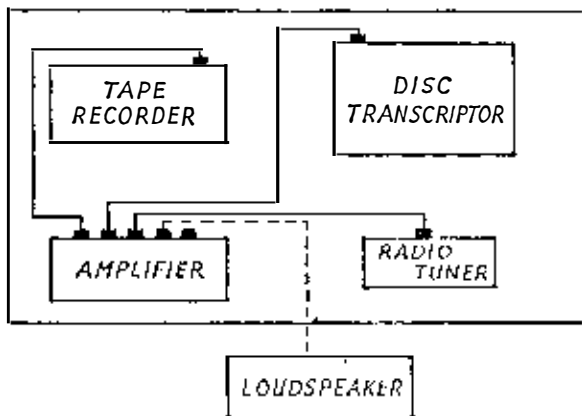


FIG. 12. Simple layout for a hi-fi console, showing leads to loud-speaker and amplifier. Loudspeaker is free-standing elsewhere in room or studio.

for the job unless you are prepared to include plenty of stabilising battens. The best material by far is $\frac{3}{4}$ in. hardwood plywood, which your local do-it-yourself shop will probably stock in 4 ft. \times 8 ft. sheets, veneered or plain.

When constructing the console make quite sure that all the corners are properly cut and mitre-jointed. In the case of a short-length corner, it is often possible to use one of the strong glues now available, but hardwood cleats can also be used for additional security.

Do not use plastic materials anywhere in the construction. They often fracture or shatter. Among unconventional materials is an expanded metal screening in

YOUR OWN SOUND STUDIO

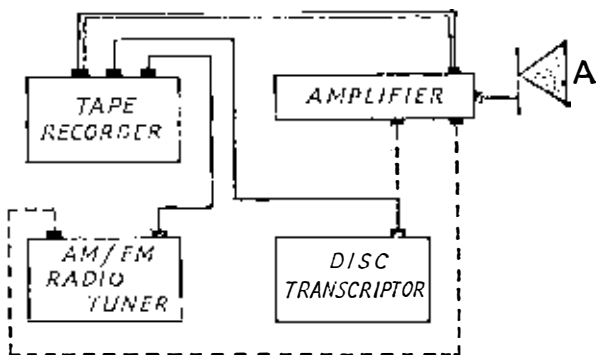


FIG. 13. Suggested hi-fi equipment plan. Broken line suggests an alternative feed system between tuner and amplifier, then back to recorder to obtain additional tonal emphasis. Loudspeaker (A) is for monitoring purposes only, and headphones can be used if desired.

a gold or silver finish, and this can form part or all of the front of the console. This, incidentally, solves the ventilation problem, and it is quite simple to shape, being flexible. There are different thicknesses, and it is useful to choose a very rigid one for a frontage while the medium strength can be incorporated for the sake of decoration, especially in loudspeaker housing frontages. You can cut it with an old pair of scissors and the sharp edges should be filed with a fine-grade tool and smoothed.

Allow plenty of space on the top surface of the console, because you will require quick access to the component controls. It is advisable to paint and finish the surface before mounting the equipment, not afterwards when a

YOUR OWN SOUND STUDIO

shaking hand can easily deposit blobs of paint in the wrong places.

Ensure that the tape recorder has an adequate cover for the times when it is not in use, because dust is the enemy of this instrument.

12

STEREO

Crazes come and crazes go. It is still too early to say with any certainty whether stereo comes under the craze heading or not. It is certainly a dramatic sound and when first you hear it, you are unlikely to forget it for a long time. It has a reality and a depth performance which does surpass single-channel high-fidelity listening, and for that reason it is not the sort of thing to be treated casually, whereas single-channel hi-fi fills the bill when it comes to listening for pleasure. Stereo is much more compelling. It has a sense of occasion!

Stereo is not just two-channel sound. You can, of course, arrange two properly spaced loudspeakers in an ordinary monaural hi-fi installation and obtain a great and satisfying flood of sound in a room, but this is *not* stereo. It is merely a double enlargement of the single-channel sound and, with the aid of tweeters, woofers and amplifiers, a magnification of what you would otherwise be hearing through a single loudspeaker.

Stereo is an extra-special sound, recorded *as* stereo and then put through a system in which it becomes divisible and properly apportioned, not shared as in a multi-speaker monaural system. (See fig. 14.)

