HI-FI & STEREOPHONIC SOUND

LAURENCE MALLORY

EXPLAINED FOR THE LAYMAN

Here is a book which, in simple terms, explains many of the baffling problems which seem to arise as soon as Hi-Fi is mentioned. The author has tried to cover a vast subject in easy steps so that everyone who enjoys the advantages that High Fidelity Sound offers them, will be able to get the maximum pleasure from their equipment.

For those who are thinking of entering this new world of sound but have, until now, been baffled by the apparent intricate terminology and wide range of equipment, this book is specially designed to explain, without too much technical data, the outlines and fundamentals of Hi-Fi and Stereophonic Sound.

It is hoped, that after reading the following pages, the average music lover will be able to get the utmost enjoyment from his equipment, *even if his budget is a modest one.*

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HI-FI AND STEREOPHONIC SOUND

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BY

LAURENCE MALLORY

AUTHOR OF "THE RIGHT WAY TO TAPE RECORD"

ELLIOT'S
RIGHT WAY BOOKS
KINGSWOOD SURREY

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You can learn more from books—perhaps even from one book—than from all the universities in the world

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INTRODUCTION

THE introduction of the microgroove record at a price that was well within the reach of everyone's pocket, made Hi-Fi Sound available to all music lovers, whether it was Pop, or Classical, or just something sweet. It is so easy to walk into a shop and purchase a record that contains the best that the manufacturer can offer, that one already takes this service for granted.

This book does not deal with the technical aspects of either High Fidelity Sound, or Stereophonic Reproduction. For those who are technically minded, there are many excellent works available. The aim of the following pages is to give the non-technical minded music lover a brief and concise explanation of how he can hear the music to the best possible advantage and how he can get a set-up which will *best suit his own individual requirements and budget.*

The range of equipment is so large that the beginner may well be somewhat confused. After reading this book it is hoped that the Hi-Fi enthusiast as well as the person who just enjoys music, will be able to get the maximum amount of pleasure from their apparatus.

1

THE RIGHT WAY TO HIGH FIDELITY AND STEREOPHONIC SOUND

THE phonograph, forerunner of the gramophone, was invented by Edison more than eighty years ago. Sounds were registered on a wax cylinder and this was used for playback in much the same way as the modern record of today. Since the end of the Second World War, the record industry has improved greatly, the result being the superb reproduction which it is now possible to obtain from discs.

New words have been introduced into everyday speech, the most common being High Fidelity, or Hi-Fi as it has come to be known. Unfortunately it is often misused to describe equipment that bears no resemblance to the term. The ultimate aim of every Hi-Fi enthusiast is to achieve Concert Hall Realism at home. While it is not possible to obtain the exact effect, the latest equipment brings this aim close to reality.

Several factors are concerned with this "Realism". The human ear, the psychological effect (the concert hall contains an audience of which the listener is a member), the acoustics of the living-room; all have to be considered. It is the aim of this book to introduce the reader to Hi-Fi.

Once the basic principles of sound are appreciated, half the battle is over. Then, with the most moderate priced equipment, the full range of music from Jazz to a complete Symphony Orchestra can be enjoyed in our own homes.

FIDELITY

The faithful reproduction of sound depends on several factors. Perhaps the most important is the loudspeaker, that piece of equipment that is, all too often, taken for granted. Very High Frequency Broadcasting, the Long Playing record, top-quality tape recorders, a large selection of record players, speakers and allied equipment makes the choice rather difficult. There is such a wide variety available that the beginner may well find it confusing. To make the situation more complicated, Stereophonic sound is readily available, the records costing the same price as ordinary Long Playing discs.

After having made our "Journey in Sound", the author hopes that many of the problems that may have puzzled the newcomer will be explained and that he will be able to get the maximum enjoyment from his equipment and the best results from his budget. Shall we commence our "Journey into Sound" always keeping in mind that High Fidelity is our aim? The best is possible for all of us today.

HOW WE ENJOY HI-FI

Music is produced in the studio. From there it either arrives at our home by way of the radio or "Packaged". The latter form can either be Tape or Disc. As discs are

more widely used and offer a large selection of music, it is with these that we will here concern ourselves.

A record is bought and taken home. On it is the best that the manufacturer can produce; High Fidelity sound. It is within our means to bring the full range of the Symphony Orchestra right into our homes. The throb of the Bongo drums, the exquisite haunting melodies of the Mantovani orchestra, the wild abandon of Stravinsky's "Rites of Spring" and the nostalgic Neapolitan song from sunny Italy—all are ours to command.

Very little thought will show how much we rely on sound for our enjoyment. When the eyes are closed, the mind paints a picture of our own conception, the only stimulus being the sounds that the ears are receiving. To complete this realism, Stereophonic sound brings the orchestra into the room. It is there, spread out in front of us. Realism has been achieved.

COSTS

How wonderful it would be if you could walk into a shop and buy whatever you fancied! But what a shock when the bill arrived. Fortunately this need not happen. For a moderate sum, it is possible to purchase either a complete unit, or build up an individual set-up by adding gradually as finances permit. Which is it to be? By the end of this book it should not be difficult to decide what is the best for YOU.

The individual is very important, as no two people hear sound in quite the same way. While a full orchestra reproduced in Stereo sound might delight one listener, another

person may find the entire thing too loud and overpowering.

The author recently played a stereo disc of the Vienna Philharmonic to two friends. One of the listeners sat relaxed, savouring every note of what was concert hall realism. The other friend found the performance too powerful. The sound seemed to envelop him and the sensation was not pleasing. Such is individual taste.

Always keep in mind that the equipment is for your entertainment. What do you find pleasing? It is for you to choose.

2

SOUND EXPLAINED SIMPLY

WE receive information about our environment by way of five senses: Taste, Touch, Smell, Sight and Sound. There is little doubt that Sight and Sound play a major part in everyday life. Yet how often do we take these for granted? Every time a cinema is visited, sight and sound provide the means of entertainment although smell is a sensation that appears to be just around the corner.

Sound is so commonplace that many people the author has talked to miss the wonders of Stereophonic sound in the cinema. The effect is realism. As we hear the same thing every day, it seems quite natural to the listener. In fact it *is* natural. Why should the ear be amazed when the sound follows the picture? After all it is quite normal for the sound of a person's voice to follow him across a room.

WHAT IS SOUND?

Like many simple questions, the answer often provides difficulties. Sound is a longitudinal air vibration that affects the human ear and that of animals. Let us take an object which is vibrating. The motion of the object affects the air immediately surrounding it, causing it to vibrate. This, in turn, affects air further from the source to be set

FIG. 1

in motion. A sound wave has been produced which travels outwards from the source in a longitudinal wave form.

To visualise a sound wave, let us imagine that we have thrown a stone into a pool of water. As the stone hits the surface of the water, a series of concentric circles are formed, radiating outwards in all directions. The spaces between the ripples represent the spaces between the sound waves. The stone is replaced by the cone of a loudspeaker which is our vibrating body (Fig. 2A).

The loudspeaker cone vibrates backwards and forwards

as electrical impulses activate the mechanism. Each forward movement of the cone produces a wave of pressure in the surrounding air, corresponding to our ripple in the pool of water. This wave spreads outwards and is followed by another wave.

As the cone is moving both backwards and forwards, there will be a space between two waves of pressure while the cone is moving in the reverse direction. This is an area of rarefaction or negative pressure. Having completed the movement the cone then commences to send out another wave of compression.

Fig. 2B illustrates this series of events which make up a cycle.

FIG. 2A.

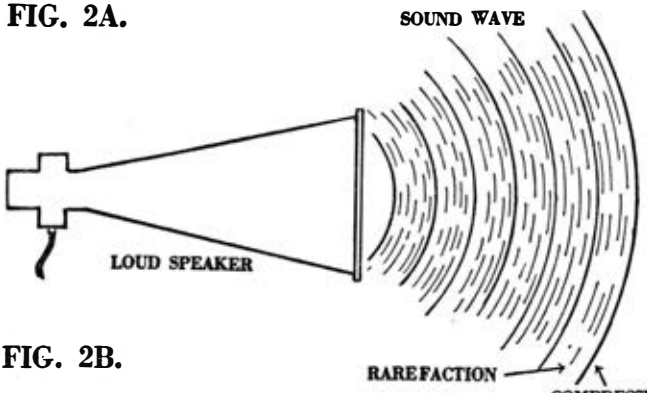
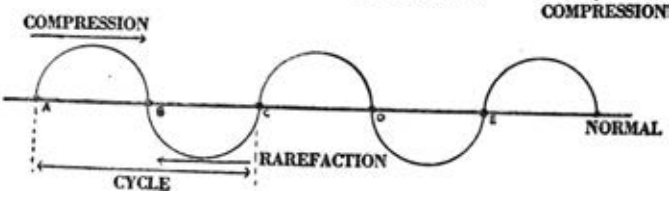


FIG. 2B.



CYCLE

Naturally the above series of events occur many times each second. One forward movement of the cone (a wave of compression) followed by a reverse movement (wave of rarefaction) produce a cycle. The diagram resembles an alternating current. The compression wave is represented by the positive section of the line between points A and B. The second half of the cycle is in reverse (rarefaction or negative pressure) shown by the line from B to C. These two movements together form one complete cycle (points A to C).

FREQUENCY

The loudspeaker has set the surrounding air in motion producing positive and negative pressure waves. These changes occur rapidly, the number of cycles taking place every second being known as the frequency. This frequency is often noted as c.p.s. (cycles per second).

The piano is convenient to use for our illustrations as it is one of the most common of instruments. If a string is plucked, it will vibrate very fast, the movement setting up waves in the surrounding air. The *number* of vibrations produced each second by that particular string is the *frequency* of the note.

The piano has quite a wide range of frequencies ranging from about 20 c.p.s. up to the region of 4,200 c.p.s. The difference in frequencies is produced by the difference in the strings. The piano string varies in length, thickness and tension. If a string is tightened up—a violinist does

this when he tunes his instrument—the frequency of that particular string will vary. The greater the tension, the higher the frequency. The higher the frequency, the higher the note that our ear receives.

Some confusion might be caused by the term "Pitch". A musician will place a note in the musical scale by its pitch. The sound engineer will refer to this as the frequency of the note. When an instrument is tuned, as in our example a piano, the strings are tightened or slackened until the correct pitch (frequency) is found for that particular string.

HARMONICS

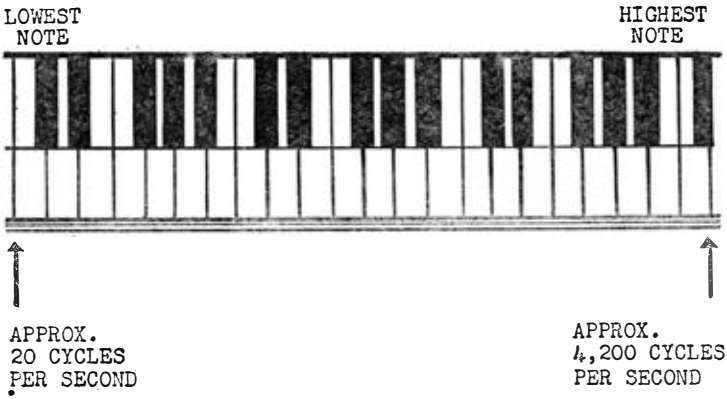
It should follow that a string tuned to the frequency of middle C should sound exactly the same whether it is on a piano, violin or 'cello. This is not the case. The frequencies that we have been discussing are the *Fundamental* tones; the single note produced when a string is plucked.

Despite the fact that the fundamental tone is the same in all the instruments for a given note, harmonics give it a difference which enables the ear to distinguish between the different instruments and even between two instruments of the same type.

Suppose we strike a note that has a fundamental frequency of 200 c.p.s. The string will vibrate at this frequency, placing the note for us in its correct position in the musical scale. As well as vibrating as a whole at 200 c.p.s., the string will also vibrate in sections. If the fundamental frequency is 200 c.p.s., the two sections will

FIG. 3

PIANO



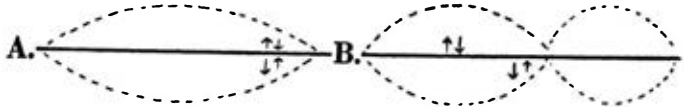
vibrate at 400 c.p.s. This secondary vibration is known as the second harmonic. Third, fourth and fifth harmonics are possible, each one adding to the complexity of our original note. As each harmonic contributes to the total energy of the sound, they play an important part in its production.

We have seen that a note depends on its frequency and the harmonics involved; we have now to understand how these sounds are received by us, the listener.

THE HUMAN EAR

Sound is created by a body set in motion. This, in its turn, activates the surrounding air. The waves of compression and rarefaction radiate outwards to be picked up by our ears. Here the reverse motion applies. The move-

FIG. 4



STRING VIBRATING

VIBRATING IN TWO PARTS TO GIVE THE SECONDARY HARMONIC

ments in the surrounding air are collected by the Pinna, the external visible part of the ear. In animals this is movable. The sound wave travels down the Auditory Canal and moves the delicate membrane known as the Ear Drum.

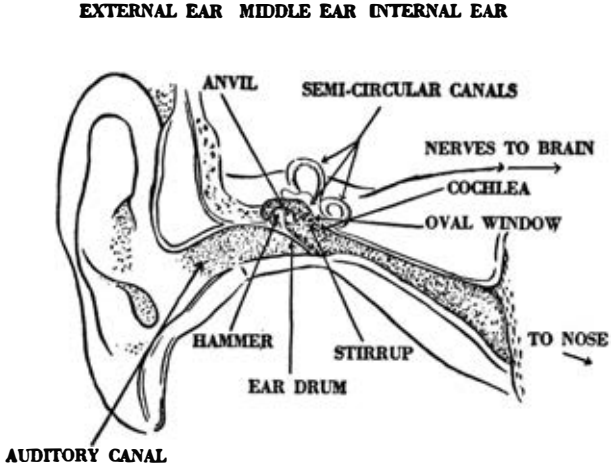
Each wave of Compression and Rarefaction causes the membrane to move backwards and forwards, though these movements are very slight. On the inner side of the Ear Drum lie three bones, their function being to magnify the movements of the membrane. The three bones, the Hammer, Anvil and the Stirrup, are in the Middle Ear. The Hammer connects with the inner surface of the Ear Drum. In its turn it touches the Anvil. This bone links the Hammer with the Stirrup which connects with the Inner Ear. The bones conduct and magnify the sound from the Ear Drum and transmit it to the Inner Ear.

To keep the pressure equal on both sides of the Ear Drum, the Middle Ear connects with the back of the Throat. When this passage becomes blocked, when we have a cold, slight temporary deafness might be experienced due to the inequality of air pressures on either side of the Drum. Most of us have experienced this effect when flying.

The Inner Ear is filled with fluid and contains nerve endings which connect it with the brain. The three bones cause vibrations to be set up in this fluid which stimulates the nerve endings, the sound being passed on to the brain.

FIG. 5

THE HUMAN EAR



The Human Ear is sensitive to frequencies from about 20 to 20,000 c.p.s. This range varies with age and the response is not equal throughout the entire acoustic spectrum. Many people cannot hear the 10,000 cycle sound transmitted when a television receiver is working. Our ears also enable us to hear Stereophonic sound, although the exact way in which this occurs is not quite

understood. Like Three Dimensional vision, it is necessary to have two ears to appreciate Stereo sound.

Understanding what a sound wave is and how we are able to receive it will aid us in the following chapters when loudspeakers and Very High Frequency radio are discussed.

3

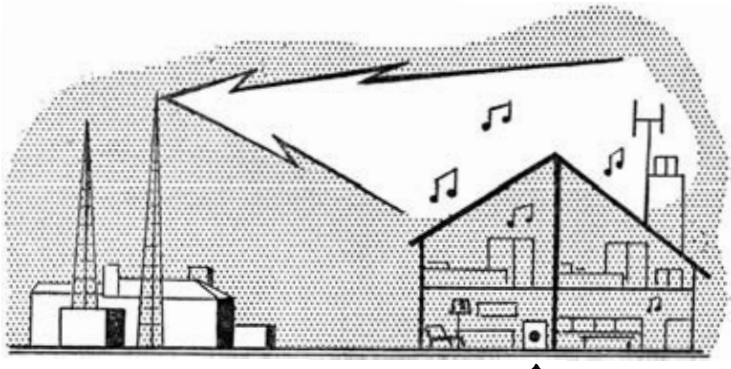
RADIO–TAPE–RECORDS

As we have the choice of three different methods of top-quality sound, Very High Frequency Radio, Tape Recordings and Disc, it is of interest to briefly examine these three mediums. As television sound is part of a visual medium, it will not be included in this chapter. Once again, in the last 15 years, radio has made great strides, most of the country now being within the coverage of V.H.F. or Very High Frequency, often called F.M. (Frequency Modulation). As the time is, we hope, near when regular Stereo transmissions will be a feature of broadcasting, Frequency Modulation radio is of interest. It also gives us much better reproduction than the older A.M. (Amplitude Modulation) system, although the latter is still widely used and will continue to be.

