

**servicing  
record  
changers**

**harry mileaf**

# SERVICING RECORD CHANGERS

HARRY MILEAF

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To Eleanor, Danny and Daryl,  
for patiently waiting



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# introduction

**S**INCE the days when the technician had only simple radios to contend with, the field of electronics has expanded by leaps and bounds. Other electronic and electromechanical items have entered the scene: washing machines, refrigerators, air conditioners, clock radios, FM radios, hi-fi equipment, TV, automatic-record changers, tape recorders and numerous household appliances. Some of these items have, naturally enough, become specialized fields of service but the remainder have become the burden of the neighborhood technician. His electronic training has given him a keen sense of deduction so that he can handle most new electronic developments that are introduced but, unfortunately, some present-day electronic equipment is associated with mechanical devices. Due to his lack of training in basic mechanical principles, an undue amount of difficulty is encountered.

This book deals with one of the technician's biggest mechanical problems, the automatic record changer. The record changer has caused unusual confusion because it is mainly a mechanical item that employs very little electronic coordination. When the automatic record changer first entered the service scene and the technician attempted repairs, it was comparable to an auto mechanic attacking a small radio. This situation has not been alleviated by manufacturers' literature because the average technician still lacks a complete understanding of the various record changers' basic functions. The actions of trips, levers, pawls, idlers, cams and inclines baffle him, as well as the senseless-looking rotation and reciprocation that takes place at the underside of a record changer when it goes through its change cycle.

To meet this serious lack of understanding, the information in

this book is presented very simply, so that the technician will have no trouble comprehending it. The subject is not treated as in other publications by discussing the functional assemblies as part of the overall changer. It is, on the other hand, presented with each functional assembly shown as a mechanical unit in its entirety. In this way the reader will become familiar, not only with a few changer types, but with the basic principles and variations of any automatic record changer he may encounter. The book bypasses for the sake of clarity the use of photographs for demonstration purposes. The underside of an automatic record changer is a three-dimensional complexity and a photograph of it only presents a maze of confusion. Instead, the functional assemblies will be presented as mechanical schematics, spread out so that their basic operation is obvious. Great pains have been taken by the author, Harry Mileaf, in preparing approximately 170 drawings. These show how simple an automatic record changer really is.

Nomenclature has been assigned to the various parts so that the names used are as descriptive as possible as determined by their functions and physical characteristics. This has been done to avoid unnecessary confusion. Manufacturers have not standardized names, and so one component is sometimes given two different names by two separate manufacturers. Also, sometimes a name used by one manufacturer is used for an entirely different item by another. However, the descriptive names in the text will follow as closely as possible those employed by manufacturers.

It will be noted that the chapter sequence of this book is according to the sequence of operation of the automatic record changer; also, Chapters 2 through 5 are applicable to nonautomatic record players.

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Line drawings by Art Santinelli.

# general information

**A**LTHOUGH the underside of the automatic record changer appears complex as it goes through its change cycle, it is actually a series of simple mechanical motions. The main reason for the apparent complexity is that the various levers, cams, etc. are mounted over one another and most of their movements are not clearly visible. While the record is being played, the only motions that can be seen are the pickup arm traveling across the record and a part in the mechanism that follows the arm motion to indicate the finish of the record playing. When the record playing ends, however, and the change cycle starts, the various sections of the mechanism suddenly go into operation, raising the arm, swinging it out, dropping the next record, swinging the arm in and then setting it down. These steps require quite a bit of motion by a number of parts within a period of only seconds to complete the change cycle. Also, although each step of the cycle sequence seems to take place one at a time from above the record changer, the operating movements of the gears, cams, levers, etc. overlap and almost appear to act simultaneously. Therefore, when an inexperienced person attempts to figure out the activity during actual operation, he becomes confused, lost and even afraid to attempt a repair.

Actually, if the various functional assemblies were spread out alongside one another and arranged to operate one at a time, the entire basic theory of the mechanism would be obvious. It is understood that space and material do not permit the manufacturer to design a record changer in such a manner, but for simplicity



and complete comprehension, we shall study each line of assembly in just that way.

### **Basic operating parts**

Before going further, it would be better to become familiar with the operating parts of the automatic record changer which can be seen from above the chassis. These are shown in Fig. 101.

#### **Spindle**

The spindle is the part that extends up from the center of the turntable. It is also known as the *centerpost*. Up near the top of the spindle is a ledge which holds the stack of records to be played. Some automatic record changers have an ejector mechanism inside the spindle which pushes off the bottom record of the stack, causing it to drop down the spindle to the turntable. Since the spindle passes through the center hole of the records, it keeps the records centered on the turntable. The spindle shown on the changer is for standard small-hole records. The other, stubby (large-hole) spindle is used for large-hole records.

#### **Shelf**

Some record changers employ a shelf support to help hold up the stack of records. While the spindle holds up the center of the stack, the shelf supports the edge of the stack. Sometimes the record-dropping mechanism is part of the shelf.

#### **Leveling arm**

When a record changer does not have a shelf to help hold the records, a leveling arm is used. This arm is also called the *ballast*, *balance*, *stabilizer*, *support* or *pressure arm*. The leveling arm moves up and down. Placed on top of the record stack, its pressure holds the records in a level position. This leveling arm plays an important part in automatic shutoff mechanisms.

#### **Index arm**

The index arm is considered a special part and is seen on only a few changer types. The end of the index arm rests against the side of the record stack. It indicates the size of the record to be played or that no more records are on the spindle.

#### **Index feelers**

These parts are used to determine automatically the size of the record that is to be played. The parts shown are the most common type.

#### **Turntable**

The turntable is the rotating part of the record changer that

carries the playing records. In most automatic record changers it revolves at three different speeds—78, 45 and 33-1/3 r.p.m.—depending on the records to be played. The turntable has a soft surface to cushion the records when they drop.