This means that the treble appears out of one loudspeaker and the bass out of the other. It does not end there, for in the blending of orchestral tones situated in the middle of the sound-spectrum this division is still quite clearly discernible.

If you listen to a stereo demonstration disc or tape, you

DEMONSTRATING STEREOPHONIC SOUND

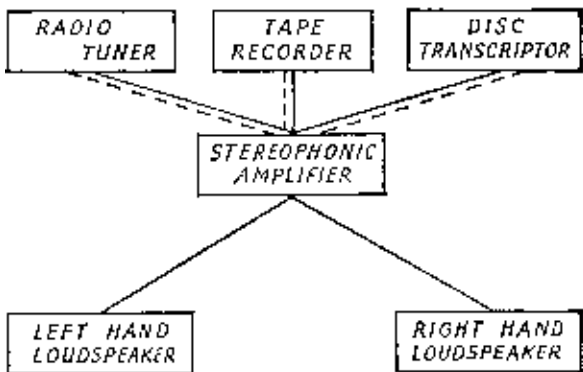


FIG. 14. Schematic layout of a preliminary stereophonic system.

will quickly notice that when an instrument, or instruments, play a full scale, the sound commences on one loudspeaker and then, when it reaches a certain point, "crosses over" to the other speaker. Many demonstration discs include a recording of two people playing table tennis in which it seems that the ball is flying through the air between the loudspeakers. The same with an express train and other representative spatial sounds. First impressions are electrifying if you have any sense at all of sound and acoustics.

There has been a continuing controversy over stereo. The pro single-channel lobby says that perfection on one channel with one loudspeaker at its best is much better than second-rate stereo. For their part, the stereo enthusiasts always emphasise the division of tone colour, the sharp separation of individual notes, the enhancing of

STEREO

orchestral and other works. They think that stereo is the only way of achieving realism.

While everything possible for perfection in sound is offered by manufacturers of parts for hi-fi systems, the fact remains that single-channel sound is inherently false and cannot represent sound as it really is in the concert hall. This is because it issues from a single source and then spreads out. Dependent upon your position in relation to the "spread", it is unlikely that you will receive fidelity in the true sense of the word, although the results may be aesthetically satisfying and quite sufficient for your needs.

Stereo, on the other hand, pinpoints with accuracy the orchestra, the singer or the soloist. In the best examples of stereo you really are "there", sitting right in front of the performers.

Only a few years ago stereo was considered the ultimate acoustic luxury, and while it is still not commonplace, it has attracted many hi-fi addicts and made them lay out that little extra—it need not be very much in terms of hard cash—for the satisfaction of the "presence" sound. Stereo tape recorders are now available, and while they are undoubtedly expensive, they serve a secondary use in that they can also be used for monaural recording. Stereo tapes and discs of high quality are on sale, too.

A stereo tape recorder has stacked heads in order to record two sets of sounds. It is also equipped with additional input and output stages to enable you to feed the two balanced speakers. But stereo does not end there, for the essence of it is *balance*. This means that one amplifier cannot deal with the doubled output. Hence, you require a second amplifier, preferably of the same make and model as your original one. Five watts for each amplifier is quite sufficient as far as power is concerned.

You may at first believe that you can make do with a makeshift speaker for the second channel. Some amateurs

STEREO RECORDING AND LISTENING

try and utilise the monitor speaker of their tape recorder, but it is doubtful if this will yield any success, because such a speaker is meant only for monitoring, and is generally much too small for a full-scale performance.

A limited number of stereo broadcasts enable you to make your own stereo tapes, utilising AM/FM tuners. This is no more difficult than making a monaural tape, except that the balance on the two simultaneously recorded tracks must be adjusted with great care.

Live stereo recording is done with two ribbon microphones resting at ninety degrees between the axes at the point where the sensitivity is greatest. Even in professional stereo recording studios, it is often necessary to carry out extensive tests before the best setting can be achieved. Live stereo recording can be done by the amateur, but it is necessary to experiment first of all.

For private (and often unnerving) stereo listening there is nothing to surpass the use of headphones. More economical as far as the installation is concerned, because it obviates the buying of a second loudspeaker, it has certain drawbacks. For one thing, it is so private that only you can obtain enjoyment from it. This irritates the womenfolk.

If you decide on the headphone method, all you need do is to detach the headphone pieces and connect each to a separate plug. One of these is now connected to one amplifier and the other to the second amplifier.