RADIO

Eleven years after Edison and his phonograph, Hertz observed the phenomenon of the transmission of speech by electro-magnetic waves. It was Marconi who applied this to practical use. Radio waves radiate from the sending station. Many of them shoot into the sky, being reflected back to earth by the various layers in the upper atmosphere, particularly the Heaviside Layer situated at

FIG. 6



a height from fifteen to twenty miles above the earth's surface.

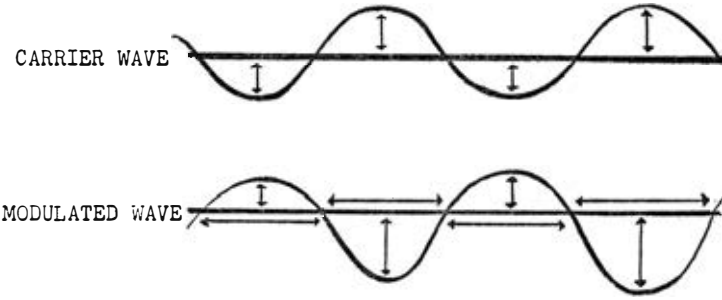
As these reflecting layers in the atmosphere vary, the radio waves are reflected back at different angles. We have all experienced the annoying fading of a foreign station, due to this trouble. Reception is best at night, but unfortunately interference is also bad at this time.

AMPLITUDE MODULATION (A.M.)

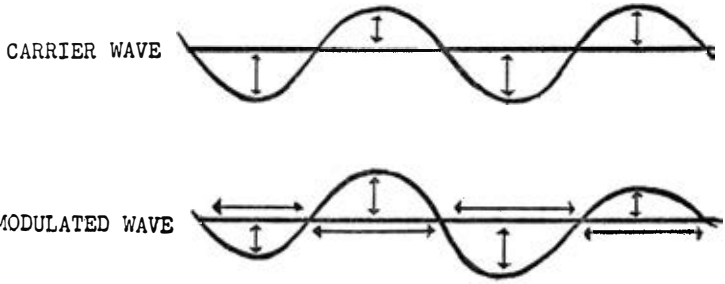
A radio wave can be made to act as a carrier for an audio signal. Something like a bus going between two points and taking us along its route with it. Fig. 7, on page 26, shows a *carrier* wave. The width of the wave (amplitude) remains the same. When an audio signal is added to the carrier wave, the *amplitude* of the combined

FIG. 7.

A.M. AMPLITUDE MODULATION



F.M. FREQUENCY MODULATION



C. FILTERING OF INTERFERENCE

wave varies according to the frequency of the audio wave. The wave has been subject to *Amplitude Modulation.*

This method of broadcasting while being very satisfactory, suffers two disadvantages. Firstly the amplitude of the carrier wave radio can be affected by static electricity (e.g. Lightning). So our wave picks up interference which, apart from being unwanted, can be most irritating to the listener, even spoiling a complete broadcast if conditions are sufficiently severe.

Secondly the frequency range in Amplitude Modulation transmissions is limited. A radio station is allowed only a certain width of band to broadcast on, about 9–10 kilocycles. That means that the frequency range must be within these limits. Also, to overcome static, radio stations often condense the range of transmission, and broadcast at maximum loudness to overcome interference.

As the band width is only 9–10 kilocycles (a kilocycle is 1,000 cycles) it is appreciated that the dynamic range of the broadcast falls short of the range that we are able to hear (20–20,000 cycles).

FREQUENCY MODULATION (F.M.)

A tremendous advance was made when it was discovered that a Frequency Modulated wave could be demodulated. While in Amplitude Modulation transmissions, the carrier wave varies in amplitude according to the audio frequency it is carrying, in Frequency Modulation, the *frequency* and not the amplitude of the wave is varied by the audio signal. Fig. 7 shows our carrier wave and how its frequency is altered by the audio signal.

Two advantages with this system are, firstly that static is virtually eliminated as it affects the amplitude of the wave and not the frequency. Thus Frequency Modulation reception has given us a broadcast free from all annoying interference. To be technical, lightning does affect the Frequency Modulation signal slightly, but this is so small in proportion to the audio signal that we can ignore it.

Secondly, as the Broadcasting Stations have wider bands on Frequency Modulation transmissions, it is possible to produce Higher Fidelity of programme material. As there is no background noise to be overcome, the transmission hasn't any difficulties with a quiet passage of music which might well have been lost in the static of an Amplitude Modulation broadcast.

Fig. 7C illustrates how unwanted interference can be filtered out of Frequency Modulation. The carrier wave with its attendant audio signal is passed through what can be called a filter. While the filter will allow changes in *frequency* to pass, it will reduce the *amplitude* of the wave. Background noise has vanished, our listening become more enjoyable.

TAPE

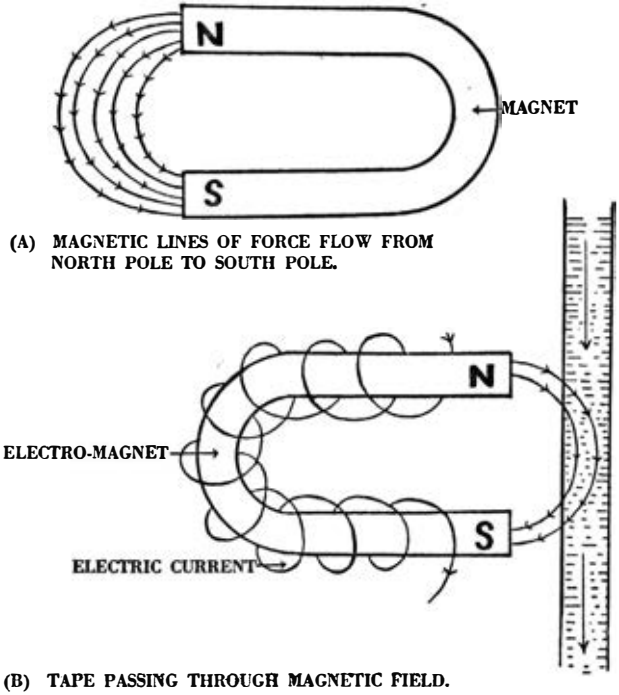
Once again, it was during the war that tape recording was developed and brought to perfection. As it is possible to purchase a tape deck and add it to a High Fidelity set-up, it is worth while discussing tape recordings in this chapter.

Recording tape is coated with a magnetic oxide. As the alternating current, produced by the positive and negative phases of a sound wave, flows through the head

of a tape recorder, the head becomes magnetised, first in one direction, then in the other. This magnetic effect will be discussed in some detail in the chapter dealing with loudspeakers.

These fluctuations in the magnetic field produce corresponding magnetic effects on the tape which is passing

FIG. 8.
MAGNET



(A) MAGNETIC LINES OF FORCE FLOW FROM NORTH POLE TO SOUTH POLE.

(B) TAPE PASSING THROUGH MAGNETIC FIELD.

through the field radiating from the recording head. The final result is that the sound waves have been translated into millions of tiny magnetic impulses on the recording tape.

On playback, the reverse process operates. The tape causes changes in the current passing through the head of the recorder. This is amplified and used to drive the loudspeaker. The speaker produces sound waves corresponding to the impulses received originally from the tape. Then our ears pick up these fluctuations in the air and we hear the music or whatever has been recorded. It is indeed a wonderful invention.

RECORDS

We have seen how sound can reach us through the air by means of radio waves which are used to drive the loudspeaker in our radio. Magnetic impulses on tape can be translated into music in a similar way. Now we have come to the Disc or Record, depending on which term you prefer. Today one has only to walk into any store to be confronted with a staggering selection of material. A record is essentially a disc on which a groove has been cut. The delicate stylus in the pick-up head follows the course of this groove. The movements so produced are converted into electrical variations and amplified. Once again, the signal is fed into a loudspeaker system. With Long Playing and Extended Playing records, the fidelity of reproduction can be remarkable, always providing that the various component parts of the equipment used are capable of getting the best from the record.

4

THE LOUDSPEAKER

So far we have seen how sound is formed and how it travels through the air to reach our ears. We have briefly discussed the three ways in which we are able to enjoy music and how modern science has made it possible for that music to be reproduced as near as possible to "Concert Hall Realism".

High Fidelity has been called a disease. The enthusiast strives all the time for better and more perfect equipment. Eventually he finds that financial difficulties have become more pressing than another, and more perfect, piece of equipment. This is, of course, carrying matters to an extreme. Providing the equipment produces, for you, top-quality sound, bringing the concert hall into your living-room, then *you* have achieved that realism. The world's finest orchestras play for you, spread out only a few feet away, or so it seems. Fantastic? Not so. Beyond your purse? Certainly not.

While it has been said that a chain is only as strong as its weakest link, the loudspeaker plays a prime role in the reproduction of High Fidelity sound. If we intend to capture in full what the manufacturer has put on to the disc, we have to be able to understand something about

speakers and how to place them to the best advantage in our own listening area.

HOW A LOUDSPEAKER WORKS

If a simple bar magnet is taken, placed beneath a piece of paper and then iron filings sprinkled on to the top of the paper, the filings will immediately take up the lines of force, running between the two poles (or ends) of the magnet. This experiment has been performed by most of us at school. A magnet consists of two poles, a North pole and a South pole.

Let us take another magnet similar to the first one. If we hold the two magnets end to end, we will find that in one position they will be strongly attracted, while in the other position, where we have reversed one of the magnets, they will repel each other. *Like* poles repel, *unlike* poles attract.

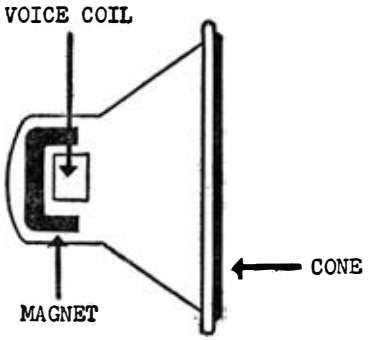
Another fundamental is, that if a magnet is moved through a coil of wire, a current will be generated in that coil. Conversely, if a current is passed through a coil, the bar of metal lying within the coil will become magnetised.

This second application is used to make an *electro-magnet.*

Loudspeakers are of various types, but the most widely used is the dynamic, or permanent magnet type. Basically, the unit consists of a magnet, a voice coil and a cone.

The permanent magnet produces a strong magnetic field between its poles, the lines of force flowing from North to South. In this magnetic field is suspended the voice coil. The coil is connected to the amplifier, being fed

FIG. 9



SPEAKER CONE

by an alternating current. The current through the coil interacts with the magnetic field in which it is suspended. The result of this action is that the coil moves, depending on the forces acting upon it.

The cone of the loudspeaker is attached to the coil. As the latter moves, the cone is made to vibrate in a forward and backward movement, somewhat like a piston. Each forward movement pushes out a wave of compression while each backward movement produces a wave of rarefaction.

We can visualise the loudspeaker as a fist punching out into the surrounding air and then being rapidly withdrawn only to quickly recover and deliver another punch. This movement occurs many times each second to provide us with a note of the correct frequency. Basically, that is the function of a speaker; to activate the surrounding air in

co-ordination with the electrical impulses being fed into the voice coil from the amplifier.

Electro-dynamic speakers do not have permanent magnets. Their magnets are electro-magnets which have to be powered by a Direct Current Rectifier. There are also electrostatic speakers and even ionic varieties.

But let us keep to the type we have just described. Unfortunately it isn't as simple as all that. Most of us have, at one time or another, heard two words connected with Hi-Fi. Enthusiasts will constantly talk about "Woofers" and "Tweeters". To the tyro this sounds a lot of jargon and perhaps makes him feel somewhat of a square. Woofers and tweeters are an essential part of fidelity reproduction. While a single speaker can be very good, our two friends of whom we have just made the acquaintance will prove their worth. Coupled with a crossover network, the listener will quickly discover that sounds have been lying dormant, the existence of which he would never have believed possible.

TYPES OF LOUDSPEAKERS

Different sounds have different frequencies. The deep notes produced by a double bass have a much lower frequency than those produced by an E string of a violin. In a full symphony orchestra, a wide range of frequencies are heard and naturally we wish to receive them as accurately as possible with our equipment.

To put it in its simplest form, large speaker cones handle the lower frequencies best. Small speaker cones are ideally suited to the higher frequencies. These are our woofers

and tweeters. A single speaker can be designed which will produce the audio spectrum remarkably well, handling bass and treble notes.

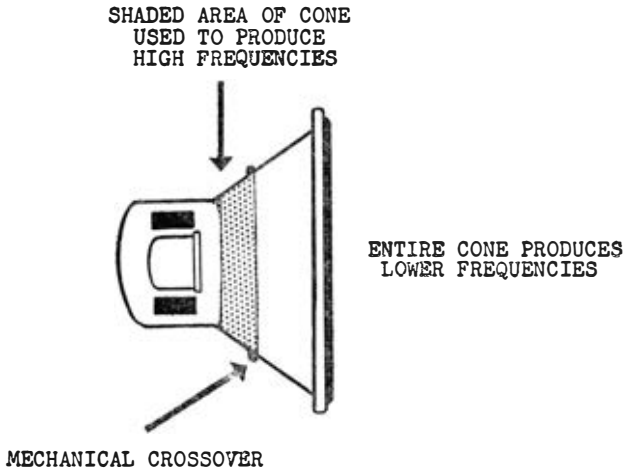
The one cone in a single speaker can be made to produce both the upper and lower ends of the audio spectrum. Let us look at Fig. 10.

DIFFERENT SECTIONS OF SPEAKER CONE

The low frequency sounds activate the entire cone surface, as a large volume of air has to be moved in the production of these sounds. In contrast, the higher frequencies need only a small cone area.

While the lower notes will move the whole of the

FIG. 10



speaker cone, the higher notes activate only a small area situated round the centre of the cone. Combining this fact with the knowledge that the lower notes utilise a heavy, loosely suspended cone, against the high notes' rigid well supported cone, has enabled an "Uncoupling" device to be built into the loudspeaker cone.

This action, as its name suggests, uncouples the greater area of the cone when high frequency sounds are being passed, allowing only the central area to vibrate. When low frequencies are being transmitted, the entire cone vibrates. This "Uncoupling" device is built into the cone. While it acts in its way as a crossover, it is quite different to what is often called a "Crossover Network".

WOOFERS

The larger the speaker the greater the volume of air it will affect. Therefore large speakers handle the Bass notes to the best advantage. A twelve- or fifteen-inch speaker is ideal for such work, but it is always best to keep in mind that such units and their housing have to be installed in the average home; often a severely limiting factor.

A great deal of power is required to work a large speaker. Much more than for a smaller unit. Perhaps the best suggestion is to buy a medium-sized speaker, say a twelve-inch. This, coupled with a tweeter, will give excellent results, although the author has had good sound reproduction from an eight-inch woofer linked with a tweeter and a crossover network.

The lower frequencies radiate outwards, filling the room. On their own they would leave an orchestra very flat

indeed. While a woofer and its deep notes give a feeling of solidity to the music, speakers handling the upper range of frequencies are necessary to produce the feeling of actuality and brilliance.

Suppose we wish to commence our set-up with only *one* speaker unit. Then it is perhaps best to invest in an eight-inch speaker. At a later date a tweeter can be added for the higher notes. For the time being the single speaker will give good general reproduction.

TWEETERS

The names might, on first acquaintance, be amusing, but they are remarkably apt. Woofer for low notes, deep and resonant, tweeter for highs, brilliant and spine-tingling.