### Pickup arm

This part carries the cartridge and needle (stylus). The needle

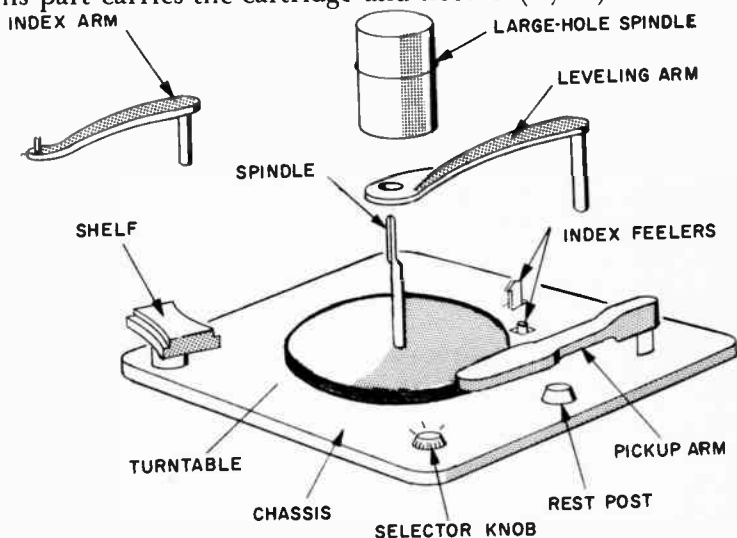


Fig. 101. View of above-the-chassis components of an automatic record changer.

rides the record grooves and the cartridge reproduces the music. The pickup arm is also known as the *tone arm*.

### Rest post

The rest post holds the pickup arm when the record changer is not being used.

### Selector control

This is usually a knob which turns the power on and off and determines the speed at which the turntable will operate. With some record changers, this knob also has settings for the different record sizes (7, 10 and 12 inches). It may also be used to reject records and control manual operation. Sometimes two or three controls are used for the various functions.

### Chassis

The chassis is the principal supporting member of the automatic record changer. Beneath the chassis is the change-cycle mechanism which brings about the automatic operation of the record changer.

## How to make servicing easy

To facilitate the study of the automatic record changer, it should be mounted on a service stand, as shown in Fig. 102. An alternate setup, which can be used temporarily, is two stacks of books or boxes. With the service-stand arrangement, however, the changer can be tilted to the most convenient position for viewing without hindering the motion of any of its parts. The record changer service stand is easy to use. The chassis is held in place by a pair of chassis clamps. It can be tilted back and forth to the most convenient servicing position and locked into place by the tilt-locking knobs. The sliding bar is an adjustment for different sizes of chassis.

The most important thing to remember for simplifying the task of understanding record changer operation is that the parts of the change-cycle mechanism should be studied in slow motion. To do this, disconnect the power and rotate the turntable by hand. Turn it only as fast as you can comprehend the activity of the change-cycle mechanism and stop whenever it is necessary to study some part more closely.

## Record changer sequence of operation

The operation of an automatic record changer follows a definite sequence and when this sequence is observed and understood the fault in a defective record changer can be easily determined. The sequence of operation is as follows:

1. The electric motor and drive assembly supply power to the change-cycle mechanism and rotate the turntable.
2. The pickup arm allows the cartridge and needle to follow the grooves of the record; the cartridge reproduces the sound.
3. After the record playing is completed, the trip mechanism starts the change cycle.
4. The change-cycle drive is engaged.
5. The pickup arm is raised.
6. The pickup arm is swung out to the edge of the chassis over the rest post.
7. The next record is dropped.
8. The pickup arm is swung in and stopped over the lead-in grooves of the record whether it is 7, 10 or 12 inches in diameter.
9. The pickup arm is set down.
10. After the last record has been played, the pickup arm is lowered to the rest post and the power is shut off.

This sequence is performed by a fully automatic record changer.

Some changers, however, are designed only to be partially automatic—they cannot intermix different record sizes nor shut off automatically after the last record. In partially automatic changers, these operations are controlled manually; they will be discussed with the associated automatic assembly.

The 10 automatic steps do not explain actual operation, but give only the end result of each assembly. There are various ways of accomplishing each step and so it would do no good to have a

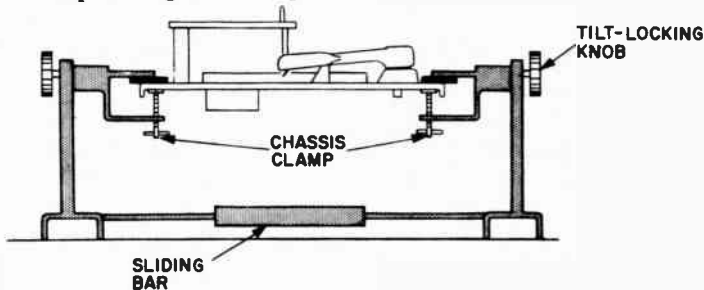


Fig. 102. Service stand facilitates repair of record changers.

combined discussion about them. Instead the functions are described in various chapters so that it will be easier to study the different basic principles.

### Isolating the defective mechanical network

If we keep in mind the 10 functional steps of an automatic record changer, the defective mechanical network is obviously automatically isolated. Fortunately, although many changer types differ greatly, the defects encountered in them fall into the same categories. The following table gives the troubles that can be encountered and their possible causes. Refer to the particular chapter for each cause, and study the methods used in the different changers; then use the recommended service procedures.

Contrary to general belief, automatic record changers are easy to service. One reason for this is that, when a defect occurs, it is usually visible whereas with most electronic troubles the cause can rarely be seen. Therefore, the first step in servicing a defective record changer is to inspect the faulty assembly. If we have a record changer that raises the pickup arm and swings it out, but the next record is not dropped, then we know the record-dropping mechanism is at fault. After reading the chapter on record-dropping mechanisms, place the changer on a service stand and rotate the turntable by hand while watching the detail parts of the record-dropping mechanism in action. The service infor-

## Trouble Isolation Table

Trouble	Possible Cause	Chapter
1. Turntable does not rotate at all.	a. On-off switch or power cord defective.	2
	b. Motor defective.	2
	c. Drive assembly defective.	3
	d. Turntable binds.	4
2. Turntable rotates too slowly or stops when change cycle starts.	a. Same as b through d above.	
3. Change cycle does not start or starts too early; or reject or manual control does not work.	a. Trip mechanism defective.	7
4. Pickup arm does not rise at all or not enough, or it rises too much and hits the stack of records on the spindle.	a. Arm-raising assembly defective.	8
5. Pickup arm is not swung out clear of the dropping record.	a. Arm swing-out assembly defective.	9
6. Records do not drop or more than one record drops at a time; records do not drop flat.	a. Record - dropping mechanism defective.	10

mation on record-dropping given later will make it easy to locate and repair the faulty part.