You should also give each of the amplifiers a fifteen ohm, ten watt wire-wound resistance to run across the terminals of the output. This is necessary because a headphone consumes much less current than a loudspeaker, and the resistance will reduce it accordingly.

13

SOMETHING WRONG?

Electronic equipment that never goes wrong is not manufactured and never will be. While some harsh things have been said about “planned obsolescence” in regard to technical equipment, it remains a fact that the life of good-quality hi-fi gear is generally long and satisfactory. Only in the cheaper and less reputable ranges do you find that a manufacturer issues equipment which will work for a limited period and then pack up. On the other hand—and let’s be fair to the manufacturers—*any* equipment must eventually wear out. Take valves, for instance. They withstand a tremendous onslaught of energy, heat and vibration, and this must in the end make them susceptible to sudden failure. The same goes for transformers, though for different operational reasons.

Where equipment embodies valves it is quite usual for the manufacturer to issue his own guarantee which does not cover the valves. As a rule a separate warranty is issued by the valve maker, though for a shorter period than the equipment itself.

While new equipment may function wonderfully well and give you instant pleasure, causing the application for guarantee registration to be put on one side and forgotten, it is a good idea to post it as soon as possible. Faults can develop quite suddenly. If your guarantee is not registered and you are forced to employ a local serviceman, this can lead to a bill which you will have to pay. With the guarantee in force you can avoid all that extra expense.

MAINTENANCE OF EQUIPMENT

What you should bear in mind is that all the best equipment is certified perfect by a qualified inspector before its departure from the factory. After it is loaded it may have to travel many hundreds of miles by road and rail, and during transit can be shaken up. Given a certain set of circumstances—the dropping of the case, for instance—one of the valves may be jarred sufficiently to put it “off centre” and cause a tonal aberration.

In fairness to the majority of dealers, it should be pointed out that they, too, test the equipment before they accept delivery. Everybody acknowledges that a fault can be hidden which will show itself only after a certain amount of use. Any dealer will be happy to help you without charge if this happens, providing you have not mishandled the equipment.

The time will come when your equipment ceases to be covered by guarantee. One way of safeguarding is by insuring it. The premium is low and there may just be a day when the valves all blow at once or the gear catches fire.

Once your equipment is out of guarantee it is a good idea to be able to diagnose and cure some of the more common ills, saving yourself money in repair bills which can mount high. In hi-fi the faults are easily diagnosed because they can be tracked down to one particular piece of equipment. Of course, repairing that particular piece of gear may sometimes be beyond you, in which case it will have to go to the workshop.

We will take a look at all the main equipment in the installation, and then pass on to the specific ills which afflict them.

It should by now be obvious that the tape recorder is not built to withstand a commando course of being banged about, dropped or jumped on. Even the comparatively stout semi-professional portable machine, which can cost

SOMETHING WRONG ?

in the region of £150, has to be handled gently and with due consideration.

Some people shove their recorders into the boot of the car, where the vibration is great, and then drive for miles. This can cause the valves to ease out of their seatings, quite apart from severely joggling the internal arrangement of hair-like filaments and metal grids.

The best place for a tape recorder when travelling is on the seat beside the driver or in the middle of the back seat, wrapped up in a blanket or travelling rug to minimise vibration.

By carting your tape recorder round with you, it does not mean that you will do it any damage, but constant movement, especially in cars, can give it such a shaking up that it will never be quite the same again as far as performance is concerned.

When the recorder is in general use at home you should treat it to a weekly spring clean. This need take only a few minutes, especially if you are always very careful when using it. The basic need is to keep it free from dust and dirt. Like any other piece of scientific equipment, the recorder has a tendency to attract dust particles because of the heat which it generates. Internally there is nothing much to worry about. The larger quality machines contain a built-in fan arrangement and this repels any dust automatically in addition to doing the primary job of keeping the valves and the motor cool.

The hazard exists on the actual tape deck, and it starts as soon as you thread a tape across the erasing and recording heads.

In motion the majority of magnetic tapes deposit first a microscopic layer of oxide particles on the heads. This is unavoidable, but it can be reduced to a minimum if you use the better known makes of tape. Unless the recording head is kept spotless, the particles will build up

THE TAPE RECORDER HEAD

until the reproduction is "furry" in the bass with an equivalent reduction of treble register. Much depends upon the frequency with which the machine is used. If you are having intensive recording sessions and using it for more than say seven to ten hours a week, the heads should be cleaned every two or three days. If you use the machine two or three times a week for short periods, then a once-weekly session is indicated.

