RCA VICTOR

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SERVICE DIVISION
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FOREWORD

The purpose of this booklet is to introduce and explain the operation of the recording and playback system used by RCA Victor to provide stereophonic sound from disc records.

To accomplish this, the booklet begins with an explanation of the principles of stereophonic sound; progresses through methods of recording sound on records; continues with the techniques of the 45° — 45° recording system; and finally, describes the elements of a typical RCA Victor Stereo-Orthophonic High Fidelity "Victrola" phonograph instrument.

The booklet is made available by the RCA Victor Company, Ltd., to provide this information to those interested in stereophonic sound reproduction.

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RCA VICTOR LIVING STEREO

Ever since Thomas Edison made a tinfoil-covered cylinder say "Mary had a little lamb" — and later, the birth of the "Victrola" — the public has demanded better reproduced sound. Sound that sounds *real* — true-to-life sound.

For many years, because of the limited techniques and the equipment and materials then available, recorded sound was played back mechanically from disc records. It sounded mechanical. At best, by our standards today, only a small portion of the sound could be recorded, and a smaller portion played back. The rich, deep resonances of the low tones and the clean, sharp trills and tings of the high tones were all lost.

Eventually, research brought new techniques, electronic recording and reproducing equipment and new materials for records.

The "brute-force" method of impressing sounds in a record groove was supplanted by a finely-controlled electronically-driven stylus. All of the sounds, the lowest and the highest — and the middle range — could now be cut into the master recording without appreciable distortion. The new record materials of smooth, tough vinyl, lightweight pickups with fine-pointed playback styli coupled with distortion-free amplifiers and acoustically-matched speaker systems provided exact — practically perfect — sound reproduction.

In fact, the sounds reproduced today are better, in many instances, than the original sound. A violin sounds like a violin. A trumpet sounds like a trumpet. A singer's voice can be enhanced to create fuller, richer tonal quality than the artist possesses. Yet, with all this — with what we call "high fidelity" — something has been missing. That "something" is realism, or "presence" as it is sometimes called.

Although the high fidelity system will reproduce sounds exactly, all the reproduction comes from one source, the loudspeaker.

Let's take an orchestra for example (most recorded sound for home use today is music). The high fidelity system compresses an orchestra which may be forty feet wide, or more, into a reproducing system usually not wider than three feet or so. All of the reproduced sounds come from this one small area. It does not sound natural.

The objective in stereophonic sound reproduction is to simulate "live" sound; to reproduce sound so that it will have maximum realism — "presence."

RCA Victor "Living Stereo" accomplishes this objective. A "Living Stereo" disc record and an RCA Victor Stereo-Orthophonic High Fidelity "Victrola" puts you there, at the performance, and for the first time in the history of recorded sound, makes this living sound available to everyone at reasonable cost.

Figure 1—RCA Victor "Living Stereo" puts you there — at the performance

WHAT IS STEREOPHONIC SOUND?

A dictionary definition of stereophonic sound says that it is "reproduced sound giving the effect of coming from two or more directions."

In the use of the term here we will be more specific and define stereophonic sound reproduction as "the reproduction of *complementary* sounds coming from two or more directions." This is the industry-accepted definition of stereophonic sound.

Two or more speakers reproducing sound from a single-channel amplifier, even though the speakers are displaced from each other for greater dispersion of sound, as shown in figure 2, do *not* provide stereophonic sound, although this arrangement generally gives more listening pleasure than sound reproduced from a single speaker sound source.

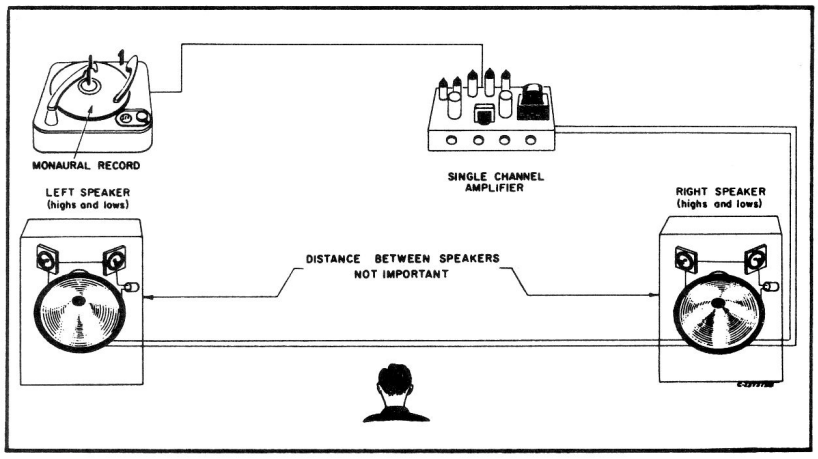


Figure 2—This Isn't Stereophonic Sound

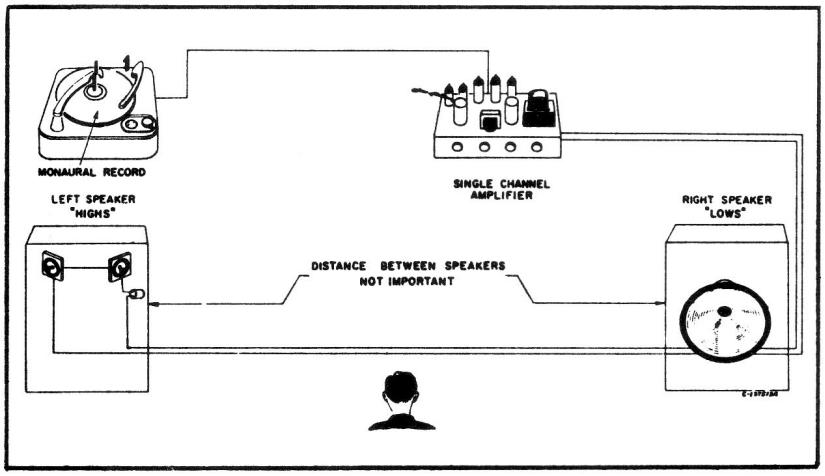


Figure 3—This Isn't Stereophonic Sound

Stereophonic sound is *not* (as shown in figure 3) two speaker systems with the high frequencies coming from one system and the lows coming from the other system.

Stereophonic sound for the home, today, uses two sound tracks played simultaneously from either magnetic tape or disc records, a dual pickup device (one pickup for each track) two separate amplifiers and two separate speaker systems. It is, as shown in figure 4, a two-channel system.

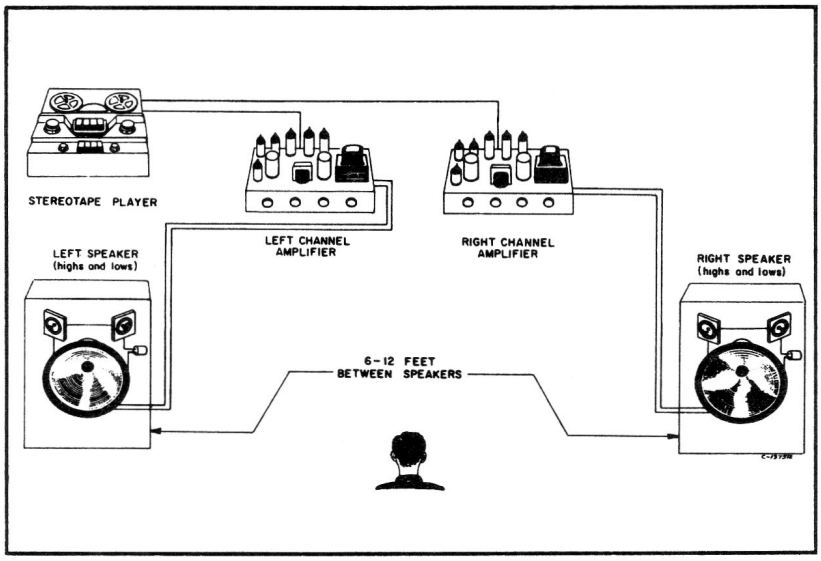


Figure 4—This Is Stereophonic Sound

THE TWO CHANNEL SYSTEM

By "two-channel" we mean that the sound is recorded by two microphones (or sets of microphones) spaced so that each microphone records the sounds from the orchestra predominantly from the section it faces, or is closest to.

The output of each of the two microphones is recorded simultaneously on separate tracks, usually on tape. Although each microphone is aimed at a particular section of the orchestra, it picks up and records sound from the entire orchestra. Thus, a microphone at the left side of the orchestra as shown in figure 5 will record sound mainly from the instruments in that section, but the sound from the right side of the orchestra will also be recorded, although at a somewhat lower level. Figure 6 shows that the microphone at the right side of the orchestra will record the sounds from the right side at normal level, and the sounds from the left at a reduced level.

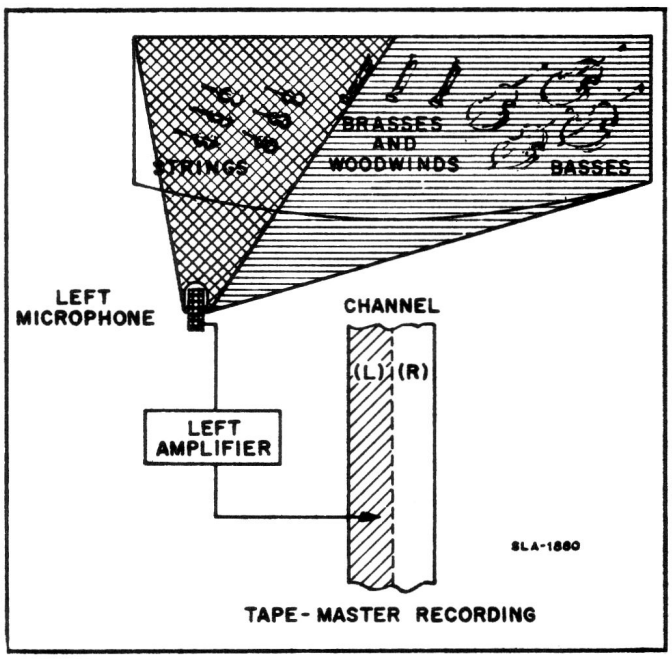


Figure 5—Stereophonic Recording—Left Channel

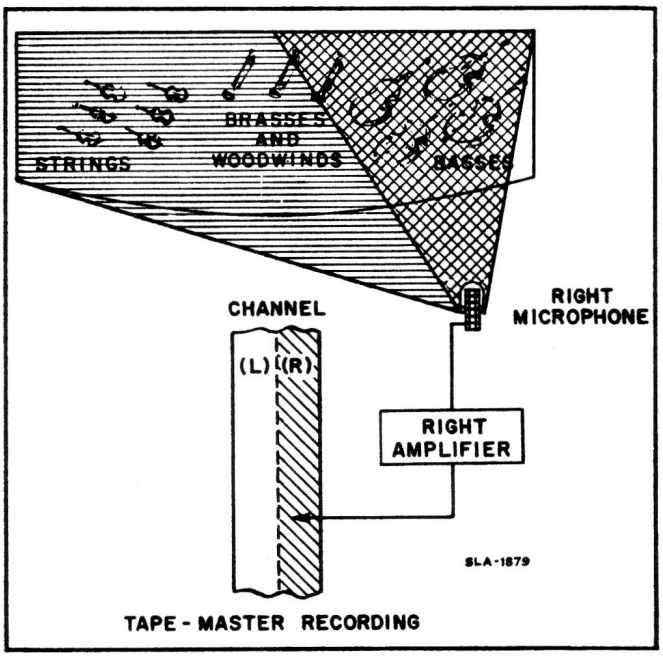


Figure 6—Stereophonic Recording—Right Channel

STEREOPHONIC PLAYBACK

When the tracks are played back simultaneously through individual amplifiers and speaker systems — one amplifier and speaker system for each track (this is a "channel") — each channel will reproduce the information recorded on only one track. The sounds that were recorded from the left-side microphone will play back through the left-side speaker. The sounds recorded from the right-side microphone will play back through the right-side speaker.