Most troubles are parts gone out of adjustment, bent parts, dirt and lack of lubrication. In nearly all cases, the repair can be made by an adjustment, a bending, cleaning, lubricating or minor replacement. This is the reason some service technicians have

### Trouble Isolation Table

Trouble	Possible Cause	Chapter
7. Pickup arm does not swing in.	a. Arm swing-in assembly defective.	11
8. Pickup arm does not set down at beginning of record.	a. Set-down index defective.	12
9. Pickup arm is not lowered to rest post or power is not shut off after last record is played.	a. Automatic shutoff mechanism defective.	13
10. No sound or sound is low, noisy or distorted. Sound is scratchy.	a. Pickup needle defective.	5
	b. Pickup cartridge defective.	5
	c. Needle does not track properly.	5
	d. Improper needle pressure.	5
11. Needle or records wear out prematurely.	a. Needle does not track properly.	5
	b. Improper needle pressure.	5
12. Record changer is noisy or causes rumble and wow.	a. Same as 1-b, -c and -d.	
13. Pickup arm skips or jumps grooves.	a. Needle defective.	5
	b. Improper needle pressure.	5
	c. Trip mechanism defective.	7

found record-changer servicing a lucrative business.

An important point to consider is what to do when the change-cycle mechanism jams. This cannot be attributed to any one line of assembly. The most important thing to remember is not to force the turntable against the binding pressure; this will only increase the damage and make the repair more difficult. The only

thing to do is to move the turntable by hand, using very little pressure, and to watch each part as it is actuated. Repeating this inspection will determine the jammed part in short order. Determine which function that part performs and refer to the applicable chapter.

### **Tools required for service**

To make proper repairs it is, of course, necessary to use the proper tools. In some cases we can improvise but it is always best to work with the tool made for the job. This will reduce the probability of causing even more damage. Using the wrong tool may compel you to replace a part which originally required only an adjustment. An improper or makeshift tool can make a repair tedious; with the right tool it may be only a simple task. The basic tools normally required when servicing an automatic record changer are:

1. Set of standard and Phillips-head screwdrivers.
2. Set of nut drivers, such as a Spintite hex wrench set.
3. Set of key wrenches, both hex and spline.
4. Pliers, large and small.
5. Stroboscope disc.
6. Tweezers.
7. Dental type inspection mirror.
8. Lubricant applicator.
9. Pair of bending tools.
10. Needle pressure gauge.
11. Magnifying lens.
12. Rivet tool (peening tool).
13. Set of open-end wrenches.
14. Snap-ring pliers.

These tools are for mechanical repairs. For electronic repairs, the tools needed are:

1. Multimeter.
2. Soldering iron.
3. Longnose pliers.
4. Wire cutters.
5. A 1,000-cycle test record.

The importance of most of the tools listed, such as the screwdrivers, nut drivers, key wrenches, etc., is obvious. The stroboscope disc is necessary to determine whether the turntable is turning at the proper speed. If the speed is considerably off, the listener will certainly notice the poor sound reproduction; if, however,

the speed is only slightly off, only a very sensitive ear will detect it. The stroboscope disc, then, can be used by the technician for a customer complaint that is not self-evident. The tweezers will be very valuable when removing and installing small parts, especially springs. The most exasperating problem the technician encounters is the handling of small parts in close quarters. But with tweezers, the job is simplified. The inspection mirror is used in partially hidden areas for viewing obscure parts and also as an aid in repair and adjustment. The lubricant applicator is usually a special syringe or eyedropper filled with either oil or grease so that the lubricant can be applied in cramped and often inaccessible places without splattering the surrounding parts that must stay dry. The applicator syringes have long, thin nozzles, so that they can be used accurately, and plungers, so that the proper amount of lubricant can be applied. The bending tools, recommended for use by Webcor (Webster-Chicago), are long slotted shafts with handles. The shafts should be long enough to grip levers inside the changer mechanism. The lever parts fit into a slot at the end of the shaft and the handle at the other end is held. The tool is then turned to bend the part for adjustment purposes. Various pliers can also be used, but you must be careful not to damage surrounding parts. The needle inspection lens and pressure gauge are used so that the records and needles will last longer and also to insure good sound reproduction. The rivet tool is for tightening loose rivets so that vibration will be kept at a minimum. The 1,000-cycle test record is helpful in testing the reproducing quality of the record changer, especially in determining if the changer produces unwanted sounds. The snap-ring pliers are for removing retaining rings.

### **Parts to stock**

Although a great deal of automatic record changer servicing will consist of cleaning, lubricating and adjusting, there will also be times when a replacement will have to be made. In any service business the repaired item stands for money. The sooner the item is repaired and sent on its way, the faster the money will be collected. One of the biggest problems in getting a record changer repaired quickly is having the replacement parts on hand. It would be very nice if we were dealing with only one automatic record changer so that all replacement parts could be stocked. There are a number of manufacturers, however, who have made numerous models in the past few years. It would be ridiculously



expensive to stock all the parts that would be required for service. The problem, then, is where to draw the line on what parts to stock or not to stock. It would not be wise to keep parts on hand that are adaptable to only a few changer types, such as special levers, pawls, turntables, switches, etc. The parts that should be stocked, on the other hand, are the smaller, commonplace ones that usually cause trouble. These are:

1. An assortment of pickup needle setscrews that will fit the more popular types. The sizes usually range from 2-56 x  $\frac{5}{8}$  inch to 1-72 x 1 inch.

2. An assortment of cartridge mounting screws to fit the more popular units. This assortment should contain spacers and machined and self-tapping screws of varied lengths.

3. An assortment of friction tires, drive wheels and drive belts for the drive assemblies. Normally, six or seven varieties of each will cover the most popular record changers.

4. A few rubber shock mounts of the type used to mount the motor assembly to the changer chassis.

5. An assortment of standard metal washers.

6. Some lockwashers.

7. Various spring friction washers.

8. A group of retaining rings and C washers.

9. A quantity of felt washers.

10. An assortment of setscrews.

11. An assorted quantity of nuts and bolts.

12. A few speed spring nuts.

13. Various cotter and hair pins.

14. A couple of phono plugs and jacks.

15. A group of expansion springs.

16. Phono hookup wire.

17. Various pickup needles.

18. A replacement cartridge.

These parts are fairly common and can be obtained at any parts distributor. Other parts of the changer can be stocked, of course, but these will have to be determined through experience. Since manufacturers' sales of record changers vary throughout the country, some localities may contain more of one type changer than another. In this case, it would probably pay to stock some of the more expensive parts—the motor for instance—according to the demand. However (and it deserves repeating) this can be determined only through experience.

# the record changer motor

**T**HE electric motor is the power supply of the automatic record changer. The motor is located under the record changer chassis, and the motor drive shaft extends up through an opening in the chassis to the drive assembly. The drive assembly is discussed in Chapter 3. By means of it, the motor operates the turntable and the change-cycle mechanism. The turntable relies on the motor for a continuous, smooth supply of this power, so that it can rotate at an even speed and thus help reproduce the recorded sounds with as much fidelity as possible. In the early days of phonograph history, the motor was a hand-wound spring-driven mechanism that would invariably run down in the middle of a playing; it is not necessary to go into the disadvantages of such a device.

