

## Chapter 1

# The How and Why of Hi-Fi



Columbia Records

**H**IGH FIDELITY has become a magic name in this most recent decade of its long and colorful life. But to many people it is still as mysterious as it is magical. What does it really mean?

To the musical artist it is another means of communicating with his listeners. To the sound engineer it is the best known means of collecting, storing, and reproducing audio. To the record and component equipment manufacturers, it spells new markets and new opportunities for profit.

But what about you and me? Mr. Average Joe Consumer. What does high fidelity really mean to us?

For you and me, high fidelity should be the means of erasing the barriers of time and space between a fine musical performance—or any other sound source if our taste happens to run that way—between the original production of this sound and our own private listening enjoyment of it.

This is quite a wonderful proposition. And because it is so wonderful, quite a

few snake-oil merchants have attempted to befuddle us with curves, charts, ten-dollar words, and other weird incantations and mumbo-jumbo.

Pay them no heed. The road to hi-fi is wide, easy to follow and well mapped out. Our objective is simple enough: *we want the best possible sound reproduction we can get without at the same time going into bankruptcy.* To achieve this we need only know the various possible approaches to our objective, choose the one which best appeals to us, plan our system with the aid of this approach, and then execute the plan.

We can save ourselves a lot of useless argument later if we agree at the outset just what hi-fi is. To begin with, the very term *high fidelity* can have only a relative meaning. It's like the old childhood conundrum, how high is up? This sort of question simply can't be answered with numbers or other specifics.

Hi-fi is constantly shifting upward with the state of the art. What was hi-fi yester-



The photo at left shows some of the members of the Cleveland Orchestra taking a short breather during recording session.

One of the top "good music" stations in this country is WQXR in New York. Below, the control room, equipped to play stereo records and tapes. Its services five studios.

day may be low-fi tomorrow. So don't think we are dodging the issue when we define hi-fi simply as *the nearest approach presently possible to true or perfect sound reproduction*.

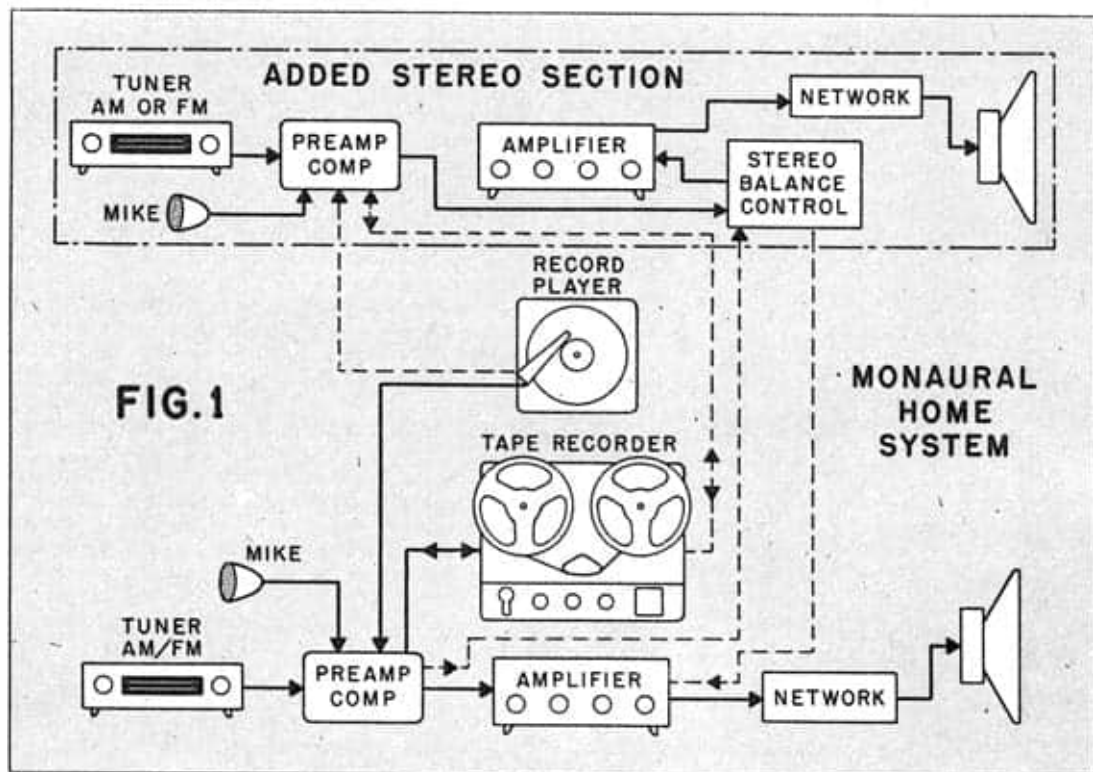
This may seem to be answering the question with another question, but we can go on and positively identify true fidelity as the exact psychological impression of actual presence at the original performance. The smaller the difference between hi-fi and true-fi, the higher the fidelity goes.