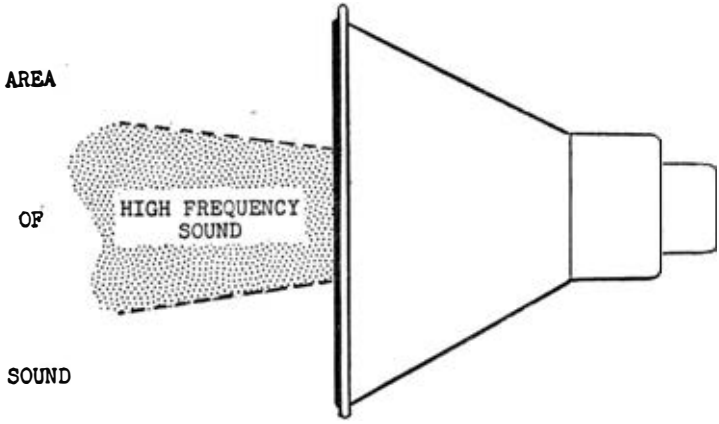
The first and important difference between the two blocks, if we may use that term, of frequencies is that the higher frequencies are directional. They are beamed outwards somewhat like a searchlight. Fig. 11 illustrates this point. While a listener sitting in a room has a wide choice of position which will enable him to receive the low frequencies, the beaming action of the higher notes makes it necessary for him to sit within a small degree of the axis of the loudspeaker.

To overcome this action, tweeters are sometimes mounted in pairs to give greater sound dispersion. Or they are made with a "Horn" to help in the dispersion of the sound.

It is very irritating to find that if the listener moves away from the speaker axis that most of the high notes

FIG. 11

HIGH FREQUENCIES ARE DIRECTIONAL

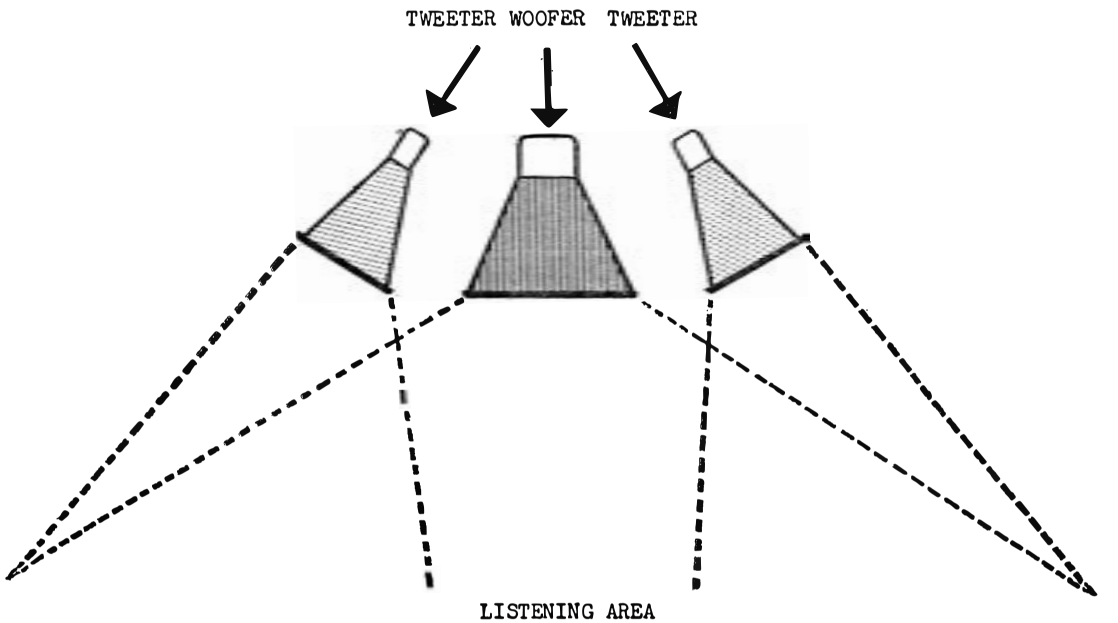


are lost. Horns sometimes are made of a multicellular arrangement, somewhat resembling a honeycomb effect. High frequency waves are difficult to bend and have to be directed to the required area of listening. The designs of these horns is, as we have seen, very important. The high notes must be spread out across a wide area.

ENCLOSURES

The loudspeaker enclosure is neither to protect the instrument nor to be admired as a piece of furniture, although both these points are important. Today, there is no need to have various pieces of equipment connected with trailing wires across the room. Everything can be housed in the one cabinet, or at the most, two units.

FIG. 12



TWEETERS ANGLED TO DISPERSE HIGH FREQUENCIES

Existing furniture can often be converted to hold turntables and allied equipment.

Our two tweeters, angled to give dispersion, and the woofer can be housed in a single enclosure less than two feet in width. Fig. 12. This system is often used for "Panoramic" sound, dealt with in the following chapter.

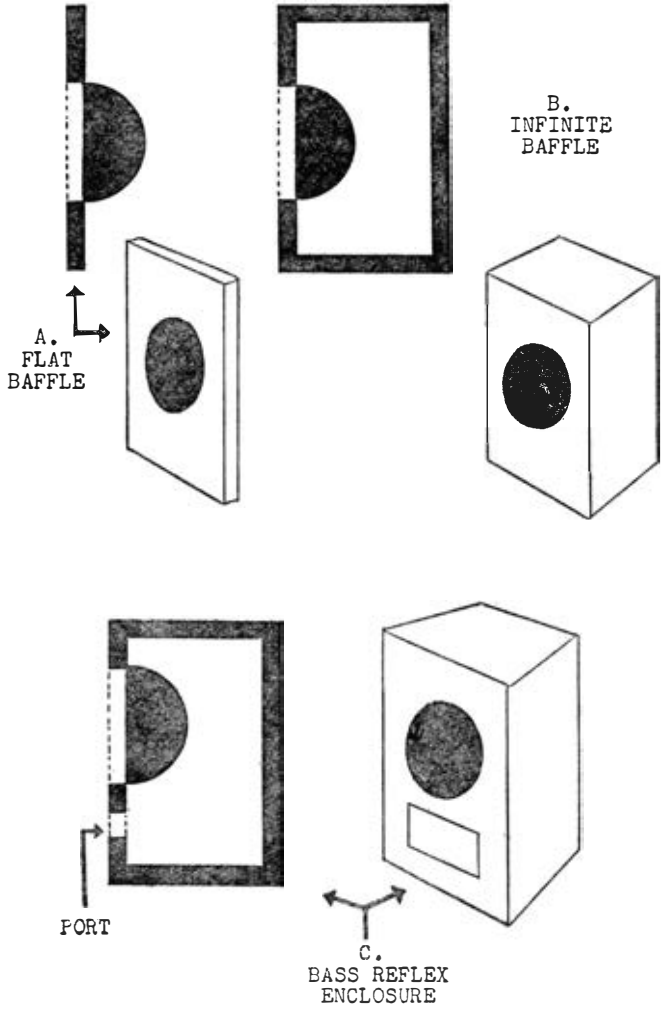
Baffles perform two important functions. They stop the cancelling out of the sound wave by the negative wave that takes place simultaneously and they help the sound produced by the speaker by acting as a radiating surface.

Let us suppose that we have a single speaker, without any baffle, connected to the amplifier. During the positive half of the cycle, the speaker cone moves forwards, sending out a wave of compression. But the air behind that speaker is working in a reverse direction, at the same time causing a negative wave of pressure, this wave being "Out of Phase" with the forward-produced wave. A degree of cancellation will take place, more so with the longer waves (lower frequencies). As soon as a baffle is introduced, the rear waves must make a longer journey. They have to travel to the end of the baffle and round its edges to the front before they can interfere with the other waves.

Obviously the larger the baffle, known as a "Flat Baffle", the longer it will take for the unwanted wave to appear in front. If the speaker is placed in a wall between two rooms, it will have an infinitely large baffle. But who wishes to start knocking holes in a wall?

Fig. 13 illustrates three types of baffle, the third type being called a Bass Reflex enclosure.

FIG. 13


A.
FLAT
BAFFLE
B.
INFINITE
BAFFLE
PORT
C.
BASS REFLEX
ENCLOSURE

To return to the second function of the baffle. Sound waves radiating from the front will go outwards in all directions. Some of them will be reflected by the hard surface of the baffle. The baffle surface is helping to radiate the sound.

If we enclose the back of a baffle, as in Fig. 13B, we have, in effect, placed the speaker in a small room all of its own. This arrangement is not always satisfactory and might lead to poor quality sound in the lower notes.

What about that negative wave that was produced? Is it not possible to make it work for us? When the backwards wave of pressure is formed, it is 180 degrees out of phase with the front wave; exactly opposite to it. If this wave could be changed, then it could be used to assist the forward sound wave that the speaker is producing.

Technically the process is called "Phase Inversion". The enclosure in Fig. 13C extends the bass reproduction of the speaker without the cabinet being cumbersome. An excellent piece of equipment.

Phase Inversion is accomplished by conducting the out of phase wave through a series of passages, a little bit like the maze at Hampton Court. By the time the wave appears at the front of the enclosure it is "In Phase". The maze is constructed to give the required time delay to the sound wave. As the speed of sound is constant, 1,080 feet per second, this appears to be quite easy. Unfortunately the wave lengths vary according to the frequency, the higher notes having a much shorter wave length.

Our passage cannot be adjustable, so the higher fre-

quencies are dampened out and the lower notes used to re-enforce the speaker production at the bass end of the audio spectrum.

Having now achieved a working idea as to how a loudspeaker produces sound, how that sound varies and needs different speakers to correctly handle the different frequencies and how the enclosure in which we place the speaker is also important, we can progress to multi-speaker systems. How to use the correct speaker and link it up with other speakers so that we have a network giving us the best possible reproduction over the entire range of sound.

5

MORE THAN ONE SPEAKER

IN the last chapter, loudspeakers were dealt with in some detail and it was seen that to produce the various frequencies to the best possible advantage, more than one speaker was necessary. Two speakers, a woofer and a tweeter, sounded much better than one speaker which had to cope with all the frequencies in the audio spectrum. Three speakers are even better, the third one handling the middle range, those frequencies higher than can be fully handled by a woofer and lower than those for the tweeter. How then do we ensure that the correct sound arrives at the correct speaker?

MULTISPEAKER SYSTEMS

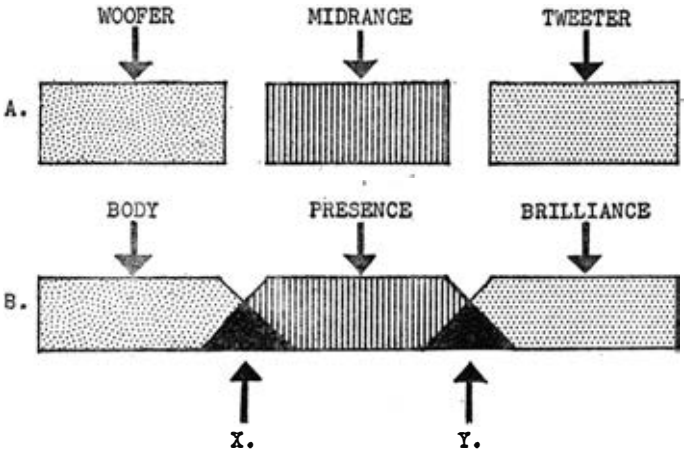
We can roughly divide the audio spectrum into three parts; three separate effects that the listener experiences.

At the low frequency end, the deep bass notes of a 'cello or double bass give us the "Body" of the sound. Moving higher up the range, the frequencies becoming shorter, we get the effect of "Presence". This is the region where the ear detects slight changes in sound variations most easily. At the upper end of the scale, the high frequencies add the "Brilliance" to the music.

A multispeaker system is designed to handle this range

divided into three sections. Fig. 14A illustrates this point. It is also important to have an overlap of frequencies. Where the change takes place between the sound "Blocks" as they are shown diagrammatically, the crossover must be smooth. If the woofer cuts off sharply and the mid-range speaker only commences to handle frequencies higher up the scale, there will obviously be a gap. A deficiency. Sounds having frequencies falling in that range will be lost as neither speaker will handle them satisfactorily. Fig. 14B shows that the ranges must overlap at points X and Y if this gap is to be avoided. This provides us with two crossover points if three speakers are used, and one crossover if it is a two-speaker system, a woofer and tweeter only.

FIG. 14



The sound, as a block, comes from the amplifier, being fed to the speakers. Somehow we have to channel the correct frequencies to the speakers designed to handle them to the best possible advantage. Fortunately this is not nearly so difficult or complicated as it might appear.

Let us take, first of all, a system where two speakers only are used. As this will probably be the next step up from our single unit, taken before we add a third speaker, it will help to understand how all this "channelling" of sound is achieved. Now imagine for a moment that we have *three* speakers, a woofer, a midrange speaker and a tweeter. These are connected to our amplifier. What will happen?

The woofer will reproduce the low frequencies, but as these become progressively higher they will be distorted. The midrange speaker will do its utmost to handle *all* the frequencies, every sound in the audio spectrum. At the opposite end of the scale, our poor little tweeter may well suffer irreparable damage by being fed with low frequencies when it has been specifically designed to handle high notes only.

NETWORKS

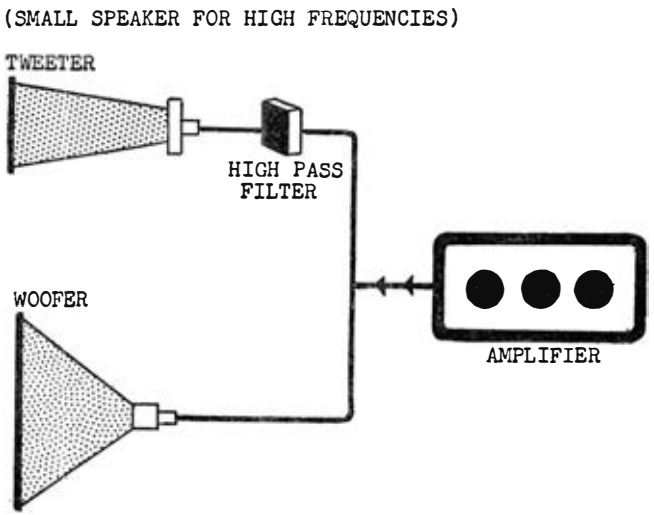
Some form of filter has to be used to sort things out. Imagine that, in the two-speaker system, we have a sieve. The mesh is of a fixed width. Any particles above a certain size will be held back, while all the smaller particles can easily make their way through the mesh. Like a sieve, the filtering properties of a network can be

adjusted to allow different sizes to pass. Take an arbitrary figure, say 500 c.p.s. The filter will allow all frequencies above this figure to flow through quite easily. Any frequency below 500 c.p.s. will be held back.

All that now remains is to connect the filter to our system so that this property is utilised. Fig. 15 shows a two-speaker system with a crossover network. All frequencies from the amplifier are fed into the circuit. Across the line leading to the tweeter, we have placed a "high

FIG. 15

CROSSOVER NETWORK



pass" filter. The woofer receives all the frequencies. The lower notes, for which it has been designed, are well reproduced. The higher notes do not affect it to any great extent.

On the other hand the tweeter, designed for high notes, is receiving *only* those notes. The filter is blocking, holding back, the lower frequencies which the woofer is capable of handling.

Sound reproduced by a single speaker can be good, very good, but once the listener has heard the same record reproduced through a multispeaker system, the difference is immediately apparent.

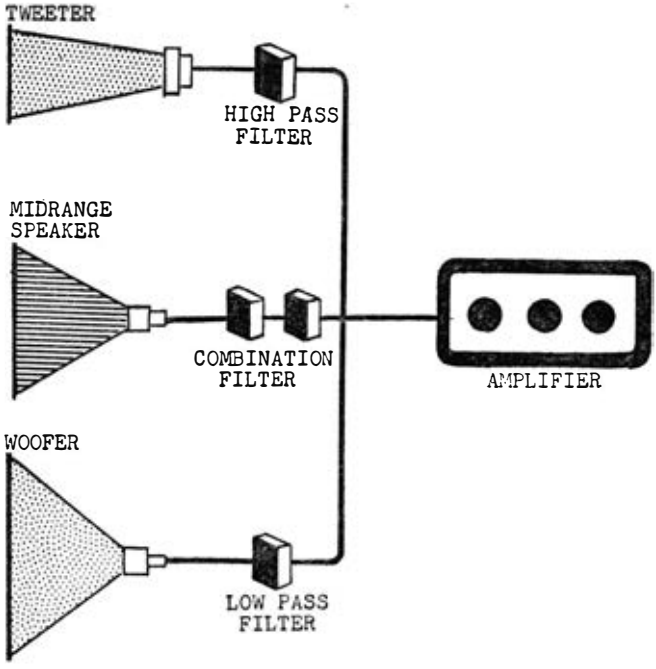
The author vividly remembers the day he purchased his first unit. The music had been recorded on tape and was a piece containing some very low notes which then led into a high passage. Played on a top-quality recorder, through a single speaker, the recording sounded pleasant. In fact, so the author thought, nothing was left to be desired. Then the two-speaker unit was assembled and connected to the output of the recorder. The bass came across magnificently, the notes throbbing out across the room. The higher frequencies handled by the little tweeter were quite remarkable. Notes that hadn't been there before suddenly appeared with a charming clarity and brilliance. Was it possible that such a difference could be made to a recording? Obviously nothing had been added. The dormant high notes had been there all the time, only waiting for the correct speakers to reproduce them to their fullest. All this, by adding a tweeter and a high pass filter.