Realizing the need for a driving device that would provide a sufficient amount of smooth power, manufacturers installed electric motors. In the past, a wide variety of electric motors were used, both for a.c.-d.c. and universal operation. Since the motors then available were not able to maintain a constant speed of operation, they invariably contained centrifugally operated governors that attempted to control the motor speed. Since that time, the art has advanced to the point where electric motors can be made so that they themselves can keep a fairly constant speed without being governed. Some capacitor, hysteresis, d.c. and universal motors are being used at present. (The d.c. and universal motors still require governor action to maintain speed.) The electric motor enjoying the greatest popularity at present, however, is

the shaded-pole squirrel-cage induction motor. This type is fairly rugged, lightweight and requires no troublesome connections to the armature, such as slip rings or commutators. It maintains its own speed and is capable of supplying instantaneous power to the change-cycle mechanism so that the record changer can change records fast.

The only variation in the use of these shaded-pole squirrel-cage induction motors is that some changers use the two-pole type, while others employ the four-pole. The four-pole motor is more efficient but basically these motors are the same. For simplicity, this text will discuss the two-pole type.

The American standard of operation for the motor is 115-volt 60-cycle power, although motors are being made for operation on 220 volts, and for 25-, 40-, 50- and 60-cycle power. These nonstandard motors are made principally for foreign use.

### **Basic operating principles**

The basic operation of the shaded-pole squirrel-cage induction motor is relatively simple. Like most induction motors, the alternating current in the field coil of the motor develops a corresponding magnetic field between the pole pieces. This alternating magnetic field, in turn, induces currents in the squirrel-cage armature, which is physically nothing more than a series of shorted copper bars. The current that is induced in the armature then develops its own magnetic field which interacts with the magnetic field between the pole pieces. This interaction between the two magnetic fields causes the armature to follow the rotating magnetic field between the poles. Shading rings around a portion of each pole make the motor self starting. (See Fig. 201-a, b.) These shading rings also have currents induced in them by the magnetic field and therefore produce their own fields. The shading fields counteract the poles' magnetic field, causing the field to build up across the poles and in effect, rotate.

If this motor were of the synchronous variety, the armature would turn at the same rate as the power frequency of the current in the field coil. If this were so and 60-cycle power were used, the armature would rotate 60 times per second, or 3,600 r.p.m. (revolutions per minute), as motors are usually rated. (The four-pole motor, however, would run at 1,800 r.p.m.) But, since this is an induction motor and not a synchronous one, the armature must always slightly lag the magnetic field to have currents induced in it. Because of this lag, there is a certain amount of armature slipage present, which, on the average, is about 200 to 400 r.p.m.

Hence, the average two-pole motor will run around 3,200 to 3,400 r.p.m. However, since the record changer is engineered with this slippage taken into consideration, it is inconsequential *as long as the slippage remains relatively constant*. If, on the other hand, the armature slippage increases, then the motor speed will be reduced, slowing the rotation of the turntable. A slow turntable can be recognized by the dragging, drawnout tones that are reproduced, because the signal frequency is lower than normal. If the

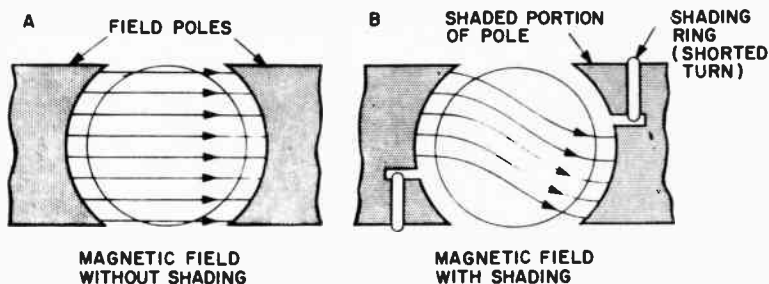


Fig. 201-a, b. *Magnetic field poles without shading (a) and with shading rings (b).*

motor speed is considerably reduced, it can convert normally soprano tones to bass.

One of the biggest factors affecting increased slippage is friction acting against the armature rotation. The armature shafts are made to ride in bearings so that rotational friction is kept at a minimum.

### Servicing the motor

Troubles caused by the record changer motor can be put into six categories:

1. Slow motor. This includes the turntable rotating too slowly (causing poor sound reproduction), stopping or slowing when too many records are on it, and stopping or slowing when the change-cycle starts.

2. Overheating.

3. Mechanical noise.

4. Rumble.

5. Wow.

6. Dead motor (the turntable does not rotate at all).

The record changer motor does not contain many parts and the maintenance procedures are fairly simple and standard. These consist of inspecting, cleaning, lubricating, tightening and replacing when required. A note of caution is necessary, however, when substituting any part in the motor. Invariably, an inexperienced

person at some time or another will attempt to replace an armature with a salvaged unit. The rotating speed of the turntable is a direct function of the armature shaft diameter. If another manufacturer's armature, having a slightly different driveshaft diameter, is installed in a motor, the turntable will revolve at an improper speed. A relatively small change in diameter (sometimes unnoticed by eye) can cause a considerable change in turntable speed. Also, the bearing plates are set up for a perfect fit so that friction will be kept as low as possible. An improper plate can unbalance the armature, increase friction and slow the motor. Because of these things, it is recommended that only direct manufacturers' replacements be used. At times it may be more economical, and sometimes necessary, to replace the entire motor because of much use or because a detail part alone is not available.

### **Slow motor**

A slow motor is easily detected by the tonal quality of the reproduced sound. As explained previously, such a motor causes the reproduced sound to drag or even to be unintelligible. At times, however, the motor may be running only slightly slower than normal, and only a very sensitive ear can detect the tendency toward poor reproduction. In this case, the turntable speed can be checked accurately with a stroboscope disc, shown in Fig. 202. The disc is shaped like a record and contains on its surface a series of lines that form a concentric circle around the disc. These lines are so spaced that when the disc is placed on a turntable that is going around at normal speed (and reflecting light from the same power source) they will give the illusion of standing still. If the turntable is rotating slowly, however, the lines will appear to be moving in a counterclockwise direction. If the turntable is moving too fast, the lines will appear to go in a clockwise direction. When using the "strobe," make sure that the proper 78, 45 or 33-1/3 lines are used.

The simplest method of getting an indication of whether the motor is at fault is to apply a very light hand pressure to the turntable while the changer is operating, so that it will be slowed even more. If, when the turntable is thus retarded, the motor shaft slips and continues to run at close to normal speed, then the motor is *not* at fault; instead, the slowness is caused by the drive assembly or turntable. It would be wise to note at this point that a *slow turntable is most often caused by the drive assembly*. If, when the turntable is retarded, the motor slows correspondingly, then the motor *is* at fault.