While you are still considering that there is a difference between hi-fi and true-fi, this may be as good a time as any for you to be let down easy, if you happen to be riding a fur-lined pink cloud over this whole hi-fi business. Because the fact is that hi-fi still has a long way to go.

Every now and then, some zealot stages a comparison demonstration between live and recorded performances, purporting to prove that the two are now indistinguishable. We could go on at some length to discuss why and how audiences are fooled by this kind of hanky-panky, but in this connection there is really only one important thing for you to remember: this sort of thing has been going on ever since the early days of broadcasting, and even before the record industry shifted from

The New York Times





the acoustical to the electrical method. Now everybody knows we didn't have perfect fidelity way back then, or anything even remotely approaching it. But you could have found plenty of people at the time who believed that the ultimate had been reached.

Don't be fooled. Just as your old Atwater Kent has been obsoleted by today's modern hi-fi tuner, so will today's equipment be obsoleted by even greater advances in hi-fi tomorrow. But this is no reason to hold back from buying hi-fi "until they perfect it," any more than it's a good reason not to buy a new car, an air conditioner or color TV. Sure, hi-fi and all these other things will improve. But hi-fi today is the best we've ever had, by a wide, wide margin.

Another important thing to remember about hi-fi is that you have control *only* over the last link in the chain. Before the sound signals ever reach your system, they may already have gone through microphones, mixers, amplifiers, filters, equalizers, telephone lines, transmitters, recorders, and "the luminiferous ether." And if any of these pieces of equipment, or the

personnel operating them, happen to have been a little sloppy, then your fidelity isn't going to be quite as high as it might have been, no matter how good your equipment is or how smartly you operate it.

This idea is illustrated by the drawing of Fig. 1, where we see that only a relatively small group of blocks comprises the monaural home system. The entire chain of events (not shown in the drawing) from original performance to recreated performance is at least three times as long.

The system shown here has three different sources of sound: radio, tape and disc. We should begin by examining these three types of transmission, finding out their similarities and their differences.

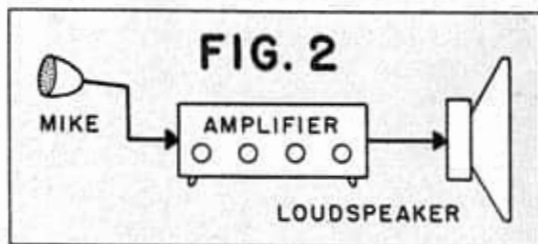
Whichever method is used, we see that the beginning element is the microphone. This is known as a *transducer*, because it converts the varying air pressures we call sound waves into a varying electrical signal. Thus the microphone is an electro-mechanical device, converting mechanical energy into similar electrical energy. This conversion is basic, and common to all types of audio systems presently known.

Now suppose that the entire purpose of



Columbia Broadcasting System

Many popular entertainers, such as Bing Crosby, above, participate frequently in live broadcasts. Good hi-fi tuners make it possible to have these famous names perform right in your living room.



this conversion is to make the sound louder, and then to reproduce it again immediately. This can be done readily using the setup of Fig. 2. Here the feeble electrical signals coming from the microphone are strengthened many times over by the amplifier, and then fed into a loudspeaker.