THREE-WAY SYSTEM

To our woofer and tweeter combination, we can now add a third speaker, the one that will handle the mid-range frequencies. If we do this we are then able to produce, by speakers specially adapted to their own frequencies, the entire audio spectrum.

The high pass filter, a capacitor, stops the low

FIG. 16



frequencies from reaching the tweeter. A low pass filter, a choke, works in reverse, blocking the high frequencies from the woofer. Add a combination of these two filters to the midrange speaker and we have our multispeaker system. Fig. 16 shows how the two filters combine to block both *low* and *high* frequencies from the midrange speaker, allowing it to receive only the midrange frequencies. At last we have each speaker doing its own job and only that. All unwanted sounds are blocked out, each set of frequencies being channelled to its appropriate speaker.

Controls can be added to adjust the brilliance of the high frequencies and the midrange of the middle speaker.

BALANCE

All the components in a multispeaker system must be correctly matched. There is very little point in having a particular speaker for a particular job if it is not matched with its fellow speakers. The production of sound must be even throughout the entire range of frequencies handled.

RANGE OF AVAILABLE UNITS

Once again we find that the range of equipment is staggering in its selection. Speakers of all shapes and sizes, speakers to do every kind of job, speakers costing from mere shillings to many pounds.

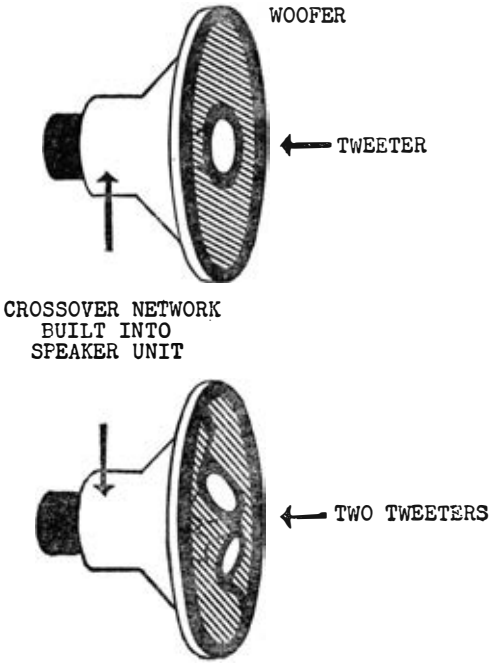
One has either the choice of buying the speakers separate and putting them in an enclosure, or purchasing the entire unit complete. The latter is by far the easiest if one isn't a handyman, but naturally costs more. Some

speakers have the crossover network built in. These are known as coaxial or triaxial speakers. They are really two or three speakers combined in a single unit. Everything that we have discussed, woofer, midrange and tweeter complete with the necessary networks is made in one single unit, which, at a glance appears to be a single speaker.

It is easily seen that the arranging of such a network

FIG. 17

COAXIAL SPEAKER



allows a wide field of choice to suit individual requirements. Many of the record players available have three speakers and a crossover network already built in to them. Often the arrangement is one large speaker with two tweeters, one on either side, so arranged as to disperse the higher frequencies. This designing gives what is sometimes called panoramic sound. The sound swells out to fill the listening area. Coupled with the fine quality of microgroove records, the effect is almost one of living presence. Despite the fact that it is *not* stereophonic sound, reproduction by means of the correct speaker system and crossover networks leaves little if anything to be desired. Operatic singers seem to be in the room with you, such is the clarity and quality of the performance.

Unfortunately, it is the author's experience that too many people go to all the trouble of buying the best equipment possible, the best recordings that the manufacturers produce and then just place the speaker or speakers, depending on the system they are using, in the most convenient spot in the room.

THE ACOUSTICS OF YOUR ROOM

"It fits in there," they will tell you. Or, "It is the only place I could put it." Not a moment's thought has been spared as to the acoustics of the room in which one has to listen to the music.

It is a regrettable fact that if you mention such a subject to them, they look at you with polite amazement. Acoustics! Isn't that a very technical subject? Does it really affect my equipment?

There is only one answer to all these queries. Yes. Acoustics can be very complicated. But if one might be excused a comparison, a man who drives his car well and gets the utmost out of its performance doesn't have to be a skilled mechanic. He just has sufficient knowledge to be able to get the best out of his car.

If we understand the *basic* facts of acoustics, we too, will be able to get the best out of our equipment. It does not mean that we have to become sound engineers.

Maybe it is a good idea to take a look at the room you contemplate installing the equipment in. Will it fit into the décor, not be in the way and give you optimum results?

Shall we go back, for a moment, to sound once again? Perfection is our goal and the only way to achieve this is to have a working knowledge of the medium we are handling; sound.

6

ACOUSTICS

WE naturally call everything that we hear, sound. But a great deal of this "sound" is in reality noise. This noise varies both in frequency and intensity; the volume of the sound. As the measurement for it, a decibel, is often quoted in specifications, etc., it is best to be familiar with the term. The range of sound is quite extraordinary, varying from the quietest of whispers to the nerve-shattering whine of the latest aircraft.

NOISE

As the range is so great, the difference between a whisper and an express being as great as thousands or even larger, an arbitrary figure has to be used as a point of reference. In the case of sound, the zero of our scale of measurement is taken as the *Threshold of Audibility*. All other noises are measured from this level, the engineer using the unit of measurement, the decibel.

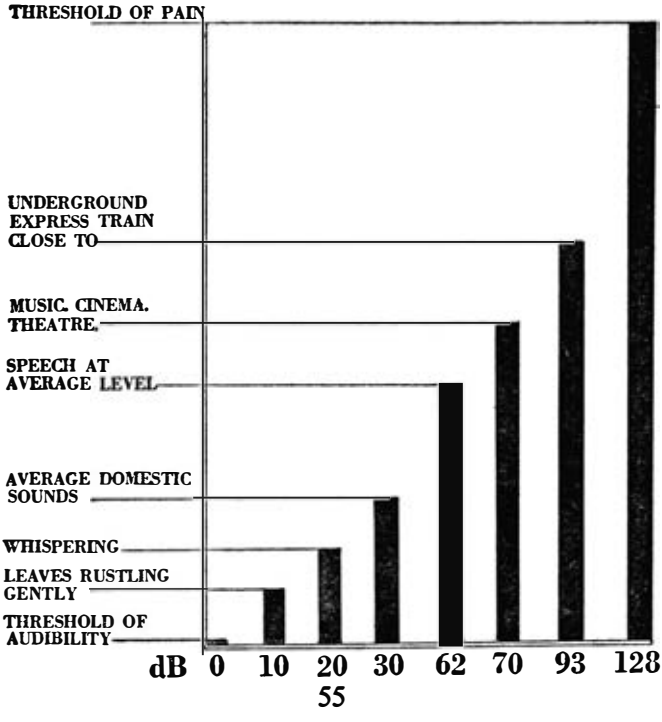
Going to the other extreme of the scale we come to the *Threshold of Feeling*. Until recent times this was considered to be the highest point reached in the scale. At this point, sounds were commencing to be felt as against audibility. Now, in this modern age, with noise ever increasing (tests for noise at International Airports for modern jet planes) the threshold has increased slightly,

about six decibels, to the *Threshold of Pain*. This level of sound is sufficient to produce a feeling of pain and might actually harm tissues, etc.

Fig. 18 shows the variation of several everyday sounds. A glance at the diagram shows us that the range of what we might call common sounds, heard in our daily lives,

FIG. 18

NOISE LEVEL OF AVERAGE DAILY SOUNDS
(APPROXIMATE)



is quite large. Happily for us, the ear can become selective. While the recording engineer's microphone is sensitive to all sounds, we can ignore these sounds that we do not wish to hear. In general conversation, several people may be talking at the same time, yet such is the human ear, and brain, that we are able to listen to one particular person to the exclusion of the others.

REFLECTION

Sound can be reflected in much the same way as light. Remember our high frequencies and the beaming effect that they have, very similar to a beam of light. While light needs a reflector, polished or treated in some similar way, sound can be reflected back from a hard surface which, to a degree, would absorb light falling on it. Mirrors will reflect light *and* sound. Bare walls and uncarpeted floors also act as sound reflectors.

One has only to enter an empty room to notice the reflection effect. For recording purposes, reflecting surfaces which are too "live" can be dampened down by the hanging of curtains, or similar material which will absorb the sound waves. In our case, the reverse often occurs. The room may be too dull. A great portion of the sound sent out by the speakers is being absorbed, giving the reproduction a flat, lifeless effect. On the other hand it is possible to have a room which is too "live".

REVERBERATION

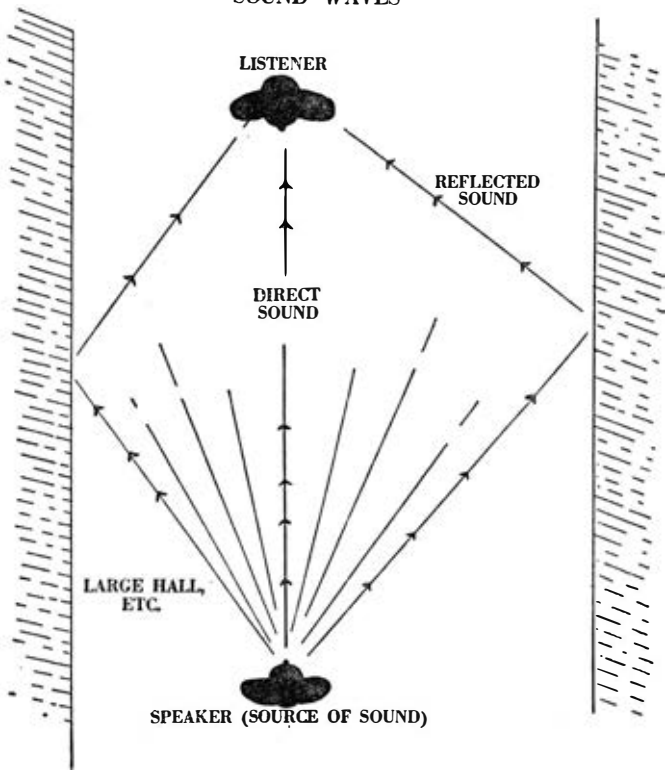
An echo is familiar to all of us. We give a shout and after a time lapse of several seconds, the sound is reflected

back to us. In a large room, church hall, or similar place, this effect can become troublesome. Fig. 19 illustrates what is actually taking place.

Some of the sound produced by the source, in our case

FIG. 19

SOUND WAVES



DIRECT & REFLECTED SOUND
IF REVERBERATION IS BAD, SPEECH BECOMES UNINTELLIGIBLE DUE TO WORDS RUNNING INTO ONE ANOTHER.

a loudspeaker, comes directly to our ears. But a proportion of it radiates outwards to the walls, floor and ceiling. If these surfaces are good reflectors, this sound is then beamed back to the listener. It arrives a short interval after the direct sound wave has reached our ears. This time lapse is very small, not nearly as long as our echo in the mountains.

The effect is to make the original sound rather woolly. The nearer the listener is to the speaker, the better the sound, as he will be receiving, in proportion, more direct sound and less reflected sound. The further away from the sound source the listener is placed, the greater will be reverberation as he is receiving a higher proportion of reflected to direct sound.

It is very similar to a pianist playing with his foot on the loud pedal. Many of the notes are blended into one another and the crispness of the performance is lost. In the author's experience, there is only one place where the reverberation actually enhances the performance. That is the Piazza San Marco in Venice. The shops and arcades lining three sides of the square exercise a most unusual effect on music. When an orchestra is playing outside in the middle of the square, the sound is made to appear fuller. Normally an orchestra performing in the open air is rather weak as the sound waves are lost into the surrounding air.

OCTAVES

Any particular note, if it is eight notes above or below a given note, is one octave higher or lower than that

particular note. Transposing this into terms of frequencies, one octave higher is double the frequency of the original note, and an octave lower is half the frequency of the same note. The full range of octaves from about twenty c.p.s. to the upper range of audibility, produce in the listener the feelings that give sounds their effect and quality.

The first octave, the lower frequencies, for example, wind, give sound its reality. From the second to the fifth octaves is the region in which one finds the rhythm side of an orchestra. As the scale progresses, the range of intelligence is reached; that range which includes speech of telephone quality. Then, as we increase the frequencies further the reality of presence is reached; the higher musical notes without which a recording lacks quality and colour. Such is the range of that apparently simple thing called sound.

ABSORPTION

Too much sound reflection is just as ruinous to faithful reproduction as too much absorption. One is the opposite of the other. Both are within our control to a certain degree. While only the Hi-Fi enthusiast with unlimited funds will re-design a room for better sound quality, or have one specially built, the average person has to manage with a few simple innovations.

After playing a record, it will be immediately apparent if the room is all right, or whether absorption or reflection is too great. If the volume has to be turned up to a high level, then the sounds are becoming absorbed. Should

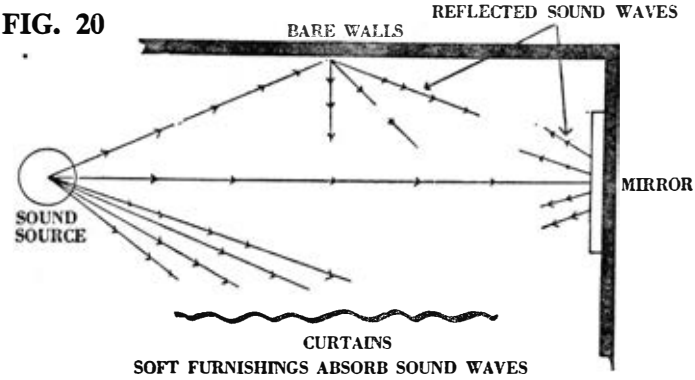
the music sound as if it is being played in a vast, empty hall, then reflection is the trouble.

As a working rule one can say that surfaces like mirrors, bare walls, windows (when closed) act as reflectors of sound. Furnishings such as carpets, curtains, chairs, etc., absorb sound to varying degrees. If the number of people in a room increases, then the absorption will also increase.

Open windows will allow the sound to be lost, as it will travel outside the listening area, while closed windows produce a hard reflecting surface.

Therefore placing of our speaker or speakers needs some thought. Curtains behind the speaker will absorb the sound falling on them, while a hard wall or window

FIG. 20

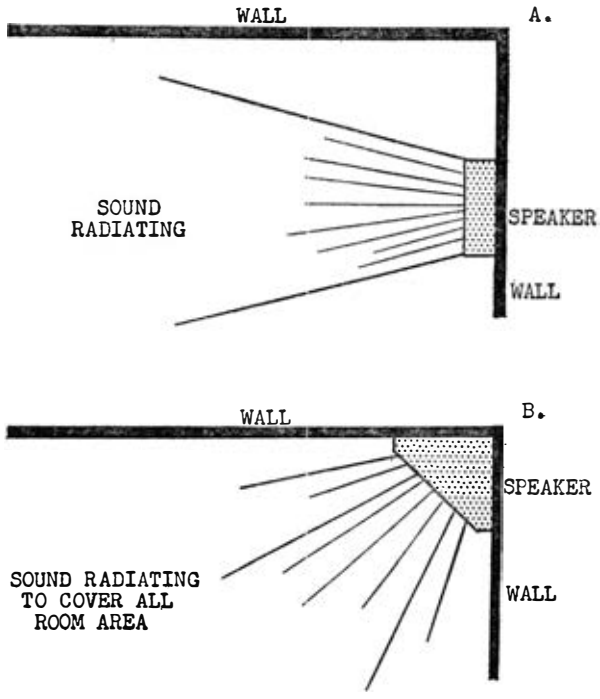


will reflect the sound. Fig. 20 shows how the sound waves are reflected from various parts of the room.