A slow motor can be caused by excessive dirt, lack of lubrication, an unbalanced armature or a reduced magnetic field.

### Cleaning the motor

The biggest factor causing a slow motor is increased slippage due to friction. The only friction that should be present is the normal operating friction at the bearing surfaces of the motor.

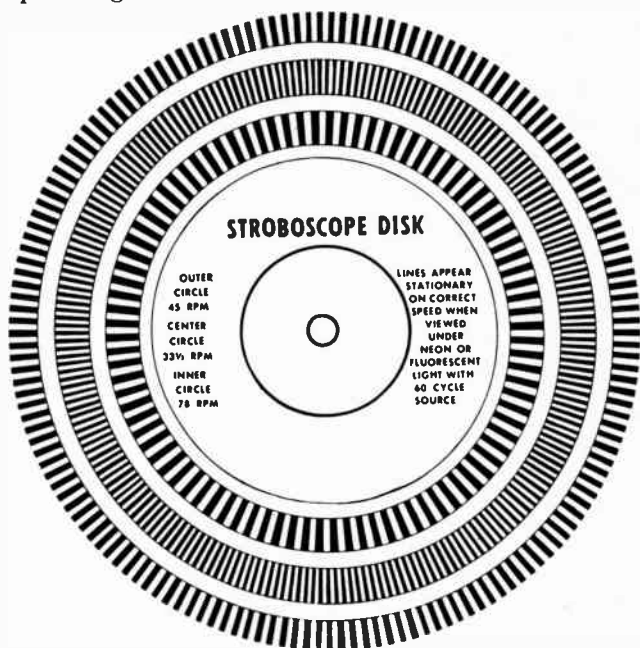


Fig. 202. Typical stroboscope disc. This is a simple and effective means for checking the speed of the motor.

These must be clean, polished smooth and lubricated to keep friction at a minimum. Dirt, dust and grime, however, accumulate at the bearing surfaces, increasing the friction and invariably polluting the lubricant.

To restore normal motor operation, the dirt, dust, grime and useless lubricant must be removed and the bearings relubricated. Carbon tetrachloride or a similar cleaning fluid can be used for this purpose. The solvent, though, must be capable of evaporating quickly to prevent damage to the wiring. Gasoline, naphtha or similar products can also be used, but the danger of fire is present. Carbon tetrachloride is desirable because it is noninflammable. Take care, however, when using it, for its fumes are poisonous and should not be inhaled.

Light dirt in a motor can be blown out but to do a thorough job use a cleaning solvent. Some technicians apply the solvent to the motor as a unit, but, since the motor can easily be disassembled (and a more thorough cleaning job can be accomplished in that manner) the detail parts should be cleaned separately. As shown in Fig. 203, the motor is easily taken apart by removing the screws holding the bearing plates, and sliding out the armature. Before taking the motor apart, though, it would be wise to mark the bottom side of the field poles. The bottom looks identical to the top and so it is easy to replace the field poles incorrectly. If the bottom of the field poles is put back on top, the motor will turn in the wrong direction and, therefore, so will the turntable. Although some motors are designed so that the poles cannot be reversed, it would be safer to mark any motor that you disassemble.

When cleaning the detail parts, keep the surroundings neat and use spotless implements so that when a part has been cleaned, it will not again pick up dirt and grit. Apply the solvent with a clean, dry cloth and rub off the dirt and grime. Repeat this action as often as required until the parts are thoroughly cleaned. The bearing plates should be repeatedly immersed in the solvent to dislodge gritty lubricant.

While the motor is disassembled, check the shaft and bearing surfaces. If friction is to be kept at a minimum, these surfaces must be perfectly smooth. Inspect them for burrs, nicks, dents or scoring. Polish their surfaces with emery cloth until they are perfectly smooth and round. Check the armature body and pole pieces and treat them in the same manner.

### **Lubricating the motor**

Sometimes the motor requires only lubrication to function properly. The lubricant, which determines the smoothness of rotation, besides becoming contaminated with dirt or grime, can also lose its value after prolonged use. To lubricate the motor properly, it should be disassembled as shown in Fig. 203. Before applying the new lubricant, clean the motor thoroughly as described previously so that the worthless lubricant will be removed and the new lubricant will not mix with any dirt or grit. SAE No. 10 oil is usually recommended for motor-lubricating purposes. Do not use too light or heavy an oil. Light oil splatters and is easily lost; heavy oil retards the motor and reduces its speed. It is important to note that an excessive amount of even the right oil will also retard the motor; so use the oil sparingly. Caution: Do not

allow the oil to touch the portion of the drive shaft that contacts the drive assembly (described in Chapter 3). This drive shaft must be absolutely dry or else the drive wheels will slip.

Fig. 204 shows the lubricating points that are most important. The bearing portions of the armature shafts should be just slightly primed with the lubricant and the oil cups in the bearing plates should be filled. Some motors have bearing plates with open oil

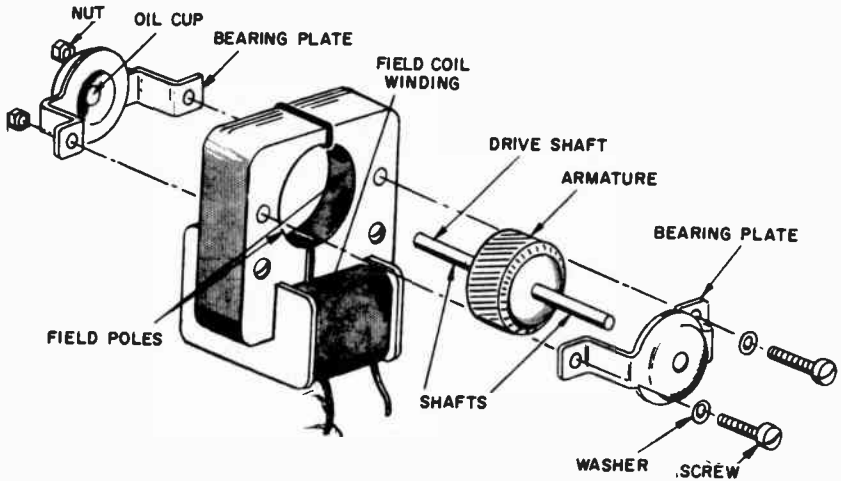


Fig. 203. *Component parts of a 2-pole record changer motor. Disassembly of the unit is fairly easy.*

cups that contain an absorbent material. The absorbent material should be saturated with the lubricant. Other motor types have closed cups. In this case, just prime the bearing. If a type of motor is encountered that has no cups, then it will probably have felt type washers that should be saturated with oil. Make sure that the felt washers have not deteriorated; if they have, replace them. The purpose of the cups and the washers is to maintain a lubricating supply for the bearings over a period of time. However, whether these lubricating supplies are or are not used, the bearing lubrication should be checked at every opportunity. Besides causing erratic operation, poor lubrication will force the armature shafts to wear beyond usable limits.