There are various fluids for cleaning the heads, all of them good. Do *not* use petrol, lighter fuel, methylated spirit, "white" spirit or surgical spirit, because it is possible that you may accidentally allow a small drop of these to fall into the head itself. If it reaches the protective shellac coating of the wiring, it will react on the shellac and dissolve it—with dire results involving the purchase of a new recording head.

The best way to clean a head is to gently brush it with a good-quality camel-hair brush, ensuring that the narrow slot is free of all particles. Do *not* use any abrasive substances on this surface.

Another normal occurrence which needs to be kept in check is an accumulation of magnetism in the recording and erasing heads. You will notice this in the form of an increase in the tape noise during playback. It may be mistaken for dirty heads, but if these are quite clean, it means that the magnetic build-up should be dispelled. There are several different de-magnetisers on the market, all reasonably priced. However, if you are only just starting out in hi-fi, it is unlikely that you really need one all the time, so the best thing you can do is take the recorder to the dealer and he will do the job for you for a few pence. On some machines the magnetic build-up is considerable, on others it is hardly noticeable, even after months of wear.

Another fault which can develop quite suddenly is wow

SOMETHING WRONG ?

and flutter. You may use the equipment one day and obtain perfect reproduction, but then, when you switch on next morning, you discover a pronounced wow and flutter without obvious cause. It may well be that you have started the tape recorder too soon after switching on, in which case the fault will soon vanish. Like the old-fashioned non-transistorised radio, many recorders take a moment or two in which to "warm up". In any case, it is unreasonable to expect a drive motor to start from scratch and equal its previous performance. The bearings need time to get going, the entire circuit requires energy. For this reason it is a good idea to remove the tape and let the drive motor run for a few minutes.

If the wow and flutter persist, the fault must obviously be elsewhere. It pays to take time to carefully check the different parts of the machine, and you should start at the capstan. Here again, dust is the enemy. But wow and flutter are caused as a general rule by tiny pieces of tape of the recording and splicing variety adhering to the magnetic head. These can be wiped off with a clean rag, after which you should try again. If the fault is still present, take another look at the capstan. The slightest smear of oil on its highly-polished surface can be the culprit, because it causes the capstan surface to lose its tight grip on the moving tape. This, in turn, affects the tension.

In the normal course of events it is enough to give the surface of the capstan a wipe over with a dry, lint-free cloth. This part of your recorder is generally made of solid brass, and some enthusiasts mistakenly use a branded metal polish to bring up the shine. This is a mistake. Many polishes contain acids which, although fairly mild, can damage the capstan and perhaps impart minute quantities to the surface of the tape.

If the capstan surface is really dirty the best way of cleaning it is with carbon tetrachloride, obtainable from

ELIMINATING WOW AND FLUTTER

any chemist, but use this substance sparingly and do not soak the capstan.

This is not necessarily the end of your wow and flutter headache. One other cause, often overlooked by amateurs, is when the take-up spool is larger or smaller than the feed-spool. Both should be the same size.

It often happens that you wish to rewind tapes and transfer certain lengths to smaller spools. In that case the best way of doing it is to locate the beginning and end of the desired recording, and then mark at appropriate points, marking the polished side with a piece of coloured splicing tape or a chinagraph pencil. You then by-pass the recording heads and wind straight across the machine.

The last cause of wow and flutter can be a fault in the motor. It is not advisable to tackle this one by yourself, but to take the machine to the dealer. It is quite possible that he will return the entire recorder to the manufacturer. It takes time, but you can be sure they are doing a thorough job on it. Many firms automatically give the machine an overhaul, and this is included in the repair price.

Hum is another of those irritating faults which needs to be tracked down with patience, especially when you have a large hi-fi installation with many different component parts. The sound may appear as soon as the new equipment is plugged in and used, or else it can develop gradually. It always appears in alternating current (AC) systems, due to the 50-cycles fluctuation.

A certain amount of hum is contained in every piece of equipment, but the manufacturer should in his specification give the level of audibility. You can be sure that it should be barely noticeable when the volume control is turned up to maximum.

Thus, there are two main sources of hum, the power supply and the equipment itself.

If hum is heard when the hi-fi system is in ordinary use,

SOMETHING WRONG ?

reversing the plug. If you are using the three-pin type, reconnect the wires. It is quite possible that you are using them "back to front", and this in itself can cause the fault.