PLACING OF THE SPEAKER

Shall we place it in the centre of that spare wall? It fits in well with the furniture in that position. Fig. 21

FIG. 21



illustrates how a speaker placed in the centre of a wall can easily produce a fall-off should the listener find himself to one side. And always remember that the higher the notes, the more directional they become. Better to try that corner over on the far wall. The sound radiates outwards to cover a larger listening area in a smaller angle. Why not try it and see—or should one say listen.

Often a compromise has to be reached. The places for

a speaker are limited. The best spot might not be practical. It is very difficult to advise for any particular room as the acoustics will differ greatly from home to home. Armed with our knowledge of sound and its properties, we can then adopt a trial and error method until our ears are satisfied with the results. Many people don't like High Fidelity. It has been described by some as "tinny". This is quite erroneous. They can be excused by saying that they have spent so many years listening to poor quality sound that they have become accustomed to it. Sound lacking in treble, sound with too much bass. The author has even seen people turning down the treble on a High Fidelity set-up until the entire effect of presence was lost.

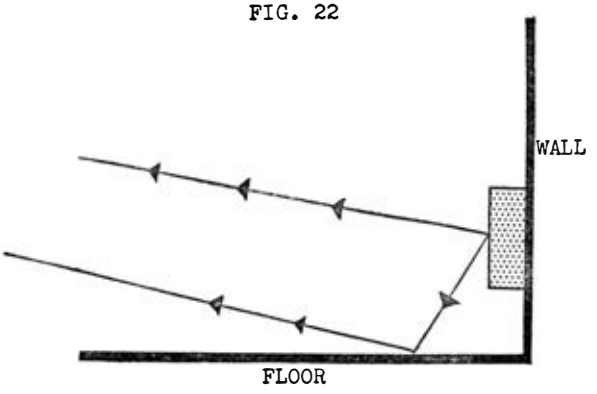
ROOM AREA CAN ASSIST SPEAKER UNIT

Fig. 22 shows that the reflecting properties of walls and floor can be used to increase the apparent effective area of a speaker.

Sound is radiated from the speaker and some of it, as we have seen, is reflected back by the baffle. Other sound waves are reflected from the floor, thus increasing the effective area of the baffle. Some speakers are designed to utilise this reflection of sound waves. Placed in a corner, they make use of the adjacent walls and the floor.

As Stereophonic Sound requires two balanced speakers, the placing of these is somewhat more critical. Obviously the balance will not be even if one speaker is positioned against a blank wall while the other has some heavy curtain immediately behind it, absorbing much of the sound.

FIG. 22



FLOOR USED TO INCREASE EFFECTIVE
AREA OF SPEAKER BAFFLE

Despite the entire thing appearing to be most difficult, five or ten minutes testing in your listening-room will soon show you where the speakers will work to the best advantage and give you the most pleasing reproduction. It is often quite easy to alter the arrangement of the room slightly. Sometimes the movement of a speaker by a foot or so, makes a difference between average quality and sound that will delight you and those listening with you.

7

STEREOPHONIC SOUND

ONLY recently has the wonder of Stereophonic sound been made readily available to the record lover. Realism, Living Presence, all are terms which, while describing this new sound accurately, cannot adequately compensate for one's first experience of true Stereophonic sound.

WHAT IT IS

We hear Stereo sound with *both* our ears the same as we need two eyes to appreciate the beauties of Three Dimensional photography. It is believed that one ear hears the sound a fraction of a second sooner than the other ear, when the same sound source is listened to. Whatever the reasons for our being able to appreciate it, this new sound has arrived. And at the same price as ordinary sound!

As it is not possible to play you a selection of stereo records, we shall have to allow our imagination to wander slightly for the next few minutes. We are going to commence the "Stereophonic" part of our "Journey into Sound".

This sound, true sound, is not only confined to music. Anything, from the ceremonial to the motor racing

circuit can be appreciated as vividly as if we, the listeners, were on the spot.

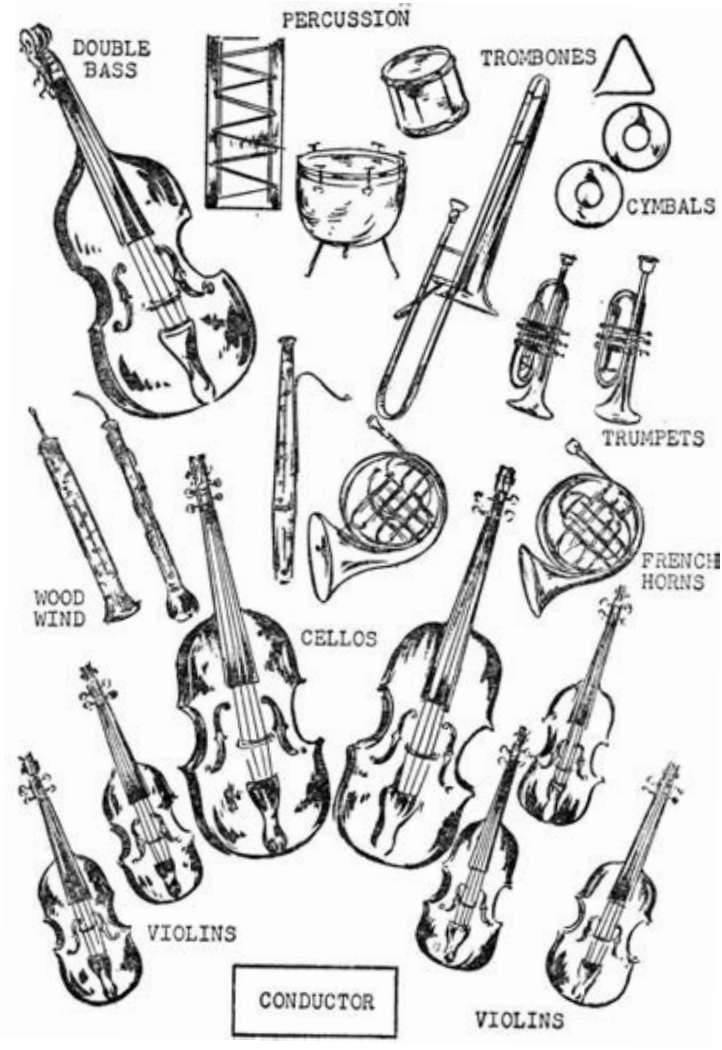
Fig. 23, illustrating the layout of a symphony orchestra will help us to visualise the positions of the various instruments. Firstly, it is important to appreciate that, as Stereo reproduction utilises *two* speakers set between six to eight feet from one another, that distance is going to be occupied by the orchestra.

The violins will stretch across the space, the pianist will be slightly to the left of centre. The brass will be up there to our right, just behind the strings. Woodwind to our left. Right up at the back, the percussion, drums, triangle and other instruments. It is as realistic as that. Having assembled the orchestra, metaphorically speaking, the player is switched on and we sit back, awaiting the opening chords.

A roll on the drums. You glance up to the back of the orchestra. You have forgotten that they are not actually there. The opening notes of a piano concerto. How well the pianist interprets the music. Without thinking you glance towards the place where the piano should be. *That is Stereo sound.* If the eyes are closed, removing the reality of the opposite wall, or fireplace, depending where the speakers are situated, one is indeed in a concert hall, swept up on the strains of one's favourite piece of music.

Let us change the mood. Opera. The stage is six to eight feet across, that distance between the two speakers. The singers move, first it is the Soprano on our left, then the Tenor on our right. They come slowly together, moving towards the middle of the stage. With our eyes closed

FIG. 23


PERCUSSION
DOUBLE BASS
TROMBONES
CYMBALS
TRUMPETS
FRENCH HORNS
WOOD WIND
CELLOS
VIOLINS
CONDUCTOR
VIOLINS

we can see them. The world of sound has come alive right in our living-room.

In contrast to a full orchestra playing the 1812 overture, the waltzes of Strauss, or the "Ride of the Walkure", we will visit the Tower of London for the ceremony of the keys.

The sentry stamps his feet. In the distance, approaching us with footsteps ringing out on the cobbles, is the new guard. The ceremony takes place, the jangling of the keys is heard and then the guard walks away into the distance. From afar the clocks strike the hour and the last post is played.

A swift change of scene and we are at the race track, the cars roaring across the room with exhausts blasting. Yet another change and the local train comes clanking into the platform, the engine hissing. Doors are slammed, a whistle blown and the train pulls out. Within seconds it is followed by an express, roaring through the station at high speed and then disappearing into the distance until the sound fades away. Impossible? Fantastic? Not at all! All these sounds that have been mentioned have been recorded and are on Long Playing records for your enjoyment.

The Pacific, the lilt of the islands, the strange sounds of the mocking bird, the throb of the conga drum and the stimulating rhythm of the marimbas. All the thrills of a tropical paradise. This can be heard on an excellent recording called "Forbidden Island". For those who lean towards the exotic, the unusual, or just something different, this Stereo disc is an asset to any record library.

As the lists of stereo recordings are increasing monthly, it is impossible to mention more than a few in this book.

For those who like their music sweeter, Mantovani and his orchestra play in their inimitable style just for you. Singers stand right in front of you, the orchestra and supporting groups in the background. The separation of sound achieved by Stereo recording is one of the wonders of this modern age.

HOW IT WORKS

Fig. 24 shows diagrammatically a Stereo arrangement. The two speakers can either be separate to the record

FIG. 24

STEREO SET-UP

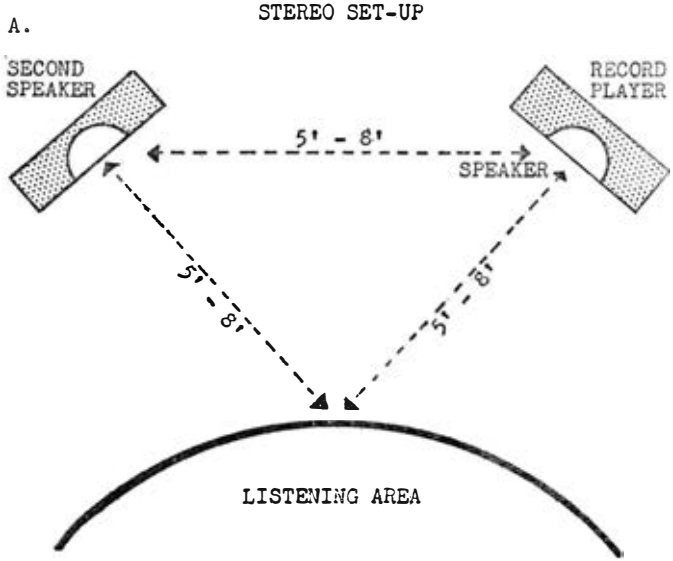
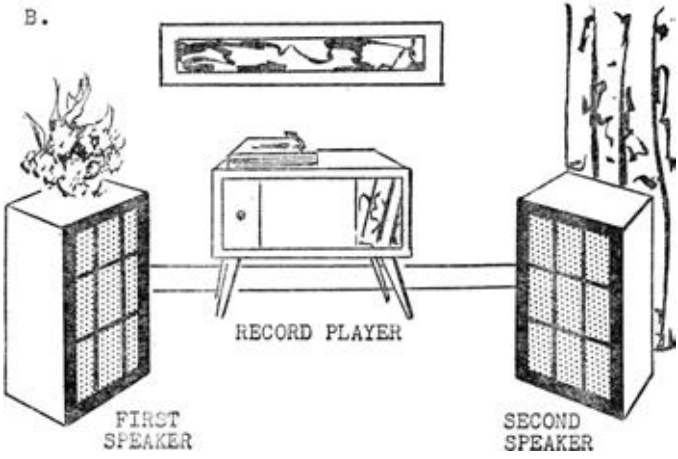


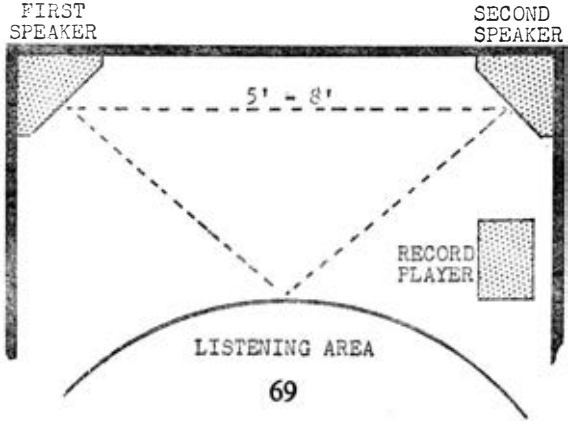
FIG. 24

STEREO SET-UP

B.



C.



player, or one of the speakers can be incorporated in the player unit. The speakers are separated by a distance of between six to eight feet. If they are brought close together, the Stereo effect will be lost. Increasing the separation will extend the Stereo effect.

The playing unit contains the stylus, twin amplifiers and, of course, our two speakers. Stereophonic sound is recorded with two microphones some distance apart. This recording is made in two parts, one part being the sounds picked up from the left-hand microphone, the other recording being concerned with the right-hand microphone. The record has *two* tracks on it, each track containing the sound from its particular microphone. These sounds are fed into the appropriate speaker and we have lifelike sound reproduction.

It is important that the left-hand speaker receives the correct sound, the sound originating from the left side of the orchestra. The record player has two sockets, if one of the speakers is built-in. Thus, whatever side of the room the player is placed, the extension speaker can be plugged into its correct socket.

A balance control is also necessary. The two speakers must be equally balanced. If a singer is standing midway between the two speakers, the sound must come from that spot. By adjusting the control, the speakers can be balanced to this effect.

It will be seen from the diagram that the Stereo area is some distance back from the speakers. Then, as the distance increases, the area widens out to cover the entire room, if it is a large one.

The listener should form the third point of an equilateral triangle. The distance from him to either speaker, and the distance between the speakers should approximately be equal.

STEREO FOR YOU

Stereophonic sound is excellent whether played in a large or a small room. Naturally, the smaller the room, the less the volume required to fill it. Many people who are not Hi-Fi addicts feel that we play our music much too loud. We are just either making a nuisance of ourselves or showing off; we have a more powerful set than the other man.

Obviously this can be true. But the author has found that if the level of sound is turned down below a certain point, the orchestra becomes flattened, the Stereo effect lost. Apart from that, the human ear is more sensitive to changes when the sound is louder. We can appreciate the subtle points of a piece of music, the clarity of the strings. This does not mean that the sound should be so loud that our neighbours down the street can hear it.

When we have purchased our Stereo equipment it is advisable to place it in the room to the best possible advantage. It might appear best on either side of the fire, but is that the position from which we obtain the best reproduction?

Fireplaces often have an alcove on either side and it is the author's experience that this is not always the best place for Stereo speakers. Much better to place them at opposite ends of a wall.

As the two speakers have to be equal when it comes to producing sound, and the manufacturers have taken a great deal of trouble to "match" both them and the amplifiers, it seems rather unwise if we place them so that they are unequal.

In Chapter Six when room acoustics were discussed, we found that there was a great difference between having a bare wall behind a speaker and hanging some form of drape, like a curtain, at the back of it. A bare wall behind one of the speakers will reflect more sound than a curtain will behind the other speaker. In the second case some of the sound will be absorbed and our speakers will not be evenly matched.

A few moments' thought soon determines the area of the room which will give maximum results. Then a record is played while the listener walks about the room, listening intently to the music. A little adjustment with the balancing control, a slight movement in the position of a speaker and all is ready. Stereophonic sound is waiting for you.

COSTS

In general the path is smooth until one asks that all-important question, "How much?" You will be delighted to learn that Stereo record players are not as expensive as all that. While they are more costly than the smaller portable players, they compare very favourably with expensive, monaural players. A stereo unit can be bought for between £38–£50. Like all things, they may become cheaper as time progresses. More costly equipment is available, but in the region quoted the reproduction is very pleasing.

One cannot advise on exactly what equipment is the best for you. Go along to your dealer and talk the matter over with him. He is there to help you with his advice and experience. It will also give you the opportunity of hearing the same record played on several different makes of player.