### Armature balance

Friction cannot be kept at a minimum unless the armature is properly balanced and it is balanced properly only when it can rotate without any evidence of binding or vibration. The armature shafts and bearings must be aligned in the same vertical plane to



achieve a balanced condition. This is shown in Fig. 205. An unbalanced armature results in excessive friction at the bearing surfaces, retards the motor, wears the shafts and causes noise. To balance the armature properly, the top and bottom bearing plates must be positioned so that the armature body is perfectly parallel

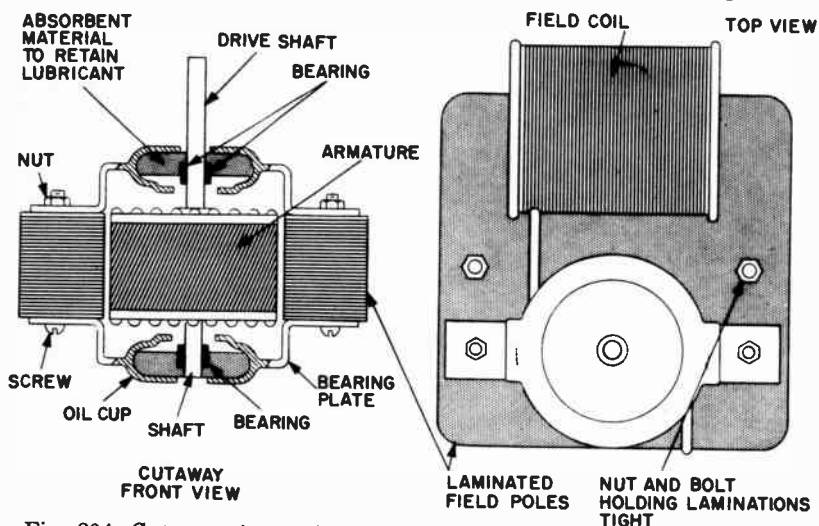


Fig. 204. *Cutaway front view of the motor shows important lubricating points.*

to the pole faces and the bearings set in perfect alignment. Adjust for armature balance using the following procedure:

1. Barely loosen the screws holding the bearing plates so that the plates can be shifted slightly.
2. Rotate the armature by hand and position the bearing plates until the armature turns freely.
3. Tighten the screws holding the plates.
4. Apply power to the motor and listen closely for any evidence of vibration or noise.
5. Using a screwdriver handle, lightly tap the top and bottom bearing plates on each side, until the noise is eliminated or minimized. (In most motors, the bearings are movable. This tapping while the motor is running, will cause the bearings to align themselves.)

If armature vibration or noise is still present or returns after a short period, disassemble the motor and check the armature shafts, the mounting holes in the bearing plates and the bearing plate mounting holes in the pole body for wear. Make sure the screws used for mounting the plates are not worn and that the bearings are not too loose.

## Reduced magnetic field

Probably the least suspected cause of a slow motor is a reduced magnetic field. When the magnetic field drops in intensity, the currents induced in the squirrel-cage armature will also be lower and, therefore, so will its magnetic field. Because of this, the coupling between the two fields will decrease and slippage will increase. When a motor has an insufficient field, it will start off rather slowly and then gain speed. With hardly any load, it may possibly

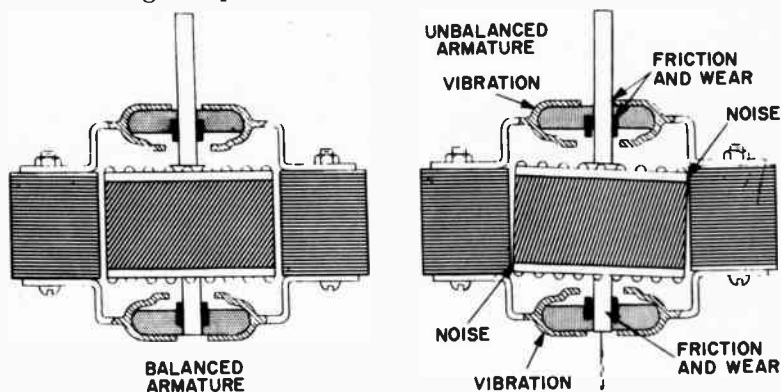


Fig. 205. *Unbalanced armature causes sliding contact, produces excessive friction, noise, and wear.*

come up close to normal speed after a time. But when a load is placed on it, the motor speed is easily retarded and, if the load is increased, the motor can easily be stopped.

The reasons for magnetic reduction are increased field-coil resistance and leakage between the coil and the core. The resistance of the field coil can be checked with an ohmmeter (Fig. 206). Since there are a great number of manufacturers the resistance of the coil varies considerably with each motor. We cannot, therefore, give any specific values. Some typical readings are, however, 24 ohms for a two-pole motor and 60 ohms for a four-pole. A difference in reading of only a few ohms between the motor in question and the manufacturer's specifications can cause erratic operation. Referring to Fig. 206 again, check for leakage between the coil and the core. The ohmmeter should give an infinite reading in this test for the motor to operate properly. If either of these ohmmeter tests indicates trouble, replace the entire motor.

## Overheating and mechanical noises

In general, when the motor overheats, it causes erratic operation such as running slowly, noisily, or intermittently. At times, though,

the record changer can appear to be operating normally, except that a burning odor may be present. The motor is usually located in an open area in the record changer so that the surrounding air will convey the heat from the motor. (Some motors have fan blades attached to the armature to increase the air circulation.) Even with this heat dissipation, though, if above average heat is developed at the motor, the circulation will not be great enough for adequate cooling. Because of this, the motor assembly must be free of minor defects to assure that excess heat will not develop. Overheating can be a result of increased friction or a shorted winding in the field coil.

Increased friction, as previously discussed, is brought about by dirt, worn parts, lack of lubrication and armature unbalance. Therefore, the service information given for a slow motor should also be used when you notice overheating.

If the field coil had a shorted winding, excess currents would be produced which would overheat the motor. For this trouble, the field coil should be checked just as it was for a reduced field, except that if a short exists the ohmmeter reading is lower than it should be.