The speakers for each channel are placed to approximate the spacing of the microphones when the recording was made. Figure 7 shows that at a comfortable listening distance, facing the speakers (and preferably from a position halfway between the speakers) the playback will give the illusion that the sounds at the left side of the orchestra come from the left side and the sounds from the right side of the orchestra come from the right side. The sounds from the center of the orchestra will appear to come from the center — from between the two speakers.

Another common misconception of stereophonic sound reproduction leads many people to believe that *only* the sounds from the left side of the orchestra come from the left speaker and the sounds from *only* the right side come from the right speaker. This is not true.

COMPLEMENTARY SOUNDS

By disabling either channel of the stereophonic playback system, proof can be established that *all* of the sounds of the orchestra are recorded on *each* track. Sound will then be reproduced through just one channel. Figure 8 shows that in most cases the reproduction from just the one channel will sound as if a monaural recording were being played, although some sounds will be weaker and some stronger than in a monaural recording. When both channels are played back — with the speakers properly positioned — sound from one channel *complements* the sound from the other channel to create an overall impression of depth and realism.

This, then, is how we arrive at our definition of stereophonic sound reproduction as "the reproduction of *complementary* sounds (part of the overall effect from one channel, and part from the other channel) from two or more directions — (displacement of the speakers, one at the left, and one at the right)."

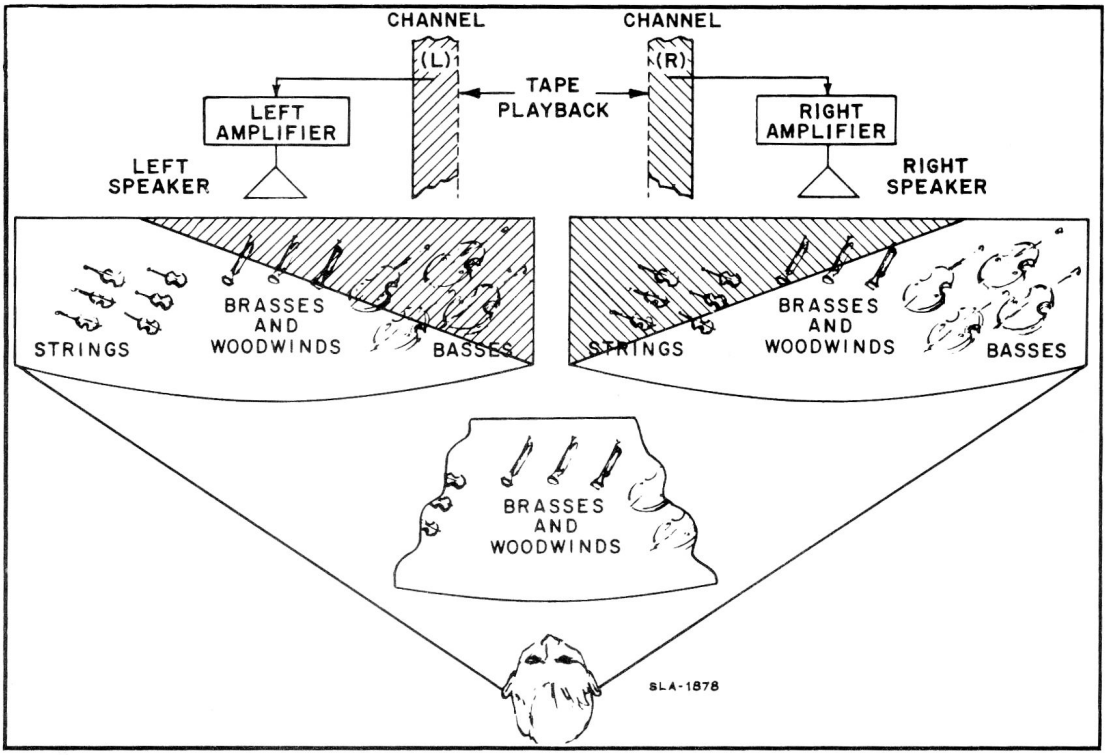


Figure 7—Stereophonic Sound—Tape Playback

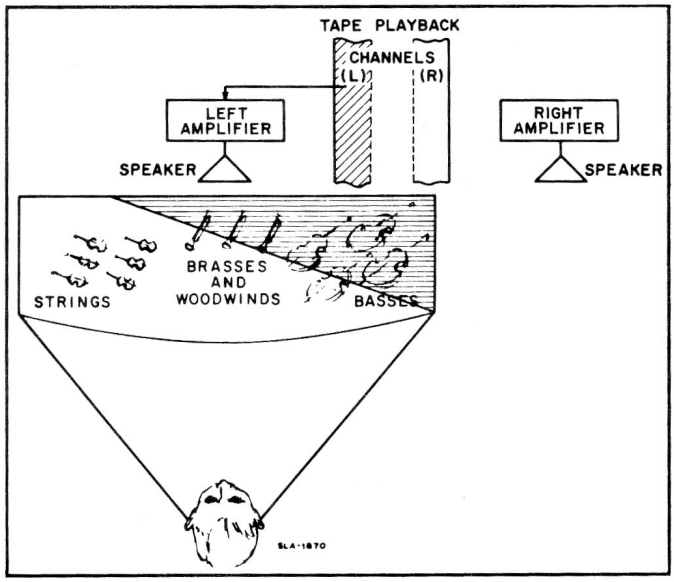


Figure 8—Stereophonic Playback—Left Channel Only

STEREOPHONIC SOUND FROM DISC RECORDS

The search for a method of providing realistic "living sound" economically, for the home, is culminated in the single-groove stereophonic disc record.

The single-groove stereophonic disc record and the playback system differ from the familiar monaural record system, but the *principles for reproducing sound* from disc records *are the same* for both monaural and stereo records.

RECORD PLAYBACK

Figure 9 shows that a stylus, following the undulations which represent the sound in the record groove, actuates a translating device which converts the mechanical motion of the stylus into an electric current.

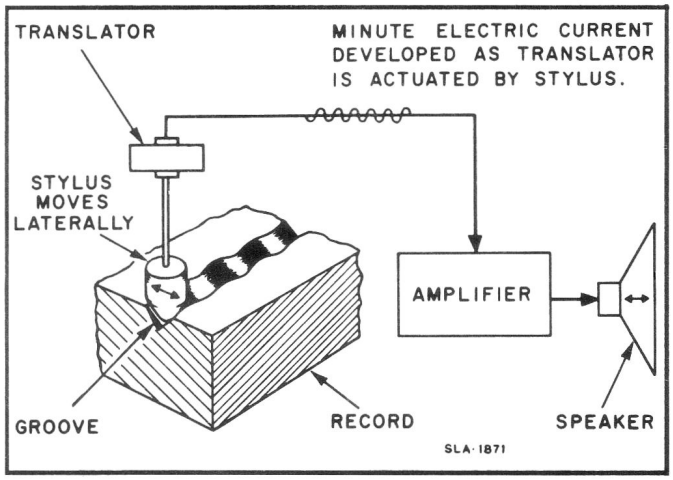


Figure 9—Record Playback Principles

The electric current is amplified and, in the speaker system, is converted again to mechanical motion — the movement of the speaker cone — and we hear the sound.

The *principles of stereophonic sound,* described in the preceding pages as applied to the stereo-tape medium, are *exactly the same* for stereo records.

THE 45°—45° RECORDING SYSTEM

The record industry has developed and refined practical methods and techniques for recording two separate information channels in a single groove of a disc record.

The method adopted by the industry as standard and used by RCA Victor to make stereophonic recordings on disc records is called the "45°—45°" system.

It is so designated because, as shown in figure 10, each channel is recorded on one wall of the record groove at an angle of 45 degrees to the surface of the record.

Before explaining the 45°—45° stereophonic sound recording system let us first review briefly the recording methods used for monaural recordings.

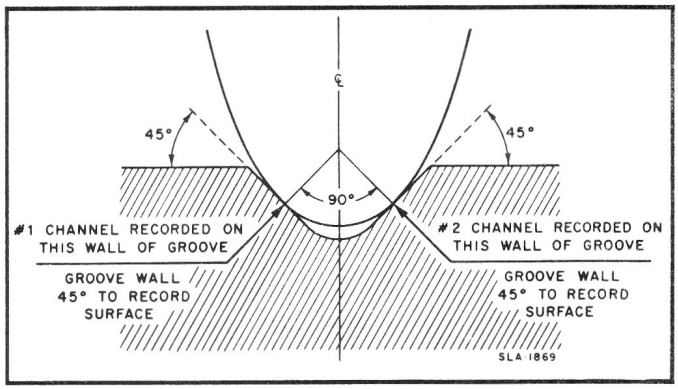


Figure 10—The 45°—45° Stereophonic Record Groove

MONAURAL RECORDING

Two major methods of recording information on monaural disc records are: first, by having the cutting stylus move vertically in unison with the sound. This will result in a groove which, in cross-section, has hills and valleys. This is called "hill and dale," or vertical recording. In vertical recording, depression of the cutting stylus requires a greater force than lifting it. This inequality of forces introduces distortion into the recording. Distortion is a major consideration if we want to reproduce sounds exactly, so the vertical method of recording has not been widely used.