RADIO

Stereo transmissions are not yet a regular feature of radio, but they should be mentioned as the B.B.C. has been carrying out many tests on Stereo broadcasting. The day might not be so far distant before we are able to receive regular broadcasts in this new medium.

Up to the present time, these broadcasts have used television sound for one channel and the radio for the other channel. A play about Sherlock Holmes came over with startling realism. The hansom cab rattled past and the foggy atmosphere of one of the scenes could not have been more realistic. There is no doubt that Stereo broadcasting has much to offer both in the field of music and drama.

If you already have some type of Hi-Fi system, then it might be as well to think twice before investing in another complete set of equipment. Maybe a few extensions to the existing set-up are to be preferred. On the other hand, if you are new to the problem, Stereophonic sound is worthy of serious consideration, always remembering that a Stereo unit will play monaural records as well, and with superb reproduction.

We still have to examine the other links in the High

Fidelity chain; the amplifier, the pick-up and the turntable. And lastly, but equally as important as all the other factors, the arranging of the various units to blend tastefully into the décor of our homes. Hi-Fi can enhanse interior decorations. The market caters for all types and tastes, cabinets being produced in a large variety of woods and modern designs.

Today High Fidelity is big business. The customer is all-important. Whether it be Long Players, Extended Players, Stereo, Tape, the choice is bewildering in its variety. The reader can be assured that he will be able to find something to suit his requirements *and* his pocket.

8

THE MICROPHONE

As the recording market is forever expanding and Stereophonic tape recorders are becoming available to the public, both for playback *and* recording of music and sounds, no book would be complete without mentioning this equipment in some detail. In this book we shall only discuss microphones and Stereo recordings. For more detailed information, the reader is advised to consult *The Right Way to Tape Record*, published by Elliot Right Way Books.

MICROPHONES

This is the instrument which collects the sounds that we wish to record and, by way of the amplifier and tape deck, records these sounds on the tape. Any fault or lack of quality in a microphone will therefore be recorded on the tape along with other sounds.

Our microphone is, in its way, similar to the human ear. Sound waves act upon it, setting up corresponding fluctuations in the instrument. These mechanical movements are translated to electrical impulses. The movement of the microphone diaphragm, or ribbon, depending on the type of instrument used, changes these variations in pressure into an electrical current which is then fed

into the amplifier. The current sets up fluctuates in proportion to the sound waves falling on the microphone, reproducing both the intensity and the frequency of the sound. Should a sound wave of 3,000 c.p.s. activate the diaphragm, it will move back and forth at that number of cycles per second. Our microphone is very much like a loudspeaker working in reverse. The speaker converts electrical impulses into sound waves, the microphone converts sound waves into electrical impulses.

In common with our speaker, the microphone must be capable of handling all the frequencies equally. Should it exaggerate any particular part of the audio spectrum, the recording will not faithfully reproduce the musical instruments.

As the harmonics enable us to differentiate between instruments, the microphone must be able to handle these. The frequency range has to be sufficient to record all the sounds falling upon the instrument.

LINEARITY RESPONSE

The microphone should be able to reproduce all the frequencies correctly. If a line is drawn, connecting all the frequencies, it should be straight, showing that the response is equal to all parts of the audio spectrum. This obviously is our ideal and the closer we approach it the better will be the recording. Some microphones show a tendency to reproduce a particular range more so than the other frequencies. If this sensitivity falls at the lower end of the spectrum, the bass notes will be emphasised. If the opposite is the case, the recordings will have a tinny sound.

DIRECTION

As the human ear is a highly selective organ, unwanted sounds do not offer any problem. We listen to the sound that we wish to hear. While external noises might be irritating, they rarely upset our selectivity to any great degree. Thus listening to any particular sound can be acquired. Try switching the radio to the short wave bands. By tuning the set you will soon find a station that has either another station close to it, or atmospherics interfering with the transmission. Just concentrate on that particular station. Don't listen to the other one, or the interference. At first you might find it difficult, but with practice it becomes quite easy. The ear has selected the sounds it wishes to listen to, ignoring all others or at least putting them into the background.

The microphone, on the other hand, will record all sounds which activate it. A current example comes readily to mind. The other night the author was recording in a friend's home. The *wanted* sounds were distant and faint so the sensitivity of the instrument (the recorder) was turned up to maximum. This caused the clock in the room to be recorded so loud that it sounded a little like a time-bomb ticking away. It had never been that noticeable before. Why? Because the ear ignored it as an unwanted sound but the sound was there all the time.

SELECTING THE CORRECT MICROPHONE

High Fidelity being our constant aim, it is very important to select the right instrument for the right job of

work. Microphones vary in type and sensitivity. With many recorders, the microphone is supplied to serve a general purpose. Recorders are used a great deal for entertainment, and the instrument must be capable of receiving a large variety of sounds at varying distances. While these microphones are good, they cannot be expected to do specialised work. For this we need the correct microphone.

WHICH TYPE OF MICROPHONE?

Quality and cost go hand in hand. Good microphones are expensive. Let us briefly consider some of the types available to us at the present time.

The carbon microphone is the one that we use every day. It is fitted into the telephone. That metallic voice that comes over the wire is quite suitable for speech but not for music, for which it was never intended.

Some recorders have a crystal microphone supplied with them. This type is sensitive to sound all around. It is known as omnidirectional. Imagine the microphone is in the centre of a circle. Sound at any point on that circle will be recorded. Unfortunately the crystal can be broken if dropped or subject to humidity or high temperatures. Today, the ceramic type is more common, the crystal being sealed in a ceramic shell to protect it against external changes in temperature and humidity.

Many of the microphones supplied with the apparatus are of the dynamic pattern. This type has a coil moving in a magnetic field to produce the fluctuations in the current as against the piezo-electric material in a crystal

mic. They, also, are remarkably sensitive and give reasonable quality.

This word quality might cause some difference of opinion. We have always said that the sound you want depends on YOU. While you might consider that a certain standard of quality is excellent, someone else will feel that it is very poor indeed.

Talking the other day with a friend who sells tape recorders, the subject of quality came into the conversation. Various machines were discussed. The fact that the author found most surprising was that a great many people purchased the recorder which gave the largest volume of sound! Putting two machines side by side, the one that made the most noise was often the one bought. Yet the other machine might well have had better quality sound reproduction.

Lastly let us consider the ribbon microphone. Not a cheap instrument, but not beyond the pocket of anyone who wishes to record music to the best advantage.

This microphone is bi-directional. Against the omni-directional type which was sensitive to sounds all round, the ribbon microphone is sensitive only on its opposite faces: forwards and backwards. At either side it is virtually insensitive to sound waves. This property immediately enables us to control unwanted sounds by placing this side of the microphone towards the source of such sounds.

The ribbon microphone is *not* suitable for recording out of doors as the delicately suspended ribbon might be damaged by wind. The most noticeable thing about this

type is that it is not nearly so sensitive as microphones which fall in other categories. The instrument which is the most sensitive to sounds is not necessarily the best one when quality is demanded.

For recording music, or for Stereo recordings, the reader is seriously recommended to consider buying a good quality microphone. And if Stereo is the aim, two matching microphones are really required. Best to buy two of the same type from the same manufacturer.

RECORDING MUSIC

Quite easy when done directly from a radio and if the broadcast is Very High Frequency the quality will be good. The only way to record from a radio is directly, *not* by placing the microphone near the speaker of the set. How to make the correct connections between recorder and radio are explained in instruction book supplied with tape recorder.

This method works but has many obvious disadvantages. The sound waves have to be produced by the speaker, cross the air between radio and microphone and then be recorded.

Should anyone come into the room and start to talk, the recording is spoilt as the sounds of speech will also be recorded. All external noises like a car going past outside, or the slamming of a door in another part of the house, may come across when the recording is played back.

Recording music in a hall or a room at home involves the same problems as when we were considering speakers

and their connection with sound reflections and reverberation. Opening a window naturally will have the reverse effect when recording. Instead of allowing our sound to go away into the outside air, it will permit outside sounds to come into the room and interfere with the recording.

Orchestras are often recorded by having several microphones placed to pick up sounds from various sections, or particular instruments. These various sound sources are mixed by the engineer in control, each one being correctly balanced to produce an excellent monaural recording.

One has only to watch a band on television to see the numerous microphones placed at different positions amongst the orchestra.

When these recordings are played at home, we know that the orchestra is spread out, the instruments separated, but the resulting sounds come from the one spot; the speaker. Spreading out our speaker system does give some form of separation, but the sound is still monaural; from one source.

Immediately we enter the field of Stereo recording, we have a medium where the sound has not only to be produced correctly as regards the range of frequencies, but has also to give the separation, the sense of space, so desired and so perfectly reproduced Stereophonically.

This is done with two microphones, either placed together or some little distance apart. It is possible to alter things when recording at home. One microphone can be placed amongst a group of people while the other is positioned near a member some distance away. This

will give the effect of two separate groups as the sound will come from the two speakers.

Tape recorders can be run from a car battery by using a piece of equipment which converts the current to that required to run the machine. This gives a wide field for those who wish to go out of doors with their Stereo recorder.

ACTUALITY

Portable recorders designed to be used anywhere and independent of mains power supplies should be mentioned as records can be made from the tapes. This makes it possible to bring back music from your holidays. The quality can hardly be described as High Fidelity, but by the time the record has been cut, the studio making the necessary adjustments for sound balance, cutting the treble and boosting the bass, or vice versa, the resulting record produces music of fair quality when played on monaural or Stereophonic equipment. The quality is quite good enough to make this a consideration.

Last year the author visited Italy where he heard many nostalgic folk tunes and some fine singing at the open air cafés in Florence. With the aid of a portable recorder, these sounds were captured. Back at home the tape was edited (unwanted and bad material cut out) and the finished effort sent off to a recording studio. A linking commentary was added and the finished tape made into a Long Playing disc. For about forty minutes, on a record, the listener is taken in the plane across the Channel and on a brief visit to Italy.

This ability to record anywhere, anytime, does open up the field for the real enthusiast. Fidelity can be sometimes sacrificed to a certain degree when availability becomes the prime factor.

A pleasing record of one's travels is far better than no record at all. Once again the market has produced several recorders which make this possible. Providing one doesn't expect a full symphony orchestra to come over with the same degree of quality that one gets with a professional recording, the acquisition of a portable recorder does widen the scope of your record library considerably.

One further advantage of having a disc cut as against using the master tape is that the tape can be stored in a safe place and when the recording on the disc is worn, another record can be immediately made.

The author strongly advises against playing the master tape (the original recording) too often. Accidents happen at the best of times. Once those sounds have been erased from the tape *nothing* will bring them back.

The cost of all this? At the moment less than three pounds for a Long Playing disc. The recorder? Rather expensive. A fine machine will be in the region of about £70 today.

9

THE TAPE RECORDER

STEREOPHONIC tape recorders are still relatively expensive. But so is an excellent High Fidelity set-up. The range of Stereo tape recorders does not yet equal that of the ordinary machines. As they are available and will no doubt become increasingly popular with the enthusiasts, and more firms will probably manufacture them, this book has to mention them.

HOW A RECORDER WORKS

The sound impulses are first converted by the microphone to electrical impulses which are put on to the recording tape, as we have seen, in the form of millions of minute magnets. The tape is thus magnetised by our sound, that process being in a pattern which, whenever we desire, is available for playback, the reverse process taking place.

As most recorders have some form of counting mechanism, generally in the form of a counter similar to the milometer on a car, any particular recording on the tape can be quickly and easily found. An index card has to be kept, noting the material recorded and the numerals on the counter, for any given piece of music.

There is the slight disadvantage that it takes a few

seconds to wind the tape on to reach the required recording, and that the recordings are always in the same sequence. Records have the advantage that they can be selected and stacked in any desired order for playing.

One great advantage is that the tape does not suffer any appreciable wear. There will be no interference due to dust particles, no scratching and crackling like one hears on an old record.

On the other hand, as the tape is magnetically recorded, the recording can be erased if the tape encounters a magnetic field. This is done when previous recordings are erased on the machine. A safety lock is usually built-in to avoid accidental erasure. Should a tape be left close to a magnetic field of sufficient strength, then the recordings will be erased. So care is needed if the material cannot be repeated.

DUAL TRACKS

Tape recorders record only on the upper or lower edges of the tape. This twin track system has the advantage of making any given spool of tape twice as long. First of all the music is recorded on track number one. Then the full spool of tape is taken off the machine, turned over to bring the *other* side of the tape (the second track) into use. The spool is then played again. A 600-foot spool virtually represents 1,200 feet of tape which can be used.

A few machines, mostly professional models, use full track recording, the entire width of the tape.

When any further recordings are required, the erase head on the recorder comes into play. An alternating current is used to erase previous recordings and the "clean" tape is then passed across the recording head, ready for further material to be put on it.

Sometimes one may encounter a machine which has an ordinary magnet for erasing. The fresh tape, supposedly clean after passing across the erase head, will have a hiss on it. Should the erase head fail, through a variety of reasons, to do its job correctly, parts of a previous recording may well be heard as a background to the new material.

A simple method to check this is to run a tape through the machine, with the controls set to record, but with no microphone connected and the volume level turned down to zero. The tape, on playback, should be free of all noise.

Tape recorders and tape decks can be incorporated into our Hi-Fi system, enlarging the scope of the set-up. Crossover networks enhance the sound reproduction in the same way as they do for music played from discs. Some recorders have a crossover network built into them and can be used as a single unit for reproduction, but many are greatly improved if, on playback, the sound is fed through a separate speaker system.

TAPES

Pre-recorded tapes are available in much the same way as records. These tapes, containing a wide variety of music can be bought, placed on the recorder and played

in exactly the same way as a disc on a record player. There are libraries which have tapes available in the same way as record libraries stock discs.

STEREOPHONIC TAPES

Like our record player, the reproduction of Stereo tapes needs two recordings played back through twin amplifiers and speakers.

In this case, Stereo tapes, the two tracks (upper and lower) are used for the one recording. Each track has received its appropriate signal from one of the two microphones used. Then, on the recorder, the two tracks are played back simultaneously, the signal being fed into dual amplifiers and speakers.

Some recorders can playback monaural and Stereo recordings, but only record normally monaural. The machine that is really interesting is the recorder which not only plays Stereo recordings but records them as well!

Up to a little while ago, such a machine was not available on the British market. Now, it is here! There are several models to select.

Using the two tracks offers many advantages over the usual system. Some tape decks are designed so that the tracks can be played back without turning over the spool of tape. That is, it is possible to switch from upper to lower track by the touch of a switch. Many recorders play only the one track. If a piece is required that happens to be on the second track, the whole spool of tape has to be re-wound before it is played.

One of the Stereophonic recorders will either play or record Stereo or monaural sound. Now it is even possible to record two different programmes on the two tracks simultaneously. And then play them back together, each one through its own speaker.

Such machines, a wonderful advance on the first models of tape recorders—how long ago that seems—are not expensive for what they do.

Naturally a lot depends on the amount of money that the beginner has to spend. There are many things to be said for both Stereo on the tape and on disc. The latter, at the moment, is not so costly. But tape does offer the enthusiast the opportunities of recording as well as playback. Indeed, food for thought.

While this book has concentrated on the sound reproduction part, how to get the best out of recordings, there is no reason why one should not actually record the original sounds first.

Each passing month sees something new, something more advanced, made available to the home user. Sound in all its varieties has indeed entered the average home. To listen to some old records, not so very long ago, makes one realise what great steps the manufacturers have achieved in so short a time.

On reflection it makes one wonder what will be next. What new device, new thrill, will we be able to obtain by merely going along to our dealer and buying it?

Sound, Stereo or Monaural can be fun. It can also be an education. One can learn to appreciate the works of the Great Masters, or just relax with something light and

easy to listen to. It really has become a "Journey into Sound"; a journey that we can take at any time and as often as we wish. A flick of a switch and the world's finest orchestras, the best musicians, the greatest musical scores are there for our enjoyment.

10

THE AMPLIFIER

THE amplifier is a very important part of our High Fidelity system. A part that we are all too often inclined to take for granted. We concentrate on records, players and speakers, always aiming to get the best out of each of the units, yet do we ever spare a thought for the amplifier?

As specifications usually mention the amplifier, even if it is only in passing, so to speak, it is worth while knowing something about this link in our audio chain.