Since the motor transfers its energy to the drive assembly by means of friction and consists of moving parts, it does have a tendency to vibrate. If the parts on the motor assembly are loosely mounted or worn, noise will develop. The first step to take when noise does occur in the record changer is to isolate its source. All the parts of the automatic record changer mechanism are mechanical and can cause noise when a defect develops. But if the noise persists when the change cycle is not taking place (that is, when the record is being played), then the source of the noise is associated with the motor, drive assembly or turntable. To determine which of these sections is at fault, remove the turntable and disengage the drive assembly. (For information on this step, refer to Chapters 3 and 4.) If the noise is still evident while the motor alone is running, then the noise is coming from the motor assembly. If, of course, the noise ceases when only the motor is operating, then the trouble is originating at the drive assembly or turntable or else the motor is noisy when under load. To check the latter, lightly press a finger against the motor drive shaft to simulate a load. If noise develops, the motor is at fault; if not, the motor is good. It is important to note that the motor is not too strong and too much pressure can slow or even stop it.

When it is determined that the motor is at fault, the first thing

that should be checked is whether the motor is shock-mounted properly. The motor is attached to a mounting plate which is held to the record changer chassis by means of rubber shock mounts. This is shown in Fig. 207. The shock mounts should ordinarily absorb any vibration or rocking at the motor, unless, of course, a

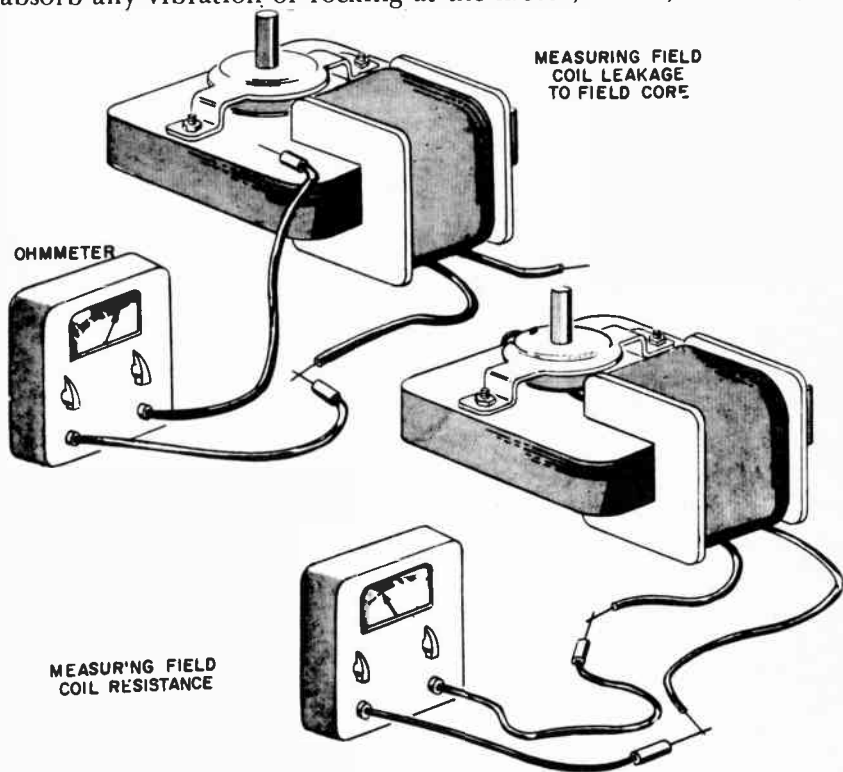


Fig. 206. Techniques for measuring field-coil leakage and field-coil resistance.

defect is present. Check for the cause of the noise using the following information:

1. Make sure that the nuts and bolts, which hold the motor mounting plate to the record changer chassis are not loose, permitting the motor assembly to vibrate. Also check to see that they are not too tight, causing the shock absorbers to lose their resiliency.

2. Inspect the shock absorbers for stiffness, enlargement or splits which would cause them to lose their shock-absorption qualities.

3. See that the screws holding the motor to its mounting plate are not loose, permitting the motor to vibrate and rock the plate.

4. Make sure that the motor or its mounting plate is not making metal-to-metal contact with any nearby assembly.

If this inspection does not find the source of the noise, then the trouble is probably due to loose or worn components of the motor itself. Some motors use rivets to join certain parts. If a motor has a loose rivet, a rivet tool can be used to tighten it or the rivet can be drilled out and a nut and bolt installed in its place.

Use Fig. 204 and the following information to inspect the individual parts of the motor. The procedure is set up so that the motor is inspected as a unit at first. As the inspection progresses, the motor should be disassembled as required.

1. Check the nuts and bolts holding the field laminations to see that they are tight. If they loosen frequently, replace them, making sure that lockwashers are being used. Some technicians have used shellac on the laminations to keep them tight. You can try this but be careful not to let the shellac obstruct the armature.

2. Make sure the field coil is mounted firmly on the laminated core. Some motors use shim slats placed between the coil and the core to hold it tightly; make sure these are in good order. If the motor does not use shim slats and the coil has worked loose, use a makeshift shim to tighten it; shellac the shim in place.

3. See that the armature is balanced. Sometimes an armature can be so far out of alignment that the armature body will contact the pole pieces. Align the armature as described previously in this chapter.

4. Check the screws and lockwashers that hold the bearing plates to the field core. The mounting holes in the bearing plates should not be enlarged or distorted. A bearing plate with worn mounting holes tends to become loose and besides causing noise itself, will throw the armature out of alignment. See that the bearing plates are not bent. Inspect the bearing surface of the plate for scoring, obstructions, nicks or wearing. See that it is clean and that the lubricant is good.

5. Inspect the armature shafts to see that they are perfectly round and smooth; they should contain no nicks, dents, scoring, cracks, or worn spots.

6. After the motor has been thoroughly inspected, it should be cleaned and lubricated before it is reassembled.

### **Rumble and wow**

Rumble is random low-frequency noise that is heard at the speaker in the "background" while a record is being played. It is composed of varying and intermingling low-frequency noises that

sound like its name—rumble. *In the majority of cases, rumble is developed at the drive assembly, but it is also associated with the turntable and the motor.* The actual cause of rumble, when it is present, cannot be readily isolated to any one of these assemblies. Each assembly must be inspected.