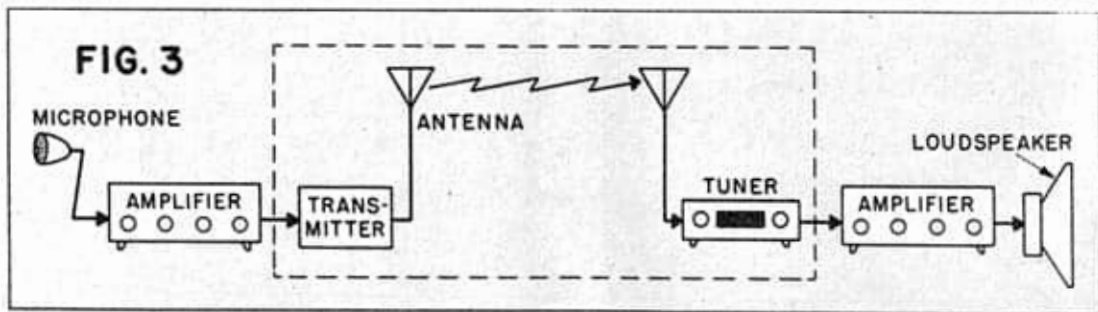
This speaker is another electromechanical device, or transducer, with a purpose exactly the opposite from that of the microphone. Its function is to receive electrical signals and reconvert them into varying air pressures which impress the human ear as sound.

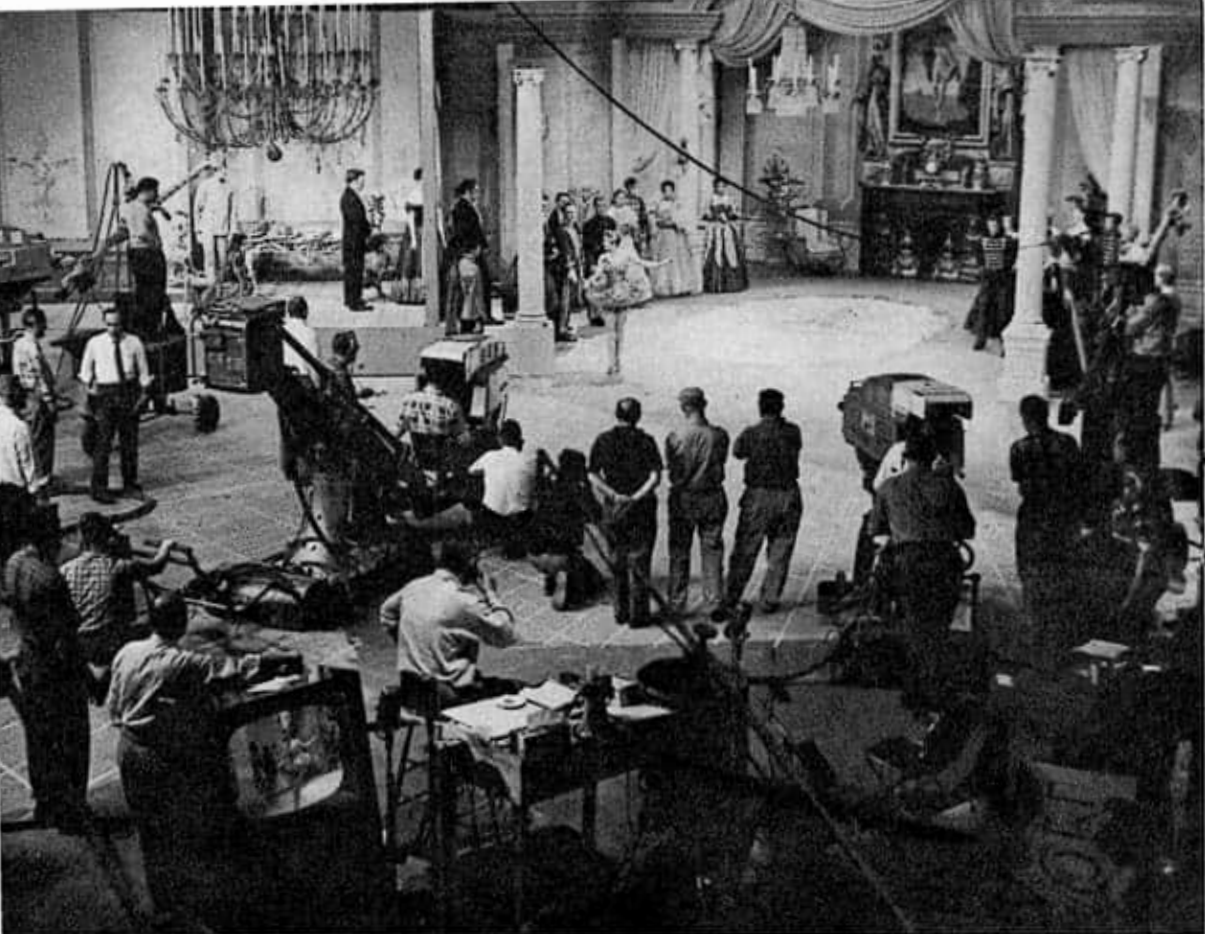
A system no more complex than this is all that is needed for public address, in which the sound of a speaking voice or musical performance is amplified and played to a large audience. This basic idea could be carried right into your home, in which case you would have your own private *closed-circuit* hi-fi system. But if there were any considerable distance between the original performance and your listening room, you would have to install rather extensive wire line facilities, or else lease those of your local telephone company. And that would be rather expensive.