The other major method is called "lateral recording." In this method the cutting stylus is driven from side-to-side. In lateral recording the movement of the stylus can be controlled to cut the modulation into the groove with either constant amplitude of the stylus, or, by moving the stylus back and forth at a constant velocity.

Modern recordings use the lateral system, with portions of the sound cut into the record at constant amplitude and portions at constant velocity. The lateral system is used because the amount of record material removed by the cutting stylus is constant — the groove width and depth are constant — and consequently there is no inherent distortion due to the cutting operation. Typical grooves for vertical and lateral recordings are shown in figure 11.

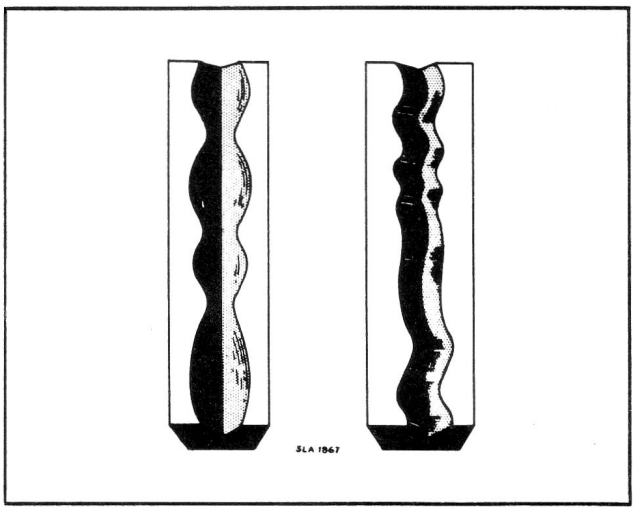


Figure 11—Grooves of Vertical and Lateral Recording— (Vertical groove at the left)

THE 45°—45° STEREO RECORD

The principles used in cutting grooves into the 45°—45° stereo record are similar to both the vertical and lateral recording methods with this important difference; in the stereo recording system a single stylus simultaneously cuts an independent information channel into each wall of the record groove!

As shown by the simplified drawing, figure 12, the single cutting stylus is connected to two driving elements. The driving elements are independently actuated by the outputs from the right channel and left channel microphones, and are connected to the stylus in such a way that each element causes the stylus to cut only the wall of the groove corresponding to its respective channel.

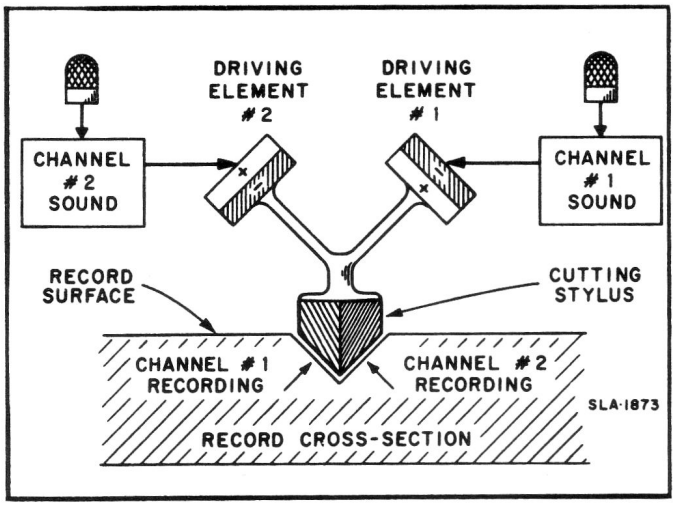


Figure 12—The 45°—45° Cutting Principle

The microphones are connected to the driving elements in reverse directions so that when the sound reaches one microphone with the same amplitude and in the same phase (this means at exactly the same time) as it reaches the other microphone, one element will be actuated to push the stylus against its corresponding groove wall, and the other element will pull away from its groove wall.

CHANNEL #1 RECORDING

In figure 13 only channel #1 is being recorded. As the stylus is actuated by the driving element it exerts a force at an angle of 45° to the surface of the record and thus cuts into the record material as shown by the arrow below the stylus. The groove, shown in the lower left corner of the picture, will have information on only the left wall.

CHANNEL #2 RECORDING

Figure 14 shows channel #2 being recorded. The stylus is driven by only the #2 element and the modulation is cut into the corresponding wall of the groove at an angle of 45° to the surface of the record. The groove for this recording is shown at the lower right side of the illustration.

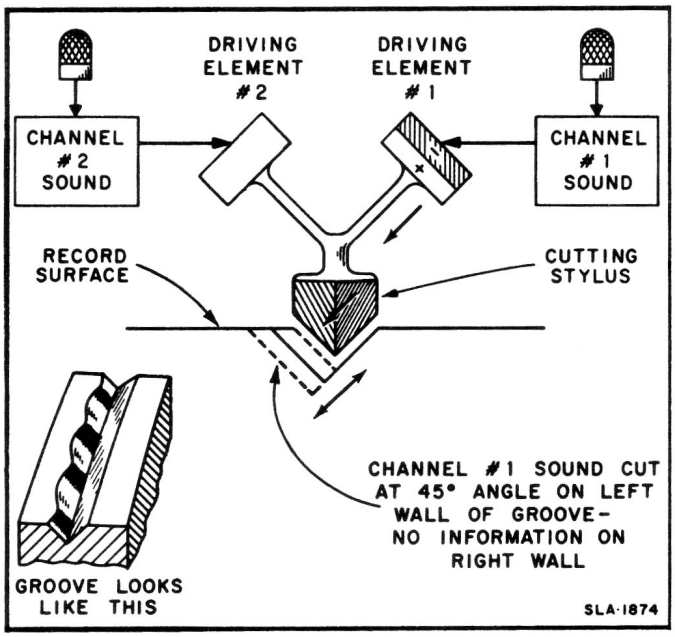


Figure 13—Recording Channel No. 1 on the Stereo Record

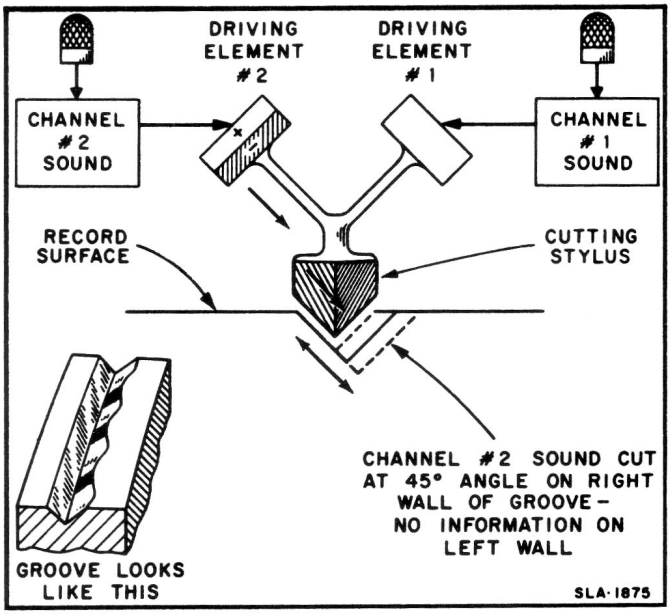


Figure 14—Recording Channel No. 2 on the Stereo Record

OUT-OF-PHASE RECORDING

Let us suppose that a trumpet, for instance, is being recorded by both microphones, one at each side of the stage, with the trumpet in the exact center. Assuming that the acoustics in the recording studio are perfect, when the trumpet is played, the sound will reach both microphones at the same time and, as shown in figure 15, will actuate each driving element oppositely with the same sound. This is "out-of-phase" recording. One microphone will cause its driving element to push the stylus, and the other microphone will cause its driving element to pull the stylus in the opposite direction. Since opposite forces (as shown by the arrows) are present in each arm driving the stylus, the result, shown by the arrow at the point of the stylus, will be a crosswise movement of the stylus, and a record groove equivalent to lateral recording. The groove will look like that in the lower left corner of the illustration.

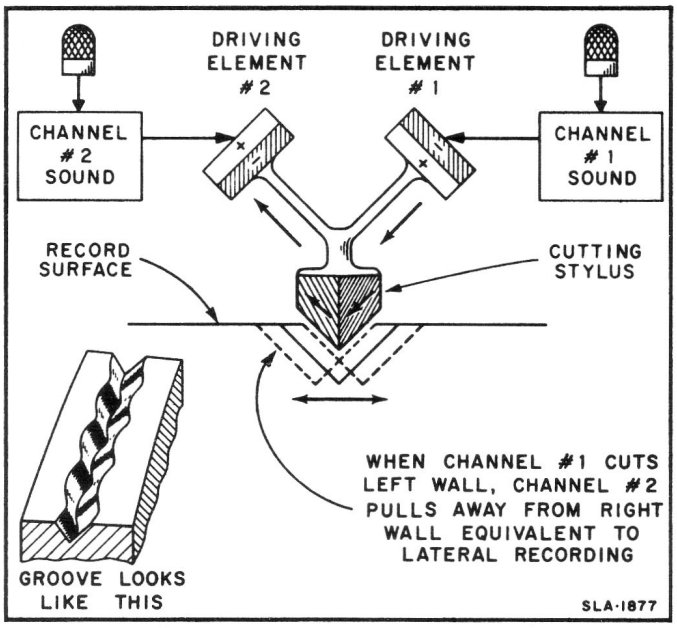


Figure 15—Channel No. 1 and Channel No. 2 Recorded Out-of-Phase

The standards of the 45°—45° stereo recording system state that the cutting head (containing the driving elements for the cutting stylus) be connected in this manner; i.e., in-phase sounds at the microphone produce an out-of-phase, or lateral cut on the record.

IN-PHASE RECORDING

When the sound reaches the microphones and causes both driving elements to be actuated with the same amplitude and at the same time in the same direction (in-phase at the stylus — out-of-phase at the microphone) the stylus will be depressed and cut equally onto both walls of the groove. This is shown by the small arrows at the tip of the stylus in figure 16.