Small signals, small in power output, are sent out from the pick-up head which is translating the groove on the record into electrical impulses. These small electrical currents are fed into the amplifier. It is the job of this unit to magnify these currents to a sufficient degree to drive the speaker system. As our speakers need a great deal more power than the pick-up cartridge develops, the amplifier is necessary.

Like all the other links in the sound chain, the amplifier must be capable of handling the sound correctly. Should it distort any particular frequency, or fail to cope with the range of sounds being fed into it, then our system is going to fail in the job we expect of it; High Fidelity sound.

As is to be expected, the manufacturers have made

some wonderful strides in the development of amplifiers, the units keeping pace with the rest of our equipment. Let us consider what the amplifier has to do. One might come across startling claims as to performance so it is worth while to have a working knowledge of this unit.

FREQUENCY RANGE

The range of frequencies capable of being handled by the amplifier must be about the same as we, the listener are able to hear, a range from about 20 to the maximum of 20,000 c.p.s. Although many people do not hear sounds above 16,000 c.p.s., a lot of amplifiers cover this range and more besides. The point is, do you want to spend more money for something that you cannot hear? A great many dealers have arranged systems so that you can hear various combinations. Why not go along and listen to a few different amplifiers? You will soon be able to discover which you find the most pleasing.

Like our microphone, the amplifier should be able to handle all the frequencies equally; in other words the frequency response should be *flat*. Fortunately this trouble has been overcome in amplifiers. Obviously, failure to handle all the frequencies correctly would result in distortion of certain frequencies, maybe causing a sharp falling off at either the treble or bass end of the audio spectrum.

HARMONIC DISTORTION

This form of distortion is the addition of false harmonics which are added to the signal as it goes on its

way through the various stages of the amplifier. Once again this trouble has been taken care of by the manufacturer. Interesting and useful as the knowledge is, one must always keep in mind that today the components of a High Fidelity system are the best that can be produced at the price which one is going to pay. Still, it is wise to know something about what goes on and what might go on in an amplifier.

Another term that one will come across in connection with amplifiers is intermodulation distortion. The sounds that are being fed into the equipment are very complex indeed. Fundamental tones, harmonics, various frequencies, different instruments all playing together. All this, forming our sound, goes simultaneously into the amplifier. It is really a remarkable piece of equipment.

More than one frequency may combine inside the amplifier to produce distortion known as intermodulation. This will adversely affect our performance and has to be counteracted, or at least minimised so that our ears will be able to tolerate the distortion. It is a peculiar thing, but the human ear, like the eye, has a tolerance up to a certain degree. We can accept a certain degree of lack of sharpness in a picture without bothering about it. If this passes a certain point, we become aware of it and find it unpleasant.

The ear will accept about 4 per cent intermodulation distortion and present-day High Fidelity equipment goes well below this figure, the average being as low as one per cent.

Frequencies might be delayed in the amplifier. Let us

imagine that two and only two frequencies are entering the system. One of them may, due to the amplifier, fall slightly behind the other causing phase distortion. This, once again, can be ignored as the ear has a tolerance to this, accepting a certain amount of phase distortion if it should occur.

STAGES

An amplifier is built up in stages, something like a set of small units all working as a whole. The number of stages shows how many amplification processes the sound is subject to between input (from the cartridge) to output (speaker system connections).

FEEDBACK

This is often stated in specifications. Does it mean anything, since it is stated it must be something which is an advantage? Part of the output signal is fed back into the system out of phase with the signal that is entering the system. This is done to cancel out anything that might have been added by the stage in question. It is described as negative feedback.

Two other occurrences might take place, but they shouldn't be there. The first is *hum*. This should not be noticeable.

The second thing that might happen is a valve might become microphonic. This can happen to any valve. If the offending valve is tapped, a ringing sound is produced. The cure is to replace it with another valve. The sound cannot be mistaken, being very much the same as

when one taps a wine glass, producing a ringing note. The author has had this trouble with an old model portable tape recorder.

POWER

Stated as watts. How are you to decide what power is suitable for you? Do you need as much power (watts) as you can get, or will a small amount satisfy your needs?

The important thing to remember is not how much power, but how distortion free. Going back to our music for a moment, let us take a passage that has several loud sections. When a drum is struck, the sound rises sharply to its peak. If you already have a tape recorder, the recording control will show this fact very quickly. Naturally the amplifier will have to be able to deal with those "peaks" but how much tolerance will your ear accept if the peaks are cut off? Select a piece of music and listen carefully to it. Your ear will tell you what sounds right for you. If the amplifier is overloaded, distortion will take place.

It is the same as turning up the volume on some radios too high. The sounds coming out of the speaker are often hopelessly distorted. You will have no doubt come across this effect before. Overloading is causing distortion. If the amplifier has sufficient power it will handle these peaks. Peak power is twice the average power of an amplifier. One might see in the specifications, five watts output rising to ten watts. Now you will be able to understand what it all means.

CONTROLS

Very often the amplifier is fitted with bass and treble controls—the tone control. These enable you to adjust either end, boosting or cutting the bass or treble ends of the sound. Stereo units also have a balance control which is to enable you to balance the two speakers. The hissing and scratchiness of an old record can be dampened down by turning down the treble control. But remember that this also cuts the higher frequencies. It is up to you to use these controls to achieve the correct balance of sound for your listening pleasure.

11

THE RECORD PLAYER

A VERY important piece of mechanism that is often taken for granted, is the turntable. While the constructional details and the mechanics of such a unit do not concern us in this book, it is worth while looking at the required functions of the turntable unit—what it has to do and what we expect from it.

Things have progressed a long way from the days when one had to wind up the gramophone with a handle. Now we expect, no, demand, that all we have to do is to plug our unit into the electricity supply and the rest will be done for us. And the manufacturer has been able to meet these demands with a very finely engineered piece of mechanism.

The stylus has to follow the groove in the record to enable us to hear the sounds recorded on the disc. The result would be the same if the record remained stationary and the stylus moved in relation to it. The first method, moving the record in relation to the stylus, is by far the easiest to design, so it has been adopted.

Considering the many things that the turntable, the motor and the changer have to do, it is quite a feat that it has been made possible at all.

FIRSTLY THE SPEEDS

A few years ago there was only one speed to contend with, 78 r.p.m. (revolutions per minute). Therefore the motor and turntable had to be designed to rotate at this one set speed. In the gramophone this was usually achieved by a piece of mechanism known as a *govenor*. The govenor, when set in motion, maintained the speed of the motor and the turntable to 78 revolutions every minute. Now, today, we have four speeds. While many units are designed for all these speeds, three of them are the ones in use at the moment.

78 r.p.m. Many of us have valuable collections of older recordings at this speed. We do not wish to lose them by not being able to have them played on our new equipment. And it is still possible to purchase records at this speed.

45 r.p.m. The speed for what are called the Extended Playing records—the small-size microgroove discs.

33 r.p.m. The speed required to play the larger size of disc, and one in very common use. These are our Long Playing records which give us such a high standard of performance and quality sound reproduction.

16 r.p.m. Used for speech. Books, the Bible, all are gradually being produced on records. Every day the range of our listening pleasure is on the increase. It has nearly reached the stage of "you name it, we've got it".

The speed of the motor which drives the turntable is of vital importance. Wow and Flutter are two complaints

which might creep in if there is any variation in the speed when the recording is being played back.

These two factors can be taken together as wow is a name used to describe a low-frequency flutter. Should the speed of our record, or tape, if the music is being produced by the latter method, vary a little, the ear will detect the variation in pitch produced.

Suppose we exaggerate this effect. Tape recorder owners will know exactly what happens when a tape is played at the wrong speed; recorded at $7\frac{1}{2}$ i.p.s. and accidentally played at $3\frac{3}{4}$ i.p.s. The voice is deep, so deep and slow that the words are unintelligible. If the reverse be the case, a singer literally sounds like a canary, the voice being high pitched—the more the speed varies from normal, the higher the pitch. Wow and flutter are *slight* variations occurring many times each second. They produce a similar effect to a singer who is unable to hold the note and keeps sliding very slightly up and down from that note. Not at all pleasing to the ear.

The entire frequency range of the recording will also be affected, according to the degree of speed variation.

ELECTRICITY SUPPLY

Recordings made on a mains supply of a certain frequency (cycles per second) should be reproduced at the same frequency. Sometimes one comes across this problem when tape recordings made in other countries are played on a machine using the standard English mains frequency.

Often the voltage of the electricity supply varies, but the *frequency* of the current remains very constant. Thus

a motor has been designed which works according to the frequency of the mains and not the voltage. This speed-controlling by the frequency is called a synchronous motor and is a necessity in all high-fidelity set-ups.

As mains frequency varies from country to country, it is well to keep this in mind if the equipment has to work, for example, in America, where the frequency is slightly different to our own.

MOTOR NOISE

The motor must be silent. Any noise would affect the recording, in the same way as an amplifier hum also distracts from the finished product. The motor must also run smoothly and maintain the determined speed for any particular type of record.

Motor noise and vibrations have to be kept out of the system, otherwise all sorts of faults might develop which will interfere with the sound reproduction of the record.

CHANGERS

Turntables and motors also come in a variety of types. We can purchase a turntable and pick-up arm which we can install into our own system. Then, again, this unit can be bought already assembled into a case. It can be linked to form a complete unit with an amplifier, etc., an arrangement found in most portable record players. This makes them a self-contained unit, not requiring an external amplifier such as a radio, for playback.

Then there are various changers which will stack a set of records so that the machine will give continuous

playing for several hours. Some models even have automatic adjustments which enable different sizes of records to be stacked together, always providing that the speed of the records is all the same. While the size of the record is compensated for by the changer, the speed must not vary.

Turntables and motors which have a variable speed control, one that can be set to almost any speed are available. Naturally such units are somewhat costly.

The size of turntable also varies—one can see very small units in the shops. Once again, what appeared to be quite a simple thing, if we had even given a moment's thought to it, has now become somewhat complex.

As many fans build up their High Fidelity systems step by step, each separate unit has to be given due and careful consideration. Perfection is only achieved by having the best in all parts of the system. As we have seen it is quite feasible to start in a modest way with the basic units and then add to them, buying a more perfect piece of equipment as finances permit.

Think a while before rushing out and getting your record player, recorder or whatever you have in mind. Do you want one single unit, or several pieces of equipment? There are many points in favour of both. If the preceding chapters have helped to clarify such a vast subject as Hi-Fi, then you will have been put on the right road. Always remember that the dealer is only too ready to help you with your problems. You are going to be a good customer.

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PICK-UPS

At last! The end of our High Fidelity chain is in sight. Who would have thought that so many different pieces of mechanism and equipment would have been required to enable us to hear music with such perfection? We have arrived at our partners the stylus and the pick-up arm. As they form a unit it is convenient to treat them together in the same chapter. We shall leave out the technicalities and once again deal with the subject in a general manner—sufficiently well to enable the user to understand what part each of these units plays in sound reproduction and to enable him to treat them with the care they deserve.

With the older records and the steel needles, when things didn't go right, we just pulled out the needle and inserted another. They were inexpensive. And how soon did we begin to hear the noises on the record caused by the needle cutting into it and producing wear? By then it was too late to do anything about it.

If you happen to have a really old record lying around the house, try it on your new equipment and listen to it. The author fully expects that you will hardly play it for more than a few moments. Terrible, isn't it? One can hardly hear the music, such as it was with old-fashioned methods of reproduction, owing to the wear on the record.

The new equipment being High Fidelity, renders all the frequencies in a way that was thought impossible many years ago. It also produces all the imperfections to an equal degree.

STYLUS

Today, players have two styli. This is necessitated by the use of 78 r.p.m. and microgroove records. The grooves in these two types of recordings are different, thus requiring two needles to play them correctly.

The older type, the seventy-eight record, has a larger groove than the Long Playing records, thus needing a larger stylus. The groove on a record is cut like a V, the stylus following the groove and vibrating from side to side, or laterally. These variations in the movement of the stylus are turned into current fluctuations by the pick-up cartridge in the pick-up head.

The two styli used today are of the dimensions of 1 and 3 mil. The larger of the two is for the bigger groove on the seventy-eight records. It can easily be seen that several problems are immediately apparent. The stylus is subject to wear. How can we give it a long life?

TYPES OF STYLUS

There is no such thing as a stylus that will wear for ever. The two types often encountered are the sapphire and the diamond styli. The diamond stylus is the best for two reasons. Diamond is the hardest material known. The diamond stylus will last much longer than the sapphire type. A great deal of heat is generated as the stylus follows

the groove on the record. The diamond is an excellent conductor of heat, allowing the heat generated to disperse from the record groove, thus avoiding damage.

It is difficult to say how long any particular stylus will last as many factors enter into the problem. But one can say that a diamond stylus will far outlive its sapphire companion.

A worn stylus instead of resting on the sides of the record groove will drop down to the bottom and act like a chisel, causing damage to the delicate groove. We are, in effect, irreparably harming the sound track, a thing that no one wants to occur.

Linked with this problem of a stylus is the pick-up arm. The stylus follows the groove on the record. The groove has a lateral play and as the stylus moves along it vibrates from side to side. These fluctuations are turned into electrical impulses by the ceramic cartridge in the pick-up arm. The system is exactly the same as for a microphone. A Piezo-electric material, or a magnetic system are used to produce the electrical energy. This is then conducted to the input socket of the amplifier.

PICK-UP ARM

It has to allow the stylus absolutely free movement to follow the record groove, be of sufficient weight to keep the stylus in the groove, yet not be too heavy.

The arm has to hold the stylus in position as accurately as possible, yet allow it freedom of movement. The pressure has to be sufficient to prevent the stylus from jumping out of the groove, yet not cause it to bear on to the

record with too much weight. It has to hold the stylus vertically in relation to the groove. Should the stylus lean over to one side, the groove would start to be worn.

These arms also come in quite a variety. The mechanism which allows the arm to drop *gently* on to the record is also important. With the introduction of the micro-groove (smaller grooves set closer together) the stylus has to be placed on the record with precision.

There are units available which allow the arm to descend gently, almost coming to a stop just before the point of contact is reached. To use an old saying, the stylus touches the record "as light as a feather".

If an autochanger is not used, the author feels that some such device is worth considering. We humans are inclined to be "ham-handed" when it comes to positioning the stylus on the disc. Like so many things, mechanism can do it infinitely better than the human hand. We, as far as science is concerned, are almost becoming back numbers. Machinery and electronics can do it better and faster.

We have come to the end of our "Journey into Sound". Starting with sound itself, we have followed it through the many stages that it goes through before arriving at our ear. We have seen that the simple action of selecting a record and putting it on the turntable is in reality a complex chain of events, each one designed to give us the ultimate, or the nearest to that aim. The manufacturer is always striving to perfect new techniques to give us better sound quality.

All that remains is to plan our High Fidelity room, if we may call it that. We have decided what we wish to

purchase, how our desires will fit in with our budget, and what we are going to look for when we arrive at our dealers to find that we are surrounded by many different machines, each one in its own way being an excellent product.

In the next chapter, the only thing left is to consider some High Fidelity set-ups which will help us in planning our own, and individual, scheme. As has been pointed out in previous chapters, there is no need to make the equipment "hard on the eye". The room can be enhanced by a carefully selected and judiciously placed set-up. In these days of home décor and originality, speakers and allied units can be fitted into things which, a few years ago, might have been considered useless.

Maybe you have some articles of furniture lying around in the attic which have been waiting to see the light of day. Now, perhaps, they will provide the very thing that you had in mind.

Or a browse through old junk shops might unearth some piece of furniture. Something that can be picked up for a few shillings and with a little ingenuity by the home handyman, turned into a container for the record player or tape recorder.

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YOUR OWN HI-FI SET-UP

At last! We have arrived at the final stage; the stage where we can plan our own *individual* High Fidelity system. From our previous knowledge we should not find this at all difficult. We now have a basic idea how each component works, its place in the set-up and the function that it has to perform. We also, unfortunately, have been examining our bank account and have determined how much we can spend on the *Basic Set-up*. Well selected, this set-up can be added to as finances permit. It is essential that we start off *right*. We can purchase the minimum of equipment, but if this is done with a little aforethought and planning, additions that come along will fit neatly into the general scheme of things. Nothing is more irritating than to find that something has been overlooked and when another unit is required it will not fit into its proper place alongside the rest of the equipment.

Maybe you have decided that a single unit, one that houses all the components in a single cabinet, is the easiest for you. Why not leave that decision until you have read this chapter? Then you might have second thoughts on the whole matter.