This leads us to one of the problems of the simple live closed-circuit system of Fig. 2. Over long distances, the expense is prohibitive. The other objection is that the performances cannot be stored. All you can hear from the speaker is whatever is happening at the microphone right now. Ideally, then, our hi-fi system must exhibit two other characteristics: it must be able to transmit the sound over long distances at low cost, and it should be capable of preserving sound indefinitely.

The first requirement is met by the system of Fig. 3. Here we have a double conversion, in which the electrical signal from the microphone and amplifier is combined with a second electrical signal known as a *radio* wave. This composite signal is sent out into space by a transmitting antenna.

When a part of this radio signal is inter-





NBC-TV

Television spectaculars, productions of musicals and operas, offer today's TV audience the best in FM sound, another inducement for hi-fi equipment purchase. Photo shows set of "The Great Waltz."

cepted by your receiving antenna, it is fed into the tuner of your hi-fi system, where the audio signal is separated from the radio wave. At this point the audio should be nearly identical to the signal at the output of the microphone amplifier at the left of Fig. 3. In other words, the radio system of Fig. 3 is essentially the same as the closed-circuit system of Fig. 2, with the addition of the broadcast equipment enclosed by the broken lines.

Since radio transmission is quite cheap, we now have at least one system for getting the sound from source to you at very reasonable cost. But we don't yet know how to tune in radio broadcasts made last week or thirty years ago, so we still must find some means of storage.

Light rays are fleeting images, but a photograph is not. Taking a cue from this analogy, we can surmise that for the storage of sound waves, we must convert them to yet another form. This form could be any

of dozens proposed or actually in use, but there are only two which are of any importance in home hi-fi systems. One of these is shown in Fig. 4.

This is the basic phonograph system, in which two more types of transducers are introduced. In this case the electrical signals out of the amplifier are converted to mechanical motion by a disc recorder or cutter. This motion is permanently recorded by an engraving tool on a rotating disc.

When the wavy groove is later traced by a stylus, the mechanical motion generated causes the development of a new electrical signal which is substantially the same as the one fed into the cutter. The second transducer, which converts mechanical motion into electrical signals, is often called a phono reproducer, cartridge or pickup.

Once again we see that our basic closed-circuit system of Fig. 2 remains, with just the addition of an electromechanical system





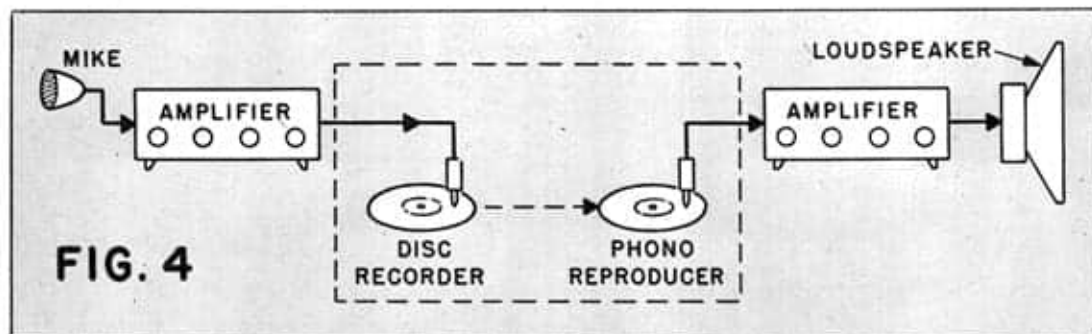
The New York Times

slipped into the middle. As a practical matter, the disc actually cut on the recorder is not the one you play on your reproducer at home, but a near-exact duplicate of it. As we shall see in a later chapter, there is a rather intricate process of duplication and manufacturing between the recorder and the reproducer, but the basic elements of the system are those shown in Fig. 4.