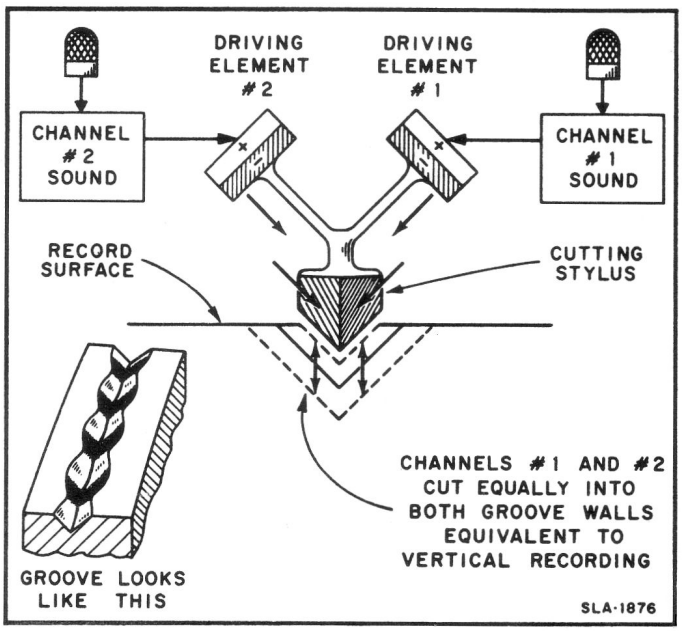


Figure 16—Channel No. 1 and Channel No. 2 Recorded In-Phase

The result of this "in-phase" recording is a groove, as shown in the illustration, equivalent to vertical recording.

THE 45°—45° RECORD GROOVE

The four examples shown above are, of course, mainly theoretical — that is, it would be rare to find only one of the examples existing alone on a stereophonic record. The program material — music, speech, singing, or other sounds, is almost always combinations of sounds from different sources. Since that is what is duplicated in stereophonic sound reproduction, that is what must be put into the record grooves.

Figure 17 is a drawing of a groove in a stereo record. Notice that each wall contains modulation and that the modulation in one wall is different from that on the other wall. In some sections the undulations appear to match — as in vertical recording, and in some sections the groove looks like a lateral recording.

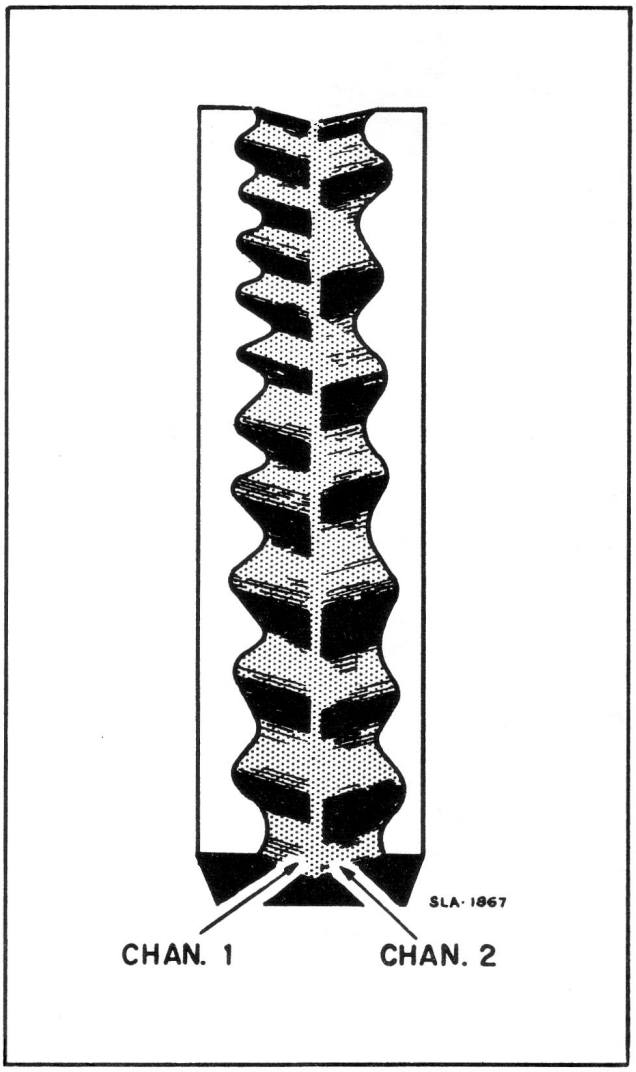


Figure 17—The 45°—45° Stereo Record Groove

Figure 18 shows actual photographs (highly magnified) of the grooves in a 45°—45° stereo record. In the photo at the left, only one side of the groove is modulated. Lateral modulation can be seen in the photo at the right.

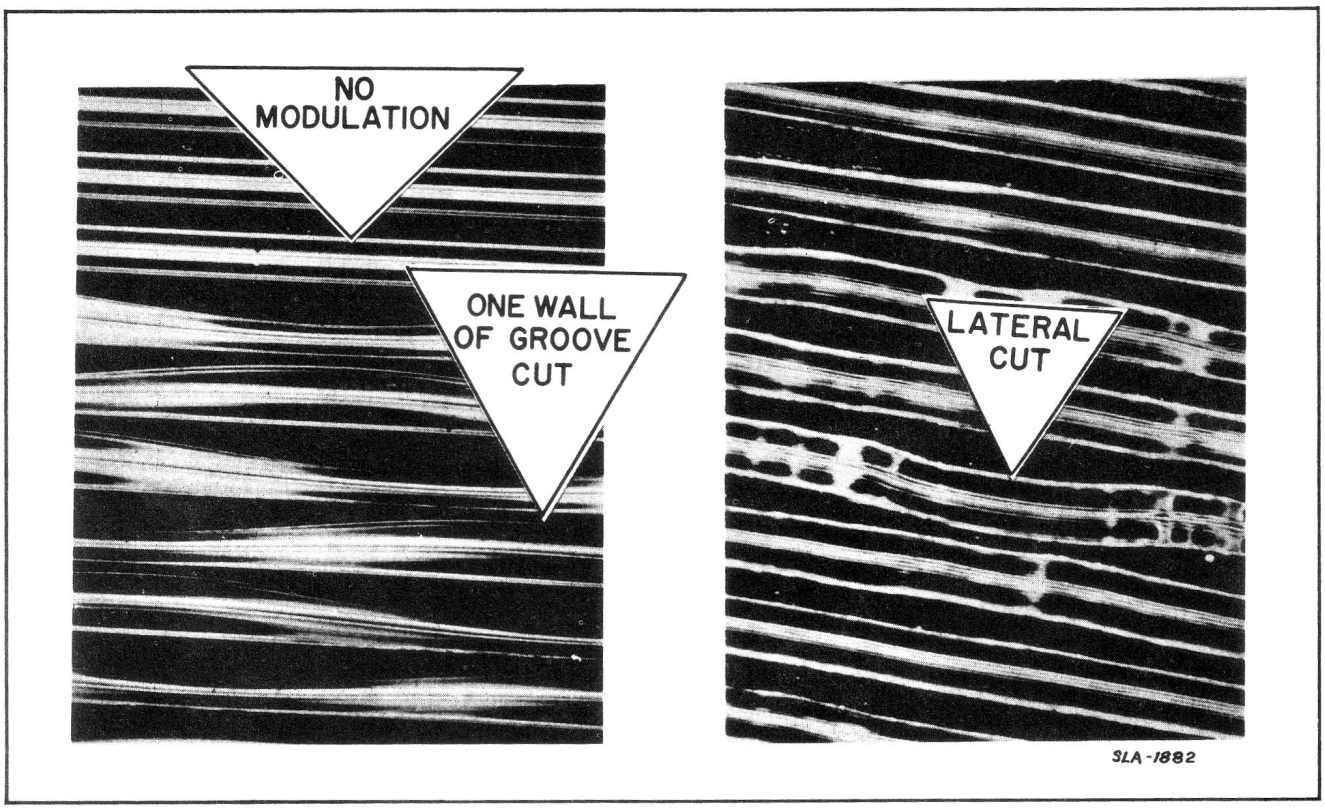


Figure 18—Photographs of 45°—45° Record Grooves

PLAYBACK FROM THE STEREO RECORD

The playback system for the 45°—45° stereo record, as mentioned previously, uses the same basic principles as the playback system for monaural records.

Figure 19 shows that the stylus moves both vertically and laterally to follow all of the modulation on both groove walls. As the stylus actuates the translator, due to either vertical or horizontal movement, or combinations of both, each translator develops a small electrical current proportional to its deflection by the stylus. The small current is amplified by a separate amplifier for each translator, and converted into sound by separate speakers for each amplifier.

When the speakers are placed to approximate the positions of the microphones during the original recording, the complementary sounds from each speaker create stereophonic sound.

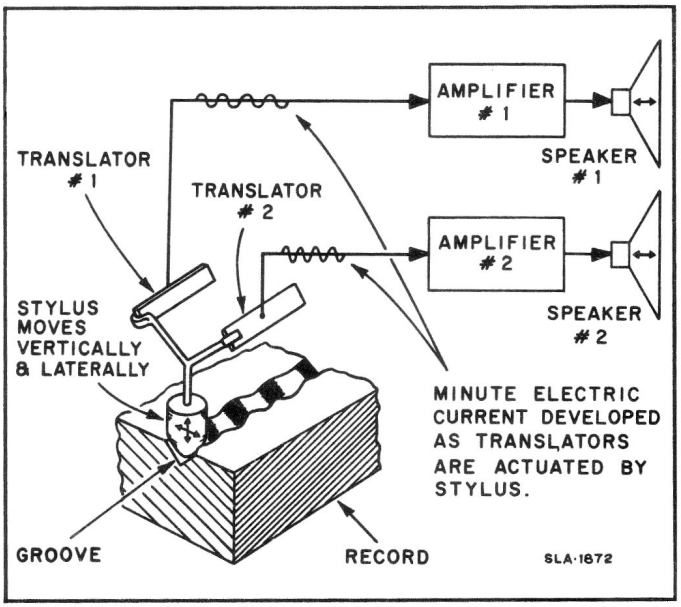


Figure 19—45°—45° Stereophonic Record Playback

OTHER RECORD CONSIDERATIONS

GROOVE WIDTH

The standard monaural 33⅓ rpm record is recorded laterally with an average of 250 grooves per inch. Figure 20 shows that the grooves, under this condition, will be 2.6 mils wide. The distance between grooves, called the "land" is 1.4 mils wide. One "mil" is one-thousandth of an inch.