It is also a good idea to discover whether the electricity supply is properly earthed.

Another cause of hum is a live television set in the same room. Since television set sound reproduction units are of such poor acoustic quality, you are liable to pick up all kinds of extraneous sounds from them. Fans, too, are offenders. However, this applies more specifically when you are making a microphone recording in the same room, and the sound of the television set or fan is picked up and recorded automatically without your realising it. By the time you hear it on playback the greatly amplified sound will suggest that something has gone wrong with your equipment.

Faulty jack-plug connections also cause hum. If you are using screened leads and the soldering is not done cleanly, this can set up irritations. Temporary connections are prone to the same trouble. Screened cable is often difficult to handle, because the woven outside metal sheath tends to break off when you twiddle it round to insert it in the plug or solder it. When you strip back the insulated covering, allow a generous quantity of the woven metal, and make sure that it is firmly soldered. The internal conductor is, of course, conventional wire and much easier to handle.

It is best to use screened cable for all equipment-to-equipment connections, because it is made to recognised high standards for this work. Some amateur recording enthusiasts try and make do with cheap electrical flex bought in chain stores at a few pennies a yard. This, too, can create hum. Screened cable is inexpensive and is a good investment. It should always be used to "bridge" amplifiers and tuners, tape recorders and disc transcriptors.

FAULTS IN THE TAPE

If there is nothing wrong with your equipment, the fault may be in the tape itself. While being tough and resistant to hard wear, it can develop various aberrations. It is as yet too early to predict its storage life under ideal conditions, because tape recording is still a young science. However, tests show that the most common faults are due to accidental erasure, sticking, shedding (of coating), print-through, induced noise, change of dynamic range and inability to erase.

Accidental erasure can happen in use or because you have parked a large magnet near the storage container.

Sticking means that it is below par and generally government surplus tape, sold cheaply. It will not feed through the recording head and capstan.

Shedding means that the coating breaks away in use. Cheap tape is prone to this.

Print-through means that you can hear a "ghost recording" in the background. It may be some time before you identify it as part of the same tape recording. This is caused by a magnetic phenomenon in which the "pattern" is transferred from one layer of tape to the other. It can be avoided by re-winding the tape "inside out." This is simple enough if you put a twist in it after it leaves the heads.

Induced noise is when extraneous noise suddenly appears on the recording. It can be simple distortion or a shriek. Again, it can be caused by storing the tape in the vicinity of a powerful magnet.

Change of dynamic range means that the recording when replayed after a long time in store has lost its previous clarity, etc. This is due to the quality of the tape.

Inability to erase is caused by making the original recording too close to the limits of level. In other words, it is deeply "imprinted" on the tape. It can be cured by using a bulk eraser (or your dealer may offer the same

SOMETHING WRONG?

service without the necessity of buying one), or you can run the same tape through the machine at "Erase" until the sound finally vanishes.

Tape should be stored in an equitable temperature. In the region of 60 to 70 degrees Fahrenheit is ideal. It should be kept in a circular metal container, well away from any magnetic field, and with a tension slack rather than tight. Tight winding can lead to print-through. Sudden changes of temperature can make the tape brittle so that it breaks without reason.

Something else can affect the quality of the playback. This is the alignment of the recording head. If it is slightly "off", you will not obtain a perfect recording and so the playback will be bad, too. This is called "frequency response distortion". It means that the head is misaligned and should be corrected to exactly 90 degrees to the edge of the tape.

Aligning a recording head calls for patience. It depends to a certain extent upon the method of adjustment incorporated by the manufacturer. In the majority of machines it is done by the turning of one screw, which is set close to the head and connected to a rocking device to tilt it one way or the other.

You cannot align a recording head unless a pre-recorded tape is passing over it and emitting a signal. Many of the test tapes incorporate a few minutes of this pure sound, and it is best heard on headphones in order to keep extraneous sounds out. These test tapes are made on machines where the heads are set at exactly 90 degrees to the tape. It means that you align your recording head with theirs. However, the human ear being as fallible as it is, it is a good idea to invest in a small meter-device, which will give you an accurate visual indication.