Another method of recording, which is enjoying increasing popularity, is that shown in Fig. 5. In this case the electrical

audio signals are used to magnetize millions of tiny grains of material on a moving plastic tape. Once again we see that the system is essentially that of Fig. 2, this time with a magnetic circuit slipped into the middle.

You can buy recorded tapes just as you buy recorded discs, in which case your system need only contain the three elements shown to the right in Fig. 5. Recorded tapes will be discussed in more detail on page 28. But it is also possible to make your own tapes, in which case your



Some 65,000 recordings and 500 tapes, the largest collection of classical music owned by a radio station, are housed in WQXR's record library.

Shopping for hi-fi components can be confusing with today's wealth of items available; however, being able to compare units with instant back and forth switching lessens the chore. Below, Jimmy Carroll of Harvey, Inc., New York, explains intricacies of the switch panel to your editor.



Mike Bonvino—FAWCETT Studios

system will contain all of those shown in Fig. 5. A thorough discussion of tape recorders will be found in Chapter 10.

Now if we consider Figs. 3, 4 and 5 together, we see that our concern is solely with the right-hand half of each drawing, this being the part having to do with reproduction in the home. Furthermore, we see that the two right-hand elements are common to all of the drawings. That is, whatever the means of transmission or recording, we still must have an amplifier and a loudspeaker for reproduction.

All that remains, then, is the input transducer. This may be a phono reproducer, tape player, tuner, TV, film projector, microphone, or some other translating device. Now since the amplifier and speaker are common to all, only one of each of these is needed (except for stereo sound, which we shall come to presently).

Now we come to the point where we can recognize the distinguishing characteristics of any hi-fi system. First, it has an amplifier and a loudspeaker. Second, it has as many input transducers as may be desired. Third, it has suitable selector switching and control equipment between the transducers and the amplifier-speaker system.

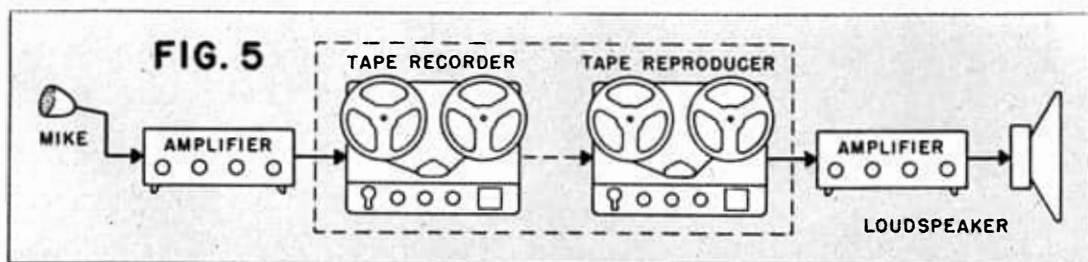
That's all there is to it. All of the other hi-fi component names you may have heard will upon closer examination be found to fall into one of these basic areas. With this simple fact in mind, the block diagram of the home system in Fig. 1 doesn't look quite so complex.

The several connections to the tape machine are required simply so that we may not only play recorded tapes, but also may record from the microphone, from discs, or off-the-air. The COMP and PRE-AMP blocks refer to refinements in the phono channel which will be discussed on page 56. Similarly, the CROSSOVER NETWORK is a refinement in the speaker system and is fully explained in Chapter 9.

## The Stereo Story

This would complete our discussion of the basic hi-fi system, if a new factor hadn't come on the scene a few seasons ago. This is called *stereophonic* transmission, and while it requires more equipment than the *monophonic* system we have just discussed, its basic principles can be developed in the same way we have just done. But first, we need some idea of its purpose.

Stereo sound is intended to give a roundness and depth to hi-fi reproduction which



Program of concert given to show how little difference there is between live and recorded music. Although remarkable, some difference was noted, especially by those sitting near front.