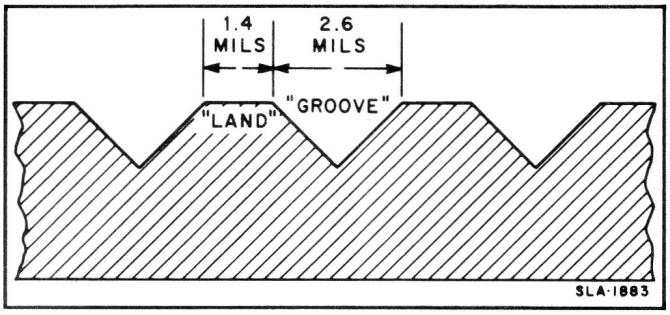


Figure 20—"Land and Groove" widths—33⅓ RPM Monaural Record

We have seen that in lateral recording the stylus moves from side to side, thus the maximum distance (amplitude) the stylus may be permitted to cut is about halfway into the land, or .7 mil. Any greater excursion of the stylus will result in "overcutting" — cutting into the next groove—and this would result in distortion and the possibility of the stylus jumping into the wrong groove.

PLAYING TIME

One of the major accomplishments of the 45°—45° stereo recording system is that the playing time on the record is practically equal to the playing time of a standard 33⅓ rpm monaural record. This means that the 45°—45° stereo record has approximately the same number of grooves per inch as the monaural record.

Remembering that *two* separate channels are recorded in the *same groove* in the stereo record, and that the stylus excursion can be only approximately .7 mil for lateral recording it would seem, as shown in figure 21, that serious "overcutting" would occur.

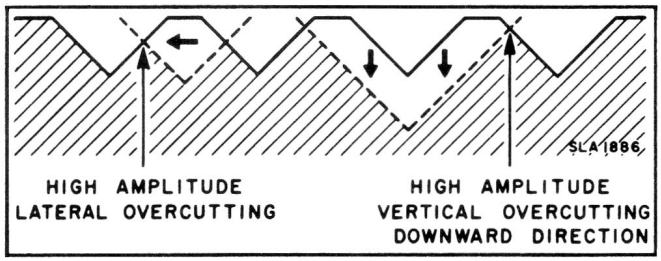


Figure 21—Overcutting

Also, since vertical recording occurs in the stereo record, a large downward excursion of the stylus may also cause overcutting into both adjacent grooves. An extremely high upward excursion might cause the stylus to rise high enough to slide across the "land" of the groove.

These problems were solved by reducing the cutting amplitude by 3 db (about ½) in each channel in the 45°—45° stereo record.

STYLUS SIZES

We have seen that in lateral recording the movement of the cutting stylus must be restricted to prevent overcutting. In the 45°—45° stereo recording system the cutting stylus moves downward at an angle of 45 degrees. Since the motion is at an angle, less than 1 unit of lateral cut (about 7 tenths of a unit) will result from a 1 unit force against the stylus.

However, in stereo recording, when both modulations are at maximum, in the upward direction, there is no groove! Therefore, we have to start with a deeper groove, but a deeper groove means a wider groove! Thus, a compromise is necessary. To avoid overcutting on downward modulation when we have a deeper groove — we just don't modulate so heavily. This also leaves some groove during maximum upward modulation.

To avoid groove jumping, with the small remaining groove, a smaller stylus is necessary. The stylus used in RCA Victor Stereo pickups for stereo reproduction has a radius of 0.7 mil.

A monaural 1 mil stylus with normal 7 to 9 grams stylus force exerts a pressure of approximately *20,000 pounds per square inch* at the point of contact with the record. With a smaller stylus diameter, the surface area of the stylus in contact with the record is less, consequently the pressure of the stylus against the record will be greater if the stylus pressure is not lessened. Greater stylus pressure will of course result in excessive record wear.

Therefore, in conjunction with decreasing the diameter of the stylus, the stylus pressure has been decreased. The RCA Victor Stereo pickup is designed to operate with a stylus pressure of from 4 to 5 grams.

As shown in figure 22, the .7 mil stereo stylus will play the standard monaural records *and* stereo records, but a 1 mil stylus is not recommended for stereo records since it will ride higher in the groove and groove jumping is likely to occur, with resultant damage to the record; also there will be more cross-modulation from adjacent grooves. This will be noticeable as distortion.

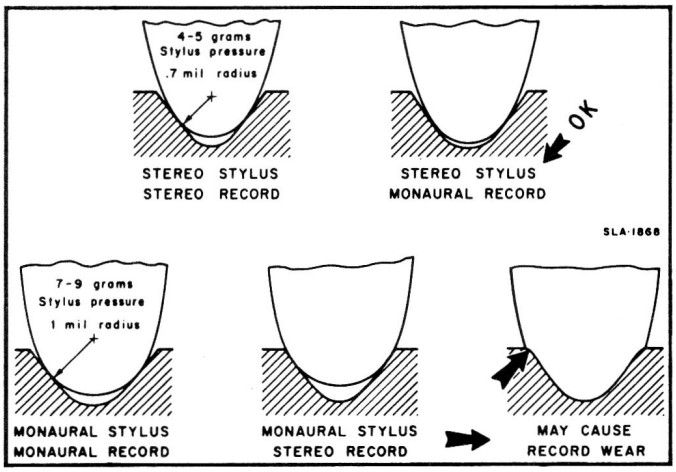


Figure 22—Groove—Stylus Comparison. Monaural vs.

THE 45°—45° STEREO PICKUP

The stereophonic pickup is the heart of the 45°—45° stereo disc record system.

RCA Victor has developed and uses a stereophonic pickup which essentially consists of two separate ceramic elements connected to a common stylus.

Figure 23 is a cutaway drawing showing how the ceramic elements are mounted and the method used to couple the stylus to the elements.

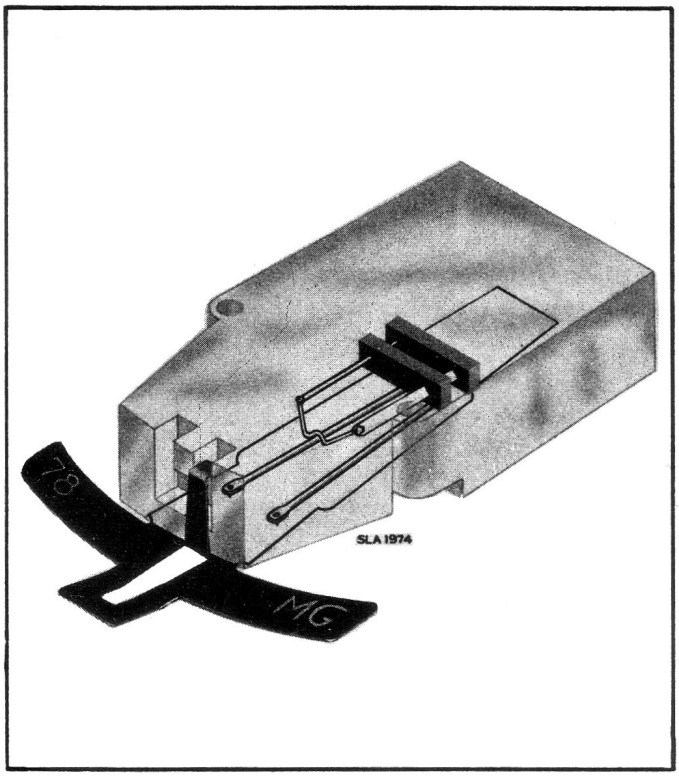


Figure 23—The RCA Victor "Swing Aside" Stereo Pickup

The ceramic elements are mounted at a 45 degree angle to the surface of the record and the elements are at right angles (90 degrees) to each other.

We have seen how the groove walls in the 45°—45° stereo record are cut individually, with the modulation on each wall at an angle of 45 degrees to the surface of the record.

In the basic principle of reproducing sound from the record groove, the stylus is connected to the translator (the ceramic element) so that the undulations in the record groove cause the stylus to create a bending force or strain, on the element. This force generates an electrical current corresponding to the modulation in the groove, and the electrical current is amplified and applied to the speaker.

Figure 24 shows that the stylus must move in four directions; up, down, to the right and to the left, in following the stereo record groove. Movement caused by modulation in the left groove wall will cause the

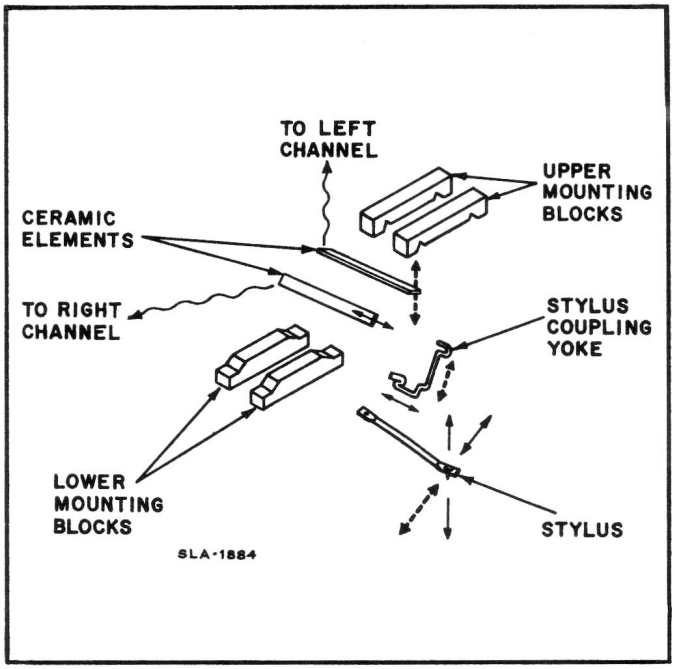


Figure 24—Stylus Movement vs. Element Output

motion to be transferred through the right arm of the stylus coupling yoke and thus cause the element on the right side of the illustration to be deflected and generate an electric current.

In the 45°—45° stereo system, information for the right channel speaker is obtained from the groove wall closest to the outside edge of the record.

The example above points out that the movement of the stylus is from the left to the right — from the left groove wall of the record (closest to the *inside* of the record). The current is generated by the element at the right side in the illustration and is amplified through the left channel.

Another important feature is that this stereo pickup may be used with monaural records! It provides the same high quality reproduction as does a conventional 1 mil stylus.

Monaural records, as explained previously, are recorded laterally. We have also shown that the stereo record is recorded both vertically and laterally and that the pickup responds to both types of recording. The only other consideration is the size of the stylus. The normal monaural stylus has a 1 mil radius while the stereo stylus has a radius of only 0.7 mil. This means that in playing a monaural record the stereo stylus will ride lower in the groove. Since the modulation in a monaural record does not depend on groove depth — which is constant — the stereo stylus will satisfactorily follow the laterally-cut groove and will provide output. Figure 15 (page 9) shows how the lateral cut is made in the stereo record groove. In playback, the reverse situation applies. Instead of the stylus acting on the record groove, the recorded information in the groove acts on the stylus.