A certain amount of general trouble can be caused when you decide to build your own control console and forget

VENTILATING AND CLEANING

to calculate for the escape of heat generated by recorders, tuners and amplifiers. Air should circulate all the time, otherwise what happens is that blankets of air are warmed inside the equipment. The surrounding temperature rises quickly, and within the equipment the valves are not receiving any breathing space. This can eventually lead to the melting of wax insulation, even a short circuit. There is no more disturbing sight than a thin column of grey or white vapour rising from a console!

The ventilation points need not be conspicuous or ugly. You may even incorporate them as decorative louvres. If they are the shape of holes bored in the wood, hiding them does not matter very much. Larger ones up to the size of a soup plate can be covered with a thin decorative cloth or the expanded metal screening or mesh referred to earlier.

Probably the best way of cleaning the interior of any equipment is by means of vacuum cleaner suction. Do *not* use the blower attachment. It only means that the dust which is blown out will go elsewhere and settle. On the market are several different types of battery-powered suction cleaners intended for wardrobe use. By trimming the circular brush down, it is possible to create a useful tool for running over circuits. If the bristles are soft and pliable, you need not disturb the wiring. But before going to this commendable length to keep your equipment in trim, switch off the equipment and remove the mains plug.

Here are the main faults with the correct diagnostic procedures:

Dead Equipment Throughout. Incredibly, this can happen. Equally incredibly, many amateurs do not think to check the mains plug where the trouble obviously originates. If you plug in and nothing happens, it means that the fuse has blown. Replace it and try again.

SOMETHING WRONG ?

Tape Deck works but Amplifier is out of action. Although the tape deck and the amplifier are actually separate components, they are supplied complete under the name "tape recorder." In many modern machines the amplifier is separately fused. Thus, if the mechanical section is working and the amplifier does not respond, it means that the amplifier fuse has probably blown. Or there may be a fault in the internal connection between the two. Connecting links occasionally burn out, and this is instantly recognisable as a blob of metal where the melt has happened. Now and then you will see a blackening of the area. Renew the connection—carefully!

Tape Recorder is apparently live but not giving out any sound. This means in all probability that the speaker connections are touching and short-circuiting the actual sound reproduction. People who toss their recorders about like cauliflowers in a market suffer from this. Open the tape recorder and examine the connections at the back of the speaker. Switch off first.

General Distortion. It generally boils down to a faulty valve. Keep a pre-recorded tape running and open the amplifier. Lightly tap each of the valves with the blunt end of a pencil (not too hard!), and listen for an increase or decrease in the *amount* of distortion. If nothing happens, try the valves in the tape recorder amplifier. Be careful where you put your fingers.

Everything is on but the disc on the Transcription Unit is not playing. Faulty connection in all probability, but first of all find out whether the stylus is actually touching the disc groove. Now check the amplifier input. Pull it half-way out of the socket and listen for hum. If you cannot obtain this, have the amplifier serviced, because that is

TOOLS REQUIRED

where the trouble is lurking. Something else to check automatically is the wiring inside the disc transcriptor cartridge. This is very fragile and faults can develop due to constant vibration.

The Tuner is not working at full capacity. Check connections. Now check the "magic eye" or whatever visual means it has to show the optimum tuning on the station. It could mean that you are using an indoor aerial when an outdoor one is required. This is caused by your geographical position, not the tuner.

When the Loudspeaker is on, it rattles. Many of these rattles are just sympathetic vibrations from nearby furniture, ornaments, windows, etc. Keep the loudspeaker working at the level where the rattle occurs, then take a walk round the room, trying to find the source. If you reach the conclusion that the fault is with the speaker after all, check the enclosure and the general housing. It may be a loose screw in the mounting or one of the framework joints which has shaken out of position.

Bass is too bass and Treble is too treble despite the amplifier adjustments. Ten to one it is the tweeter level control which is incorrectly adjusted.

Tools Required

Few hi-fi enthusiasts go in for extensive tool-kits, and the beginner should find that he will need nothing more than the following.

One narrow-pointed soldering iron. Many connections are however made by clamps and screws.

One or two screw-drivers.

One pair of pliers incorporating strippers for baring flex and cable ends.

SOMETHING WRONG ?

At a very advanced stage you could perhaps claim that other tools required comprise an oscilloscope, magnetometer, etc., but their uses and application do not come within the scope of the present book. I have mentioned the dealer-service now and then, because the beginner should make use of it until he has gained a full knowledge of electronics. It is quite dangerous for beginners to tinker with the innards of amplifiers and recorders, and the manufacturers advise against it for the same reason that television manufacturers tell people to call a service-man. Never play about with high voltages unless you really know what you are doing. There have been too many deaths already.