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## LIVE vs. RECORDED

concert at CARNEGIE RECITAL HALL

Saturday, January 10, 1959

FIG. 6

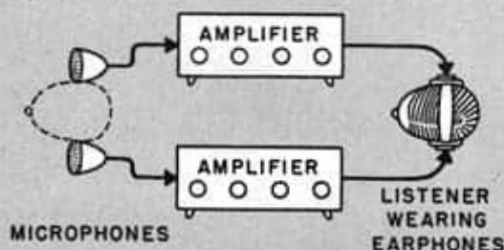
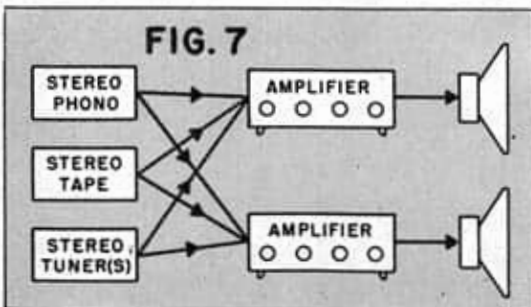


FIG. 7



The concert during one of the live portions. A previously recorded tape would be played, then the orchestra, then back to tape. Switchover from live to tape was often exceedingly smooth.





## The How and Why of Hi-Fi



is not possible with a monophonic system. Furthermore, it is more directional. That is, in stereo reproduction the listener has a more accurate idea from which direction a given sound originally came.

And just as stereo photography uses two "information channels," so does stereo sound. In stereo photography, two pictures are taken by a dual-lens camera, with two optical systems side by side. In stereo hi-fi, two sound signals are carried by two separate audio systems.

Compare Fig. 6 with Fig. 2. Except for replacing the loudspeaker with a pair of headphones, we have simply doubled the monophonic equipment to obtain the stereo type. With this setup the listener readily imagines himself to be transported to the location of the original sound.

Although the system of Fig. 6 is the most accurate means of achieving realism in sound reproduction, it has several serious disadvantages:

1. Continuous use of the earphones is tiring.
2. Group listening is difficult and awkward.
3. When the listener turns his head, the performance follows, swinging around in an arc before him.

Because of these drawbacks, most people prefer to replace the headphones of Fig. 6 with two loudspeakers. Since the sound from the two speakers blends somewhat in the room before it reaches the listener's ears, it is not as accurate or realistic as the true binaural system shown in Fig. 6. Still it does have more excitement than the ordinary monophonic system, and all but the most die-hard purists seem willing to settle for that.

Faced with the choice of mono or stereo, the beginner often doesn't know which way to turn when beginning to build up his system. To reach a decision, let's look at the building blocks which comprise a stereo system, and compare them with the monophonic elements. The basic stereo units are shown in Fig. 7.

The amplifier-speaker combination in the stereo system is just exactly double that in a monophonic system. While stereo

amplifiers specifically designed for that use usually comprise two identical amplifiers on a common chassis, there is no reason other than convenience why this need be so. In other words, it is entirely practical to buy one amplifier and speaker now, and another amplifier and speaker later, to convert to stereo.

As far as the record player is concerned, the turntable or changer as well as the tone arm remain the same. Stereo and mono cartridges are not the same, however. If you start out with a mono cartridge, you will have to replace it with a stereo type for your conversion. But since the stereo cartridge will also reproduce the mono type records, it is possible to install the stereo type in the first place. Before deciding to do that, however, you **had** better read Chapter 5.

In the tape department, the situation is much the same as for disc. The transport mechanism and other mechanical features remain the same. To convert a monophonic tape machine to stereo requires the replacement of one or two heads, plus some additional electronics. This is entirely practical although it does entail some rebuilding.

For stereo broadcasts, conventional AM and FM tuners will receive the most common type without any modification. For "multiplex" FM stereo, an adapter is required.

Obviously, then, it is quite feasible to build a solid hi-fi foundation with a good monophonic system, and later add on to build up to stereo. This is the method recommended in this book. Most of each chapter will be devoted to one of the basic components of the monophonic hi-fi system. The concluding section of each chapter will tell you how this information ties in with stereo, and what modifications must be made for your stereo conversion.

This is the simple, logical way to "go stereo" if you really want to. While the total cost may prove to be a little more, the initial cost, especially if you already own a monaural system, will be much less. And it just may be that you'll be content not to go stereo at all. •