Another feature of this pickup is shown in figure 25 — an additional stylus to play back 78 rpm records! 78 rpm records require a 3 mil stylus. A separate 3 mil stylus is incorporated and with the "Swing Aside" mounting it is only necessary to depress the stylus shift carriage and swing the proper stylus into place. When the stylus is in place, the shaft will engage the center of the stylus coupling yoke.

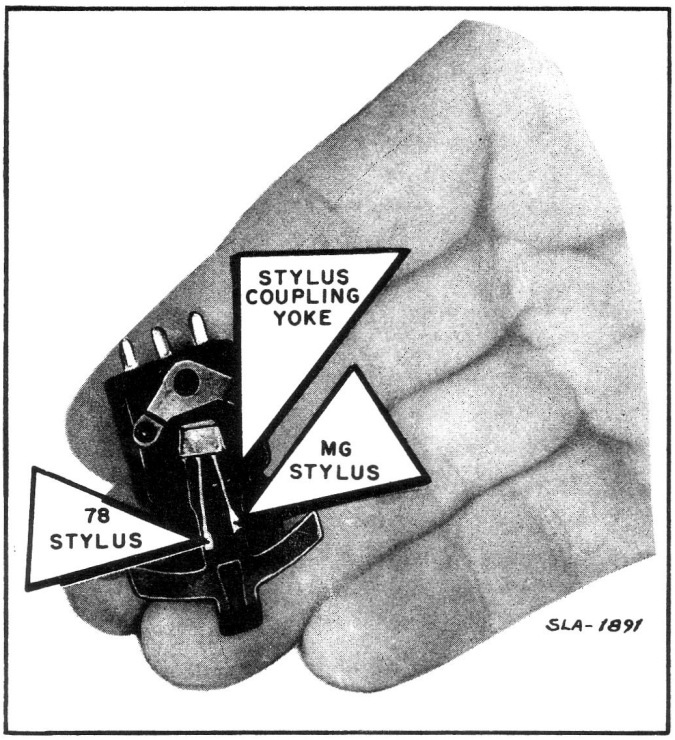


Figure 25—Microgroove Stylus in Playing Position

Figure 26 shows the stylus in position to play 78 rpm records.

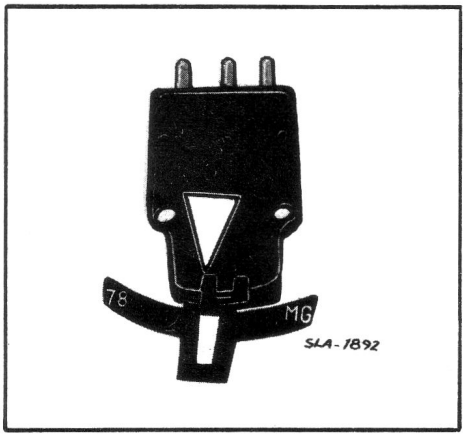


Figure 26—"78" Stylus in Playing Position

An exploded-view drawing of the RCA Victor "Swing Aside" stereophonic pickup is shown in figure 27.

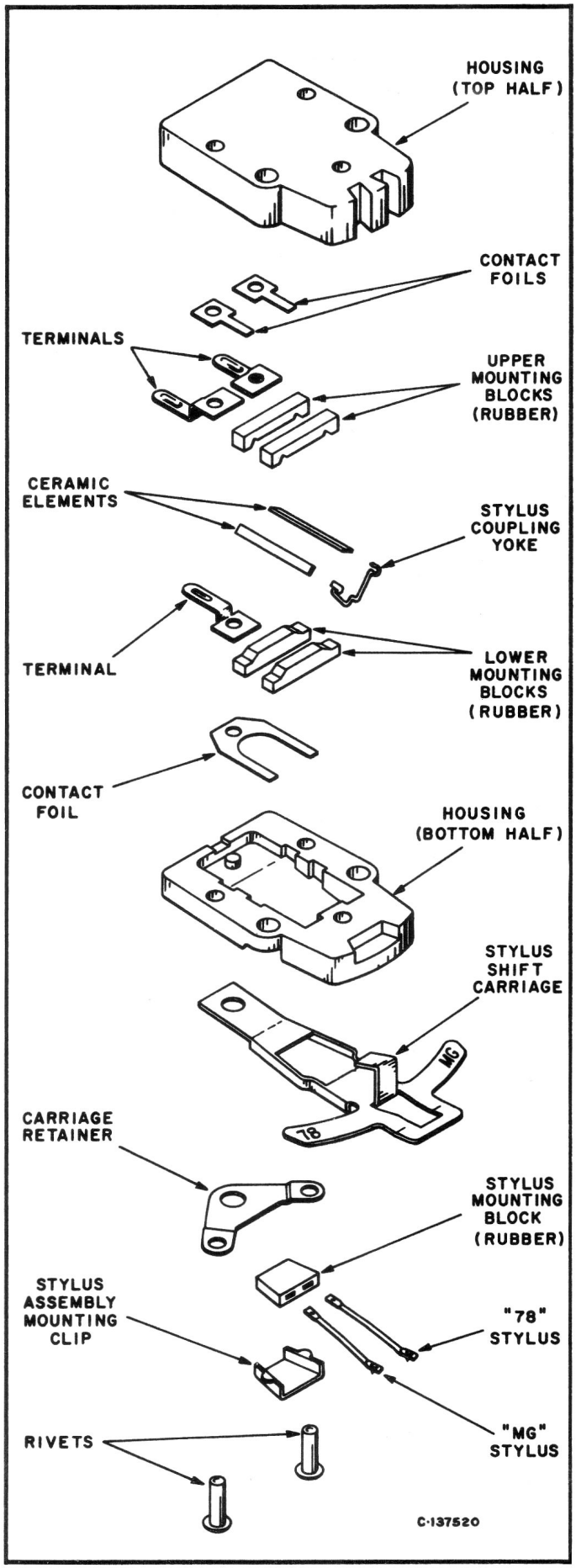


Figure 27—Exploded View—RCA Victor "Swing Aside" Stereo Pickup

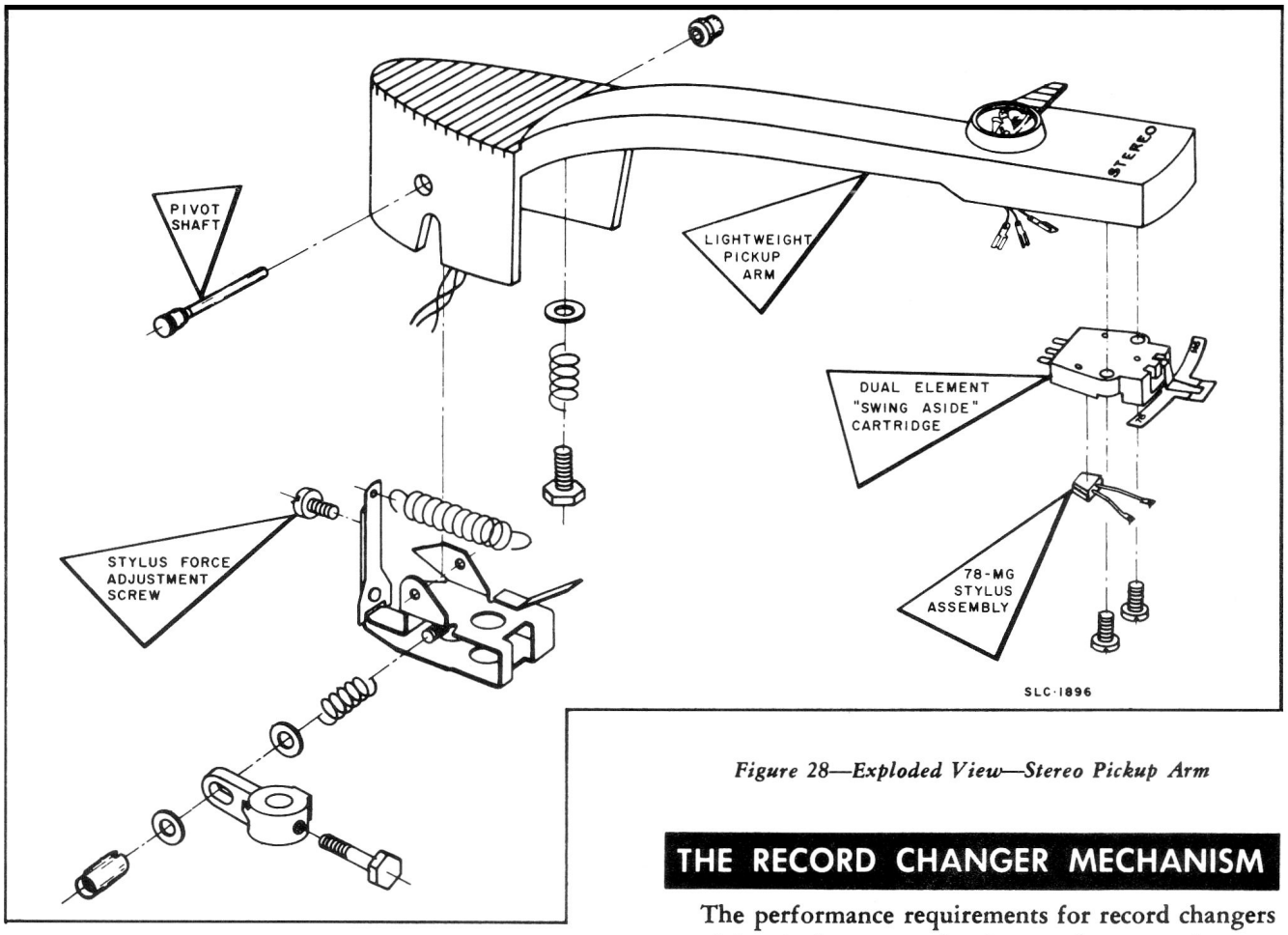


Figure 28—Exploded View—Stereo Pickup Arm

THE PICKUP ARM

We have just explained the reasons why stereo records require a stylus smaller than the 1 mil stylus used with monaural records.

We must not exceed a given stylus pressure per unit area. When we reduce the size of the stylus which contacts the record, we must correspondingly reduce the total stylus force.

The stylus force, required with the RCA Victor stereo pickup is between 4 and 5 grams, approximately half that commonly used with monaural pickups.