GLOSSARY

Amplifier—Electronic section of the tape recorder which increases the strength of a weak signal. Also applies to an individual part, as in stereo where an extra amplifier is required.

AM Radio—Amplitude modulated.

Audio Frequency—Speed of vibration of sound wave between 30 and 15,000 cycles per second.

Baffle—Generally a large flat board in which the speaker is mounted. Where a speaker is mounted in a wall, the wall itself is the baffle.

Balance—Essential for a good recording. Basically it means that speech and/or music is being recorded at an equitable level in relation to the capacity of the tape recorder.

Binaural—The sensation of sound heard by both ears (as in stereo).

Converter—Equipment which takes direct current (DC) and converts it into alternating current (AC).

Crossover Filter—Filter circuit which handles amplifier output and divides it into two or more frequency bands, which are transmitted to separate speakers.

Decibel (dB)—A unit used for the measurement of sound.

Distortion—The difference between what the human ear discerns and the sound that comes out of the loudspeaker.

Dubbing—Editing parts of one tape on to another recorder.

Extension Speaker—A free-standing or separately-mounted speaker.

External Amplifier—A separate amplifier operating in conjunction with a tape recorder to improve quality.

Feedback (Acoustic)—A squeal or groaning sound caused by sound waves from the loudspeaker being picked up by the microphone or disc transcriber and becoming amplified.

Feedback (Negative)—A device for cutting down distortion.

GLOSSARY

FM Radio—Frequency modulated.

Frequency Response—The efficiency with which equipment reproduces signals in a standard range.

Hi-fi (High Fidelity)—The faithful reproduction of tonal quality.

Jack—Commonly applied to the standard plugs and sockets on tape recorders.

Mixer—A device to take several different sounds from various sources and feed them into a tape recorder at an equitable level.

Pentode—Thermionic valve in the amplifier output stage.

Residual Noise—After a tape has been erased some trace of the previous recording may remain. A second erasing will probably cure it.

Signal-to-Noise Ratio—The background noise on every tape recording. This may be very pronounced or scarcely heard. Can be cut down by screening of plugs and connections.

Thermionic—The conversion of heat into electricity.

Tweeter—A loudspeaker used to enhance treble response.

Woofers—A loudspeaker used to enhance the bass response.

APPENDIX

We would like to draw the reader's attention to the following summary of the present copyright position. Full details of the Copyright Act of 1956 can be found in *The Law of Copyright* by J. P. Eddy, Esq., published by Butterworth & Co. (Publishers) Ltd., London 1957.

Gramophone records enjoy copyright protection under the terms of the Copyright Act 1956; under this Act unauthorised re-recording of gramophone records either directly or from a broadcast (including re-recording on to tape *whether for private purposes or otherwise*) is an infringement of the copyright in the gramophone records which is normally controlled by the issuing record company.

As regards making tape recordings from broadcasts of "live" plays and concerts, the position under the 1956 Copyright Act would appear to be that it would be an infringement of the copyright in the broadcast itself to make a recording without obtaining permission from the broadcasting authority, *unless the recording is made for private purposes only*. It would also be an infringement of the copyright in the literary or musical material being broadcast, *unless the material is recorded for purposes of research or private study only*.

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Tape Recording & Hi-Fi

Interest in tape recording and hi-fi is growing rapidly and in this book, written primarily for beginners, Frederick Oughton outlines the principles with concision and liveliness. He gives advice on all aspects of sound reproduction from the choice and purchase of equipment to its trouble-free operation.

Mr. Oughton explains the scientific basis of recording on magnetic tape and shows the enormous variety of uses to which it may be put. He discusses the actual process of recording and then goes on to the problems of editing and classifying the tapes. He also considers the merits of pre-recorded tapes, which are becoming increasingly popular.

From tape recording the author progresses to the reproduction of records and shows how the basic system of amplifier and loudspeaker may be used to enhance tape and disc. All components and possible combinations of these are discussed, with special reference to the effect required and the acoustical environment. There is also an examination of the problems which arise in the care and maintenance of equipment, followed by suggestions for the organisation of a sound-studio. Mr. Oughton in conclusion compares the virtues of monaural and stereophonic sound.

The book includes a comprehensive glossary of technical terms and an index, and the text is illustrated with photographs and diagrams.

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