Take a glance round the living-room. At first sight, a

single unit will fit nicely into that spare corner, the only place in the room for an additional piece of furniture. That might be so. At the same time your mind has probably built up a picture of several separate components with yards of connecting wires all over the place. You may well shudder at the thought of what people are going to say when you start to turn the living-room into a listening-room. No, it definitely cannot be done! or can it? That's right, take another look around. The odds are that *you* will be able to fit several separate pieces of equipment into the room. How? Well, shall we take a look? No harm done yet. We haven't bought anything, the money is still safe in our pockets.

DISADVANTAGES OF A SINGLE UNIT

The following may be disadvantages in a single unit. After all, compromises have to be made. The record changer may be subject to Wow, Hum and Rumble. The tone controls may be insufficient, the speakers might not render the high and low frequencies to your liking and the speaker enclosure might be rather poor. This does not mean that single unit is no good at all. Far from it. The author has heard many such pieces of equipment which are very fine indeed. But one must compromise when everything has to be built-in to a given area. That is obvious.

ADVANTAGES

It is all done for you. All you have to do is pay the price stated and have a lovely, shining, brand-new unit

delivered to your home. Put it in the pre-determined place in the living-room, connect the plug to the mains and all is set. It is as easy as that. And what a fine piece of furniture it is. All polished wood, gleaming, new; your pride and joy.

While all this is perfectly all right, and this is not being put forward as an argument for badly designed and ugly pieces of furniture, it has to be remembered that in High Fidelity it is the *sound* that is of prime importance. Of the two, the author would rather sacrifice looks for sound performance. Happily there is no need to do this at all. Yet it can indeed be foolish to go to the other end of the scale and sacrifice performance for looks. Sound should always come first, appearances second. We are going to see how we can have both, high-quality sound and designing which will not only add to the décor of our room, but give us the pleasure of owning a personal High Fidelity set-up; one that is as individual as ourselves. We have designed and installed it.

No one is asking you to be a technical man. You are not going to build the actual components, only assemble them the way you want them in your own home.

FIRST STEPS

Maybe we are a jump ahead of ourselves. We have already seen that the range of equipment for each component is quite large, both in size and quality *and* in price.

Why not call on your dealer and collect some literature on such things as speakers, enclosures, amplifiers and all the other things you are thinking about? Or write to

the manufacturers for full details and illustrations. Now you will have some idea of the size of the various parts that you are going to assemble.

STEP TWO

A problem appears to arise from all this. The range is so large, even when your bank balance has been considered, that you may feel that you still have a lot of different pieces of equipment to think about. If three speakers, for example, are all suitable to your pocket, which one should you buy? For that matter, which amplifier, which turntable?

Many of the larger dealers have thought of this problem and arranged matters to make it easy for you to solve this.

They have connected many pieces of equipment together, so that you are able to hear different combinations working for the same selected piece of music. You will be no further afield if you hear *different* pieces of music on different equipment. Select a record, one that you know well, one that has a good frequency range, going from the lows of a drum to the highs of the triangle and the violin. One that also has some loud passages in it and some quiet parts; *fortissimo* and *pianissimo*.

Maybe you have a record handy in your collection. If not, why not ask the dealer for a suitable piece, on a microgroove disc of course. He will let you hear several from which you should be able to make your choice. Or, as is often the case, the dealer will have a demonstration record used for just this kind of thing. If one firm is not helpful try others.

While the acoustics will not be the same as your living-room and external sounds may intrude somewhat on your listening, you will still be able to give the proposed equipment a very fair trial.

Please remember that sound is a subjective experience. You, the listener, as we have pointed out many times before in this book, are all-important. WHAT SOUNDS PLEASANT TO YOU? That is your measurement. But listen carefully. Don't feel that the first set-up you hear is exactly the right one for you. This may well be so, but why not hear a few more combinations? You can always go back to the first one again.

Then, also, what is your type of music? Is it the "pops" or are you a classic music lover. The symphony orchestra has a very wide range of frequencies and must have equipment which can adequately handle this range.

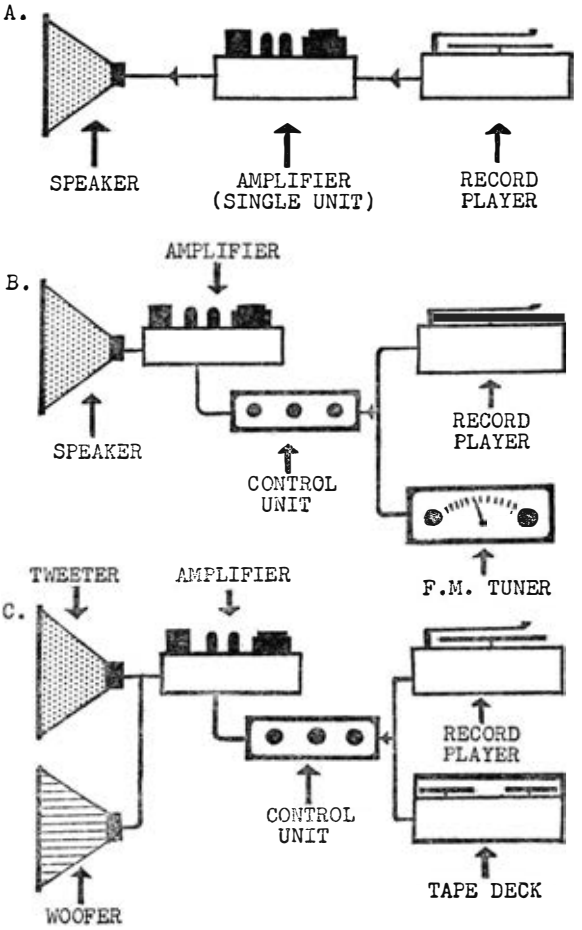
STEP THREE

You have been to the dealer, heard the equipment that you like the best. Now two out of the three problems have been satisfactorily settled; the right equipment and the cost. One point when listening to speakers. Listen to the test-piece carefully, checking the speaker for frequency response and distortion. We have seen that these are important.

The angle of sound radiation is also important. When we are facing the speaker "head on" we are on the *axis* of that speaker. Listen carefully to the music and walk away from the axis to about forty-five degrees. Remember that high frequencies are directional. Is there any fall-off

FIG. 25

SOME BASIC SYSTEMS



when the violins are playing? There shouldn't be. After all we may not be able to sit directly in front of the speaker. If we are able to do this, what about our friends? Your listening audience is bound to be somewhat spread out in the living-room so the speaker must have a reasonable angle of dispersion.

INSTALLATION

The final step. How to fit the High Fidelity set-up into our own room and how to be individual. Impossible? Not at all. Let's look round. Live in a flat? It still can be done, even if space is limited. If you happen to be fortunate enough to be refurnishing your room, many problems are solved. Cabinets, many excellent in design, are made to fit in with most modern furnishing schemes. Maybe you are like most of us, have a furnished room which has to be the way it is. Then you have to fit your new scheme into the existing layout, if we can use that term.

When we are planning we must allow sufficient space for any additions at a later date. Always keep that in mind. The room you have, will, to a degree, dictate the planning. As it is impossible to mention every conceivable installation, we can only mention three general ideas which we hope will give you food for thought and help you on the way to your own planning.

CUPBOARD

Many rooms have a cupboard in them. Inside there are several shelves. Ideal for installing the various pieces of equipment. You can, perhaps, place the speakers in the

cupboard door. Most rooms have *one* spare corner, so why not consider placing all the components in the cupboard and the speaker enclosure in a corner of the room? This method leaves no trailing wires about, the speaker connections being neatly run along the skirting board or beneath the carpet. All your units are out of sight, yet conveniently placed for use.

BOOKSHELVES

If we have no actual shelves in our room, we might have a room divider. If we happen to have bookshelves, are they really serving a useful purpose? Do we need all the shelves for those books? If we take a look we might well discover that many of our books are old and that we could do without them, or at least move them to the attic. That leaves us with some shelves free for our equipment.

CABINETS

No, we are not back to the same idea as buying our equipment in one single unit. The sideboard can easily house all the components. Worth thinking about, isn't it? And it fits into the room. Why, it is there already! In much the same way, tables, chests, corner-cabinets, in fact almost any piece of furniture can be brought into use.

If we are contemplating buying a "Do it Yourself" kit, we once again have a wide choice. Cabinets and speaker enclosures come in many designs and sizes. The home handyman, and who isn't these days, has only to assemble the various parts.

By this time several ideas should have presented themselves to you. Take a walk round your room once again. Will it fit in there? Now that we know how to look and the innumerable ways we can install our High Fidelity system, we see many possibilities.

To make absolutely certain that all will be well before we make our final decision and buy the equipment, why not make a rough sketch of our room and see how the various parts will fit into it? Let us also keep in mind that at a later date we might well require an additional amplifier so that we can increase our range to cover Stereo listening.

While the system has been looked at from the point of view of discs, we might wish to add a tape deck and a Frequency Modulation tuner to our set-up. So best allow the necessary room for this additional equipment. At the end of this chapter an approximate price list has been given. This is only *very* approximate as prices can be subject to an extremely wide range depending on the quality of the equipment purchased. The author has taken a basic set-up with a good turntable unit, and two speakers with a crossover network. From there you can add whatever you wish.

It is hoped that you will derive many hours of entertainment and enjoyment from your adventures into High Fidelity sound. The world of music, monaural and Stereo is at your feet. Folk-tunes of many lands, the finest composers in the world are there for you, waiting to be reproduced with startling reality. If a tape deck is also included, your horizons are widened further, the medium of world-wide communication with people in far-distant

lands being brought into your home. As many of these amateur tapes are of exceedingly good quality, your High Fidelity system will increase your enjoyment of them.

Cowboy songs recorded just for you from the heart of America, the drums of darkest Africa; all are possible.

Today these things are not wishful thinking. They are not only possibilities for those with limitless resources of cash. They are within your reach.

The author is sure that you will never regret your venture into sound, whatever form it may take. It is hoped that the preceding chapters have made it possible to either increase your pleasure, or, if you are a newcomer, made the path smoother into one of the most personal and delightful forms of entertainment available to us today.

Average Cost of High Fidelity System

		Additions to basic set-up	
Turntable and Pick-up Arm	£20	Tape-Deck and Pre-Amplifier	£40
Amplifier	£20	Diamond Stylus	£3
Woofer and Tweeter	£10	Frequency Modulation Unit	£15
Speaker Cabinet	£10		
Crossover Network	£7		
Total Cost	£67	**Total Cost**	£58

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RUNNING TIME FOR VARIOUS TAPE LENGTHS

THREE sizes of tape spool are in general use, although one may come across other sizes made by different manufacturers, particularly of continental makes of recorder. As the recording sense is standard, there is no need to worry about playback characteristics. The central fitting of tape spools is also standard for tape recorders; this excludes dictation machines which use tape. These spools often have a different fitting which makes them only usable on a particular make of machine.

The standard thickness of tape comes in two types—normal-play and long-play types. So we have, as a working rule, *three* common spool sizes and *two* different tape lengths, according to whether it is normal- or long-play tape. Other variations are available, but the following approximate table will give the tape recorder owner some idea of the playing time of various lengths of tape at different speeds. Now there is Double-Play tape on the market.

Four speeds are found on many tape recorders, three speeds on most, and *two* speeds on nearly all machines. As a useful working rule, the higher the speed of

the tape, that is the greater the length of tape that passes across the recording head per second, the better the quality of our music.

This quality at a determined speed is quoted in specifications as the range of frequencies capable of being handled at that given speed. To take an example; one might read that at $3\frac{3}{4}$ i.p.s. (inches per second) the frequency range of the recording will be between 50 and 8,000 c.p.s. (cycles per second). These figures are only arbitrary and do not apply to any particular make of recorder. They are merely used as an example to give one a guide when studying specifications.

Obviously, the higher the frequencies recorded, all other things being equal, the better the quality of the recorded music. An interesting experiment is to record the same musical passage at two different speeds, say $3\frac{3}{4}$ i.p.s. and 15 i.p.s. On playback there should be a noticeable difference at the upper end of the recording, as the frequency range is greatly extended. The slower speed recording will lack brilliance, while that made at four times the speed is of a much superior quality.

This does not mean that one cannot get really good musical reproduction at $3\frac{3}{4}$ i.p.s. One can. Once again the only real test is to listen to various machines oneself and then make your decision.

APPROXIMATE TAPE RUNNING TIMES (DUAL TRACK RECORDING)

	Spool Size					
	3-inch		5 inch		7 inch	
Speed	*Normal Play*	*Long Play*	*Normal Play*	*Long Play*	*Normal Play*	*Long Play*
i.p.s.						
1⅞	36 min.	50 min.	120 min.	180 min.	4 hrs. 14 min.	6 hrs. 22 min.
3¾	18 min.	25 min.	60 min.	90 min.	2 hrs. 7 min.	3 hrs. 11 min.
7½	9 min.	13 min.	31 min.	45 min.	1 hr. 3 min.	1 hr. 35 min.
15	4½ min.	6½ min.	15½ min.	22½ min.	31½ min.	47½ min.

GLOSSARY

AUDIO SPECTRUM

The frequency range that the human ear is capable of receiving. Approximately between 20–20,000 c.p.s.

BACKGROUND NOISE

Noise that is present when there is no signal. In the case of a recorded tape it might be heard as a hiss.

BAFFLE

A partition used to help the radiation of the sound waves issuing from the front of a loudspeaker and to prevent the rear waves from cancelling those in front.

BINAURAL

Usually called Stereophonic.

CORNER HORN

An enclosure for a woofer speaker and making use of the adjacent walls and floor of a room to extend the low frequencies.

CROSSOVER NETWORK

A filtering system fitted to multispeaker systems to allow only the correct frequencies to pass to any particular speaker.

CRYSTAL

Piezo-electric material. Will convert movement to electrical impulses.

CUT

Often called either "bass" or "treble" cut. Refers to the cutting of a selected frequency range.

CYCLE

One complete phase of an alternating current. A cycle is composed of both the positive and negative halves of a wave. A five-cycle current will reverse itself five times in one second.

DECIBEL

Unit for the measurement of sound intensity.

DIFFUSION OF SOUND

Spreading the sound so that it has an equal intensity throughout the room. High frequencies are more directional than low frequencies.

DISTORTION

Failure to reproduce the correctness of the original recording.

FALL-OFF

High frequencies, being directional, are reduced as the listener moves towards sides of speaker.

FILTER

A device used in a crossover network which allows certain frequencies to pass while blocking others.

FREQUENCY RESPONSE

The ability for a High Fidelity piece of mechanism to keep a flat response throughout the frequency range.

HALF TRACK

Often called twin track. This refers to a tape recorder and means that half the width of the tape is used for recording. In Stereophonic reproduction both tracks are used to carry the two recordings. Some machines are FULL TRACK, the entire width of the tape being used for recording.

HUM

A low-frequency sound often caused by bad shielding of a cable or a faulty earth connection.

KILOCYCLE

One kilocycle is equal to 1,000 cycles.

MEGACYCLE

One megacycle is equal to 1,000,000 cycles.

PIEZO ELECTRIC MATERIAL

Certain types of crystal when subject to a mechanical force produce an electrical effect.

REVERBERATION

Prolonged echoing due to sound waves being bounced back from reflecting surfaces. If this is bad the quality of the sound can be seriously affected.

RUMBLE

A noise in the lower frequencies caused by the turntable or motor in a record player.

SELECTIVITY

The ability of a radio to select between required and unwanted signals.

SENSITIVITY

The sensitivity of a receiver determines whether it will receive distant stations.

STEREOPHONIC

The ability to reproduce "Concert Hall Realism" in the home by means of two recordings played simultaneously through two separate speakers.

TWEETER

A loudspeaker designed to handle the higher frequencies.

WOOFER

A loudspeaker designed to handle the lower frequencies.

WOW

A variation in speed which affects the low frequencies. A variation in high speed is known as FLUTTER.

SOME ABBREVIATIONS

O.B.	Outside Broadcast.
P.A.	Public Address system.
c.p.s.	Cycles per second.
i.p.s.	Inches per second.
Mic.	Microphone.
Phones.	Earphones, Headphones.
r.p.m.	Revolutions per minute.

THE RIGHT WAY TO
TAPE RECORD

*

TAPE RECORDING MADE EASY

*

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