The proper stylus force is obtained by using a lightweight molded plastic pickup arm with an adjustable spring counterbalance. A screw adjustment at the rear of the arm is provided to regulate the stylus force. These are shown in figure 28.

The stylus force must be adjusted to provide between 4 and 5 grams pressure. Excessive pressure will cause record wear. Insufficient pressure may result in groove jumping and/or failure to trip the changing mechanism when the end of the record is reached.

The pickup arm pivot shaft should also be adjusted so that minimum friction is present.

To check, use a stylus force gauge and note the ***maximum force*** required to *lift* the end of the pickup arm and then note the ***minimum force*** necessary to *prevent* lowering of the pickup arm. The *difference* between the two forces must be less than 1 gram.

THE RECORD CHANGER MECHANISM

The performance requirements for record changers used in playing stereophonic records are much more rigid than for monaural sound reproduction.

With the reduced stylus force, it becomes necessary to reduce friction at all bearing points in the changer mechanism. Slight excessive friction in the trip mechanism may cause damage to the record by dragging the stylus across the grooves, or, the stylus arm may not actuate the trip mechanism due to friction in the sliding parts.

As shown in figure 29, an aluminum trip-slide is used. The trip-slide, in previous record changers, designed for monaural use only, is made from steel.

In addition to the use of a lightweight trip slide, plastic bushings are added to provide an almost frictionless bearing surface for the trip slide.

In the pickup arm assembly all bearing surfaces are cadmium plated — again, to reduce friction.

Remembering that the stereo grooves are cut partly lateral and partly vertical and the pickup is sensitive to the vertical component as well as the lateral, it can be seen that *any* vertical disturbance which might actuate the pickup is undesirable.

For stereo reproduction then, vertical rumble from the changer mechanism must be held to a very low value. Turntable bearing lubrication is very important in this respect; a heavy oil, such as Staput #320, is recommended.

To further minimize vertical rumble, a motor having a very carefully balanced rotor is used with the stereo changer.

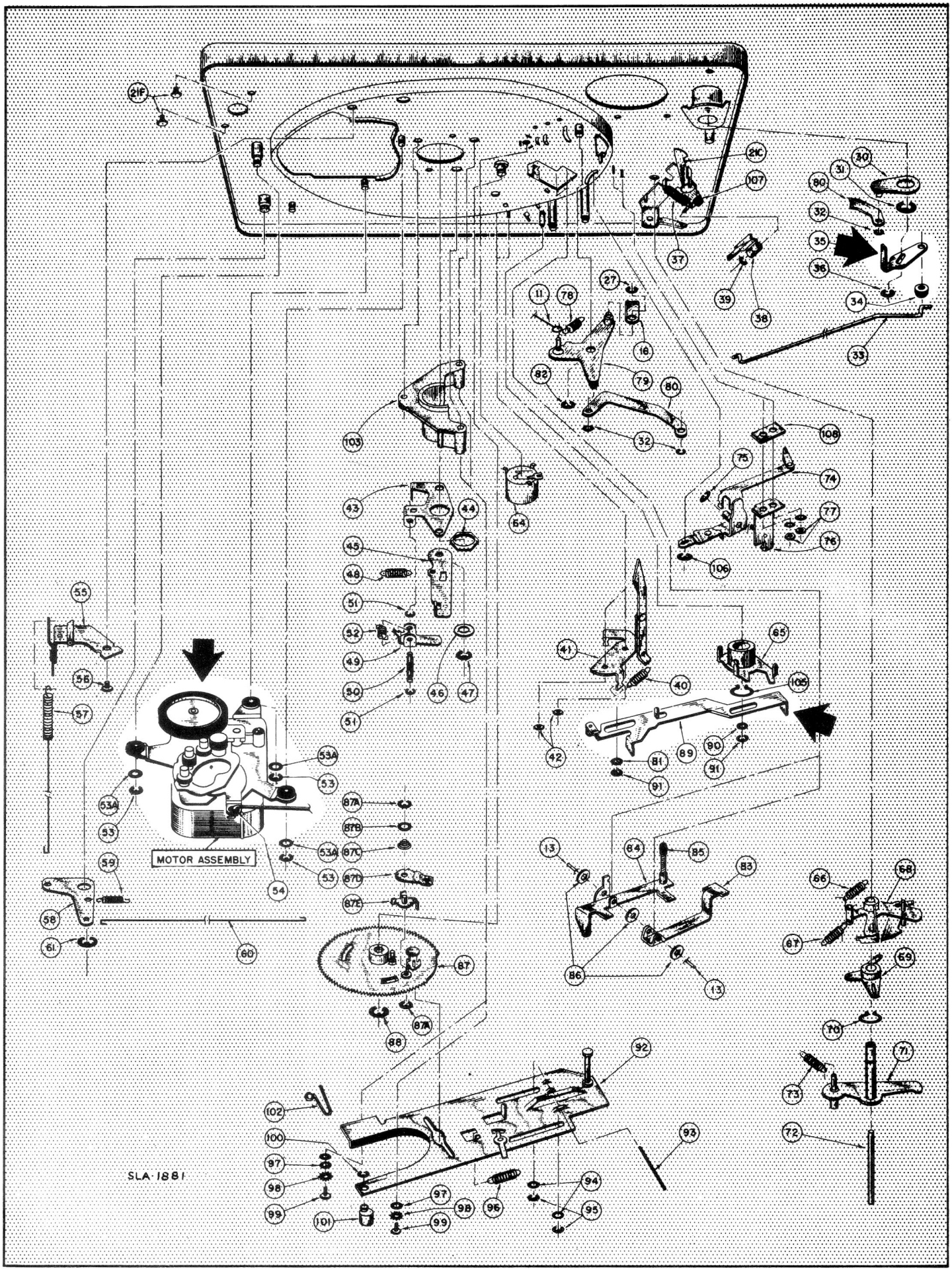


Figure 29—Exploded View—Underside of Record Changer Assembly

THE DUAL-CHANNEL AMPLIFIER

It has been stressed throughout this booklet that stereophonic sound reproduction requires two separate amplifiers and two separate speaker systems.

The RCA Victor Stereo-Orthophonic High Fidelity dual-channel amplifier provides two amplifier channels, and output circuits for both speaker systems, on a single chassis.

A block diagram for a typical dual-channel amplifier is shown in figure 30.

Three dual-triodes provide three stages of dual-channel audio amplification. A single tube is used for power output in each channel. Negative feedback, applied to the third stage in each channel, is derived from the secondaries of the two output transformers.

Figure 31, the schematic diagram of a typical dual-channel amplifier, shows dual loudness and dual tone controls. These provide equal and simultaneous regulation of loudness and tone in each amplifier channel. A gain equalization control (balance control, in the third stage of the right side channel, permits the right side channel (normally connected to the internal speaker system) to be balanced with the left side channel output (normally connected to external speakers).

The schematic diagram also shows a five position function switch which permits the use of a tuner, tape recorder, phonograph, stereo phonograph, or a stereo tape player.

An outstanding feature incorporated in this amplifier is the utilization of a method, developed in the RCA Victor Radio and "Victrola" laboratories, of providing push-pull output from the two single-ended amplifiers during monaural sound reproduction. This is accomplished without using phase-inverter tubes!

One advantage of push-pull output circuits is that even-order (2nd, 4th, etc.) harmonic distortion is cancelled.

The dual-input connections for "Phono Single," "Tuner," and "Tape Single" are arranged so that out-of-phase signals are applied to the grids of the preamplifier stages. In order to produce in-phase sound from the speakers, it is necessary to introduce a 180° phase-shift in one channel; this is done by reversing the primary leads of one output transformer, thus, no phase inverter tube is reqired.

During stereo operation the two amplifier channels operate independently. During "Single Phono," "Single Tape" and "Tuner" operation the two speaker systems are connected in parallel. A very definite advantage is obtained by connecting the two speaker systems, in parallel during "single" operation.

The outputs for the fundamental audio frequencies are in-phase, but the even-order harmonic distortions in the two amplifier channels are out-of-phase with each other and trend to cancel when interconnected in the above manner.

The speaker selection switch and provisions for connecting external speakers for the left side channel are shown in the schematic diagram. Another convenience feature permits the internal speakers to be used as a separate speaker system. When the jack marked "Speakers-Int." is used, the internal speakers of the instrument may be used as the second speaker system for other instruments system.

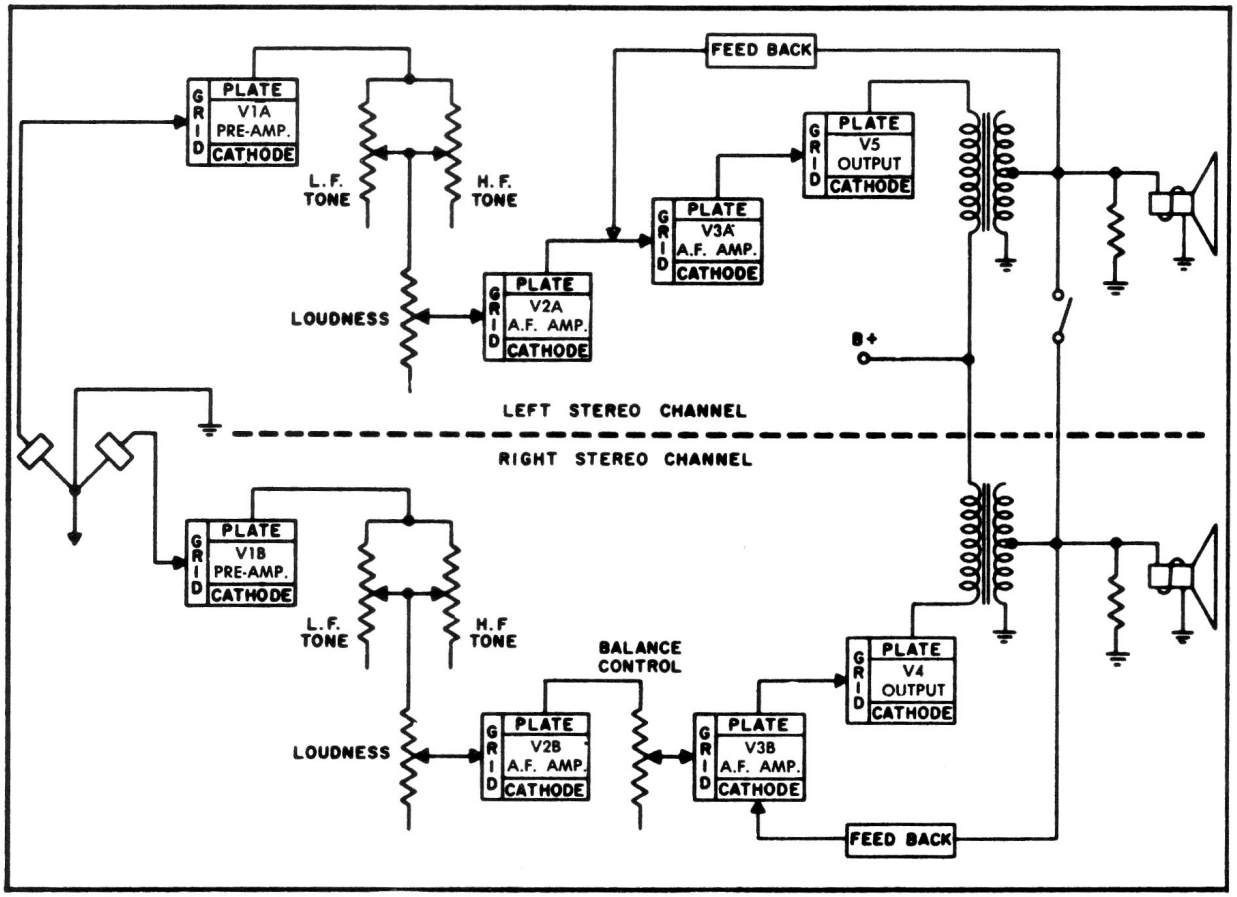


Figure 30—Block Diagram—Typical Dual-Channel Amplifier

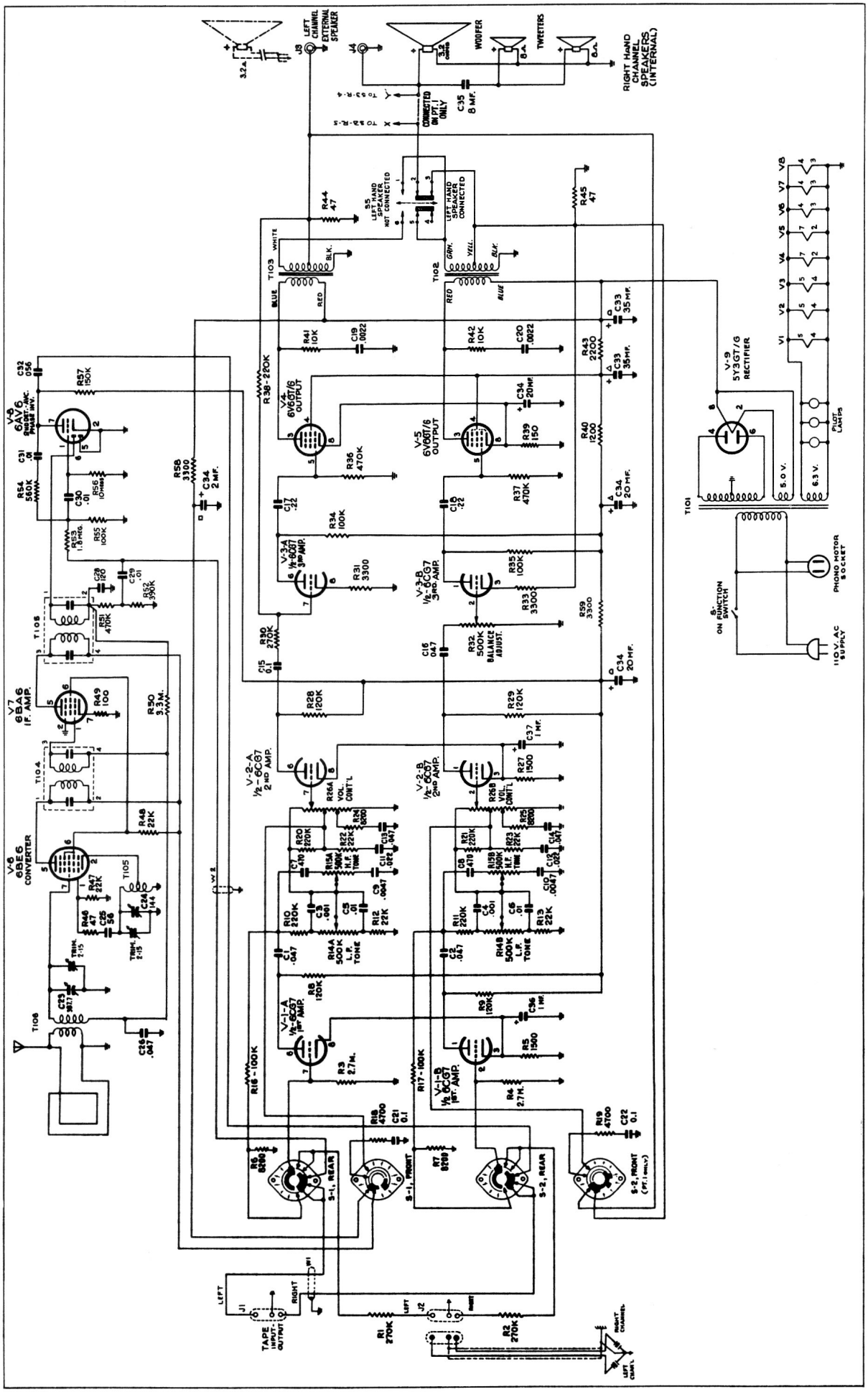


Figure 31—Schematic Diagram—Dual-Channel Amplifier

PLACEMENT OF SPEAKERS FOR STEREO LISTENING

The placement of loudspeakers for stereophonic listening, although not extremely critical, can affect the quality of the stereophonic effects perceived by the listener. It should be borne in mind that deviation from an ideal set-up will not negate the effect completely, but will deteriorate it somewhat proportionally to the degree of improper speaker and listener location.

It is important that the speakers not be too close together or too far apart with respect to the listener. If they are too close, the stereo effect is diminished and the reproduction will be similar to monaural. Placement too far apart makes the sound appear to come from two separate sources, giving the listener a confusing sensation. These are the extreme conditions. If the listener approximates the proportions described below, and shown in figure 36, the best stereophonic reproduction will result.

The listening room itself and its existing furniture generally determines the placement of the two speaker systems. In an average living room, they may be 6 to 15 feet apart. *If the listener stations himself as far away from the speakers as they are to each other, he should achieve optimum results.* However, devation from this does not ruin the effect; it merely affects the degree of stereophonic perfection. For example, if a listener sits directly in front of one loudspeaker, he will get a higher percentage of sound from that speaker. He will still hear stereo, but the effect will be unbalanced.

It is recommended that the listener make his stereo set-up and experiment with various listener locations until he is satisfied with the stereophonic effect in his particular room. If these simple rules are followed, the average person will find that full satisfaction can be achieved without being overly critical of set and listener placement.

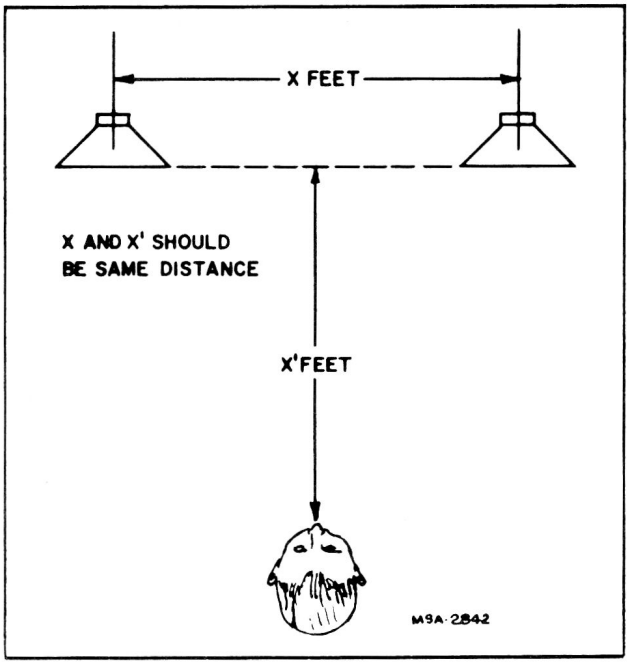


Figure 36—Optimum Speaker Placement

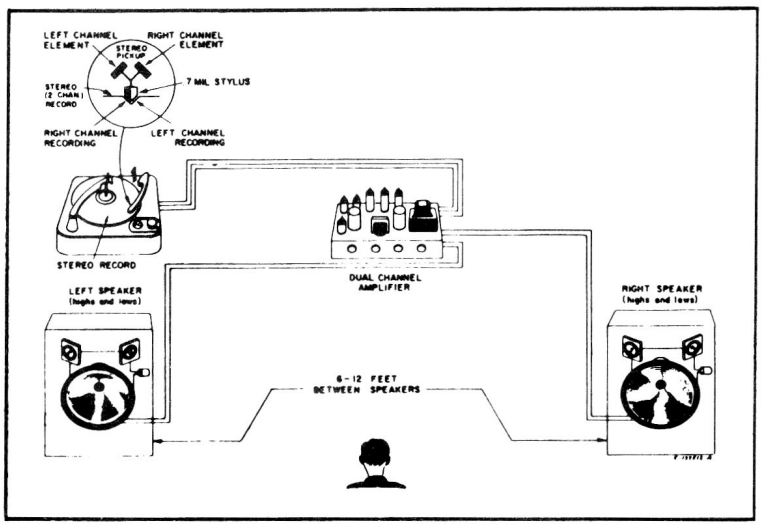
CHANNEL BALANCE CONTROL ADJUSTMENT

The channel balance control should be adjusted after the listener has decided upon the placement of the playback instrument containing the internal (right side) speakers, and the location of the external (left side) speakers.

To make this adjustment, play a *monaural* record, with the function switch in the "Phono Stereo" position and the external speaker switch in the "Internal and External" position.

The balance control is adjusted until the sound appears to emanate from the center point between the two speaker systems.

Re-adjustment of the balance control is required only if the external speaker system is changed, i.e., if new or different external speakers are used in place of the speaker used during the original adjustment.



This is Stereophonic Sound—
From RCA Victor "Living Stereo" Disc Records—For Everyone

SUMMARY

We have explained in this booklet the practical principles of stereophonic sound reproduction; how the 45°—45° stereophonic sound recording system works; and practical applications of these principles in RCA Victor Stereo-Orthophonic High Fidelity "Victrola" phonograph instruments.

We hope you will soon join us in the enjoyment of stereophonic sound from "Living Stereo" disc records.