To check for rumble, listen to the sounds coming out of the speaker while the pickup arm is riding on a record. But, listen for rumble without music being present, so that it will be more easily heard. One way to do this is to play a 1,000-cycle test record and listen for sounds other than the 1,000-cycle tone. Another way that rumble can be checked is to have the pickup arm ride the finishing groove of a record. However, automatic record changers

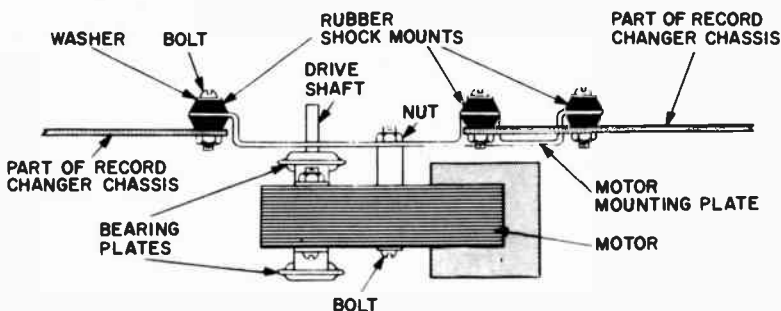


Fig. 207. *The motor is shock mounted to minimize vibration of the changer chassis.*

will change records when the pickup arm enters this area at the end of the record. Therefore, this can be done only with record changers that provide manual operation. You can avoid this difficulty by using an unmodulated test record. When checking for rumble in this manner, turn the volume up slightly higher than normal and then make sure that no noise other than normal surface noise is coming from the speaker.

Rumble caused by motor noise, naturally, is brought about by mechanical noise originating at the motor. In most instances, the noise at the source is too minute to be heard by ear. The noise is transferred to the record changer chassis and turntable, where it produces an electrical signal in the pickup cartridge. This signal is then amplified and fed to the speaker, where it becomes annoyingly evident. Under ordinary circumstances, the motor noise should not get to the changer chassis; the motor shock mounts should damp it sufficiently. Because of this, the shock mounts should be the first place to look for the cause of rumble. If they are all right, inspect the motor, using the instructions given for mechanical noise.

The term wow is uniquely descriptive in that the trouble it describes produces a sound that is very much like the word wow. This is brought about by the recorded sound suddenly dropping in frequency and then rising to normal again. This condition can occur at a fast or slow rate; the only difference in symptoms will be that the wow sound is fast or drawn out. The reason for this trouble is that the turntable slows and then speeds up again. It can also be caused by the drive assembly or turntable. The source of wow can be isolated only by inspecting each assembly.

The presence of wow can be checked by playing a 1,000-cycle

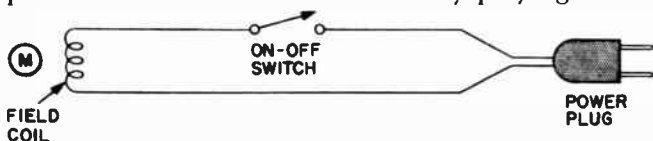


Fig. 208. The power switch is in series with the line to the motor.

test record. A steady 1,000-cycle tone should be heard. If wow is present, it will be plainly evident.

Since wow is caused by nothing more than an intermittent slowness, the cause of wow in the motor should be looked for, using the information given for a slow motor.

### Dead motor

If the turntable does not move, it can be jammed or due to a slipping drive assembly or a defective motor. With the turntable removed and the drive assembly disengaged, the motor should be operating when the power is turned on. If the motor is not operating under these conditions, then the field coil is not energized or the armature is frozen. The cause can be determined easily. Try to turn the armature. If you cannot or it is too tight, disassemble the motor and check it for dirt, lack of lubrication, worn parts, etc., according to the information given for a slow motor.

If the armature turns easily and freely, then a magnetic field is not being produced. The schematic shown in Fig. 208 gives the usual power hookup to the motor. Scrape the insulation off the two leads going to the motor and use a voltmeter across them to see if line voltage is being applied to the motor field. If 115 volts a.c. is reaching the motor, then the motor is defective. If no voltage can be measured, test the resistance of the switch, with the power off. If the switch is worked by a lever arrangement, see if the lever actuates the switch. If all the parts of the changer appear to be functioning normally, check the power cord for an open circuit.

# drive assembly

**T**HE purpose of the drive assembly is to couple the rotary motion of the motor to the turntable so that the turntable will revolve at the proper constant speed. At present, popular records are being made for three speeds: standard, 45 and LP (long playing). The standard speed is 78 r.p.m. and LP is  $33\frac{1}{3}$ . (Although they rarely will be encountered,  $16\frac{2}{3}$  r.p.m. records are also used. These are educational "talking" records, used to relate literary classics and "self-teaching" language lessons.) Therefore, the main function of the drive assembly is to take the speed of the motor, which is close to either 1,800 or 3,600 r.p.m. (depending on whether the motor used is a two- or four-pole type) and reduce it so that the turntable will revolve at the desired speed. A secondary function of the drive assembly is to keep the turntable operating at a constant speed so that high-fidelity reproduction can be obtained.

Earlier record changers operated only at 78 r.p.m. because this speed gave the most satisfactory reproduction results with a minimum of recording difficulties. Later, with the advent of better experience, techniques and materials, it was determined that the speed could be lowered without introducing recording and reproduction problems. This reduced turntable speed brought about more lifelike reproduction with less surface noise, needle-talk and distortion, and the records provided a longer playing time. The two popular lower speeds to emerge from this search for fidelity are 45 and  $33\frac{1}{3}$  r.p.m. There are two trends of thought as to which of these gives the most satisfactory results, and since there is



no consensus of opinion, both speeds are used extensively. The manufacture of 78 r.p.m. records is slowly declining (only pops are now made in that speed in the U.S.A.) and some major record companies are discontinuing manufacture of all 78's. Nevertheless, millions of families have treasured libraries of old 78's. So, record changers will continue to be made in 3-speed models for a long time to come. (Some, such as the RCA 45 series are designed only to be used at the 45 speed: in the past other changers were made that accommodated only the 78 and 33-1/3 speeds. The present trend, though, is for the changer to operate at all three speeds.) There is another trend in the making now that has been brought about by the possibility of still lower speeds becoming popular, such as the 16-2/3 speed mentioned previously. This has caused some automatic record changers to be designed to operate at four speeds, or over a wide range of speeds, such as from 10 to 85 r.p.m.

There are basically four main drive-assembly systems in use at the present time. These are:

1. Three separate direct step-drive wheels.
2. Belted (pulley) drive wheels.
3. Step-diameter motor drive shaft.
4. Variable-diameter drive wheel.

Before discussing any of the three-speed drive systems, it would be wise to review basic reduction-coupling methods and the single-speed drive assembly, so that you will more readily understand the complete technique.

### **Basic principles**

The necessity for having a drive assembly arises out of the fact that it is not practical to produce a motor that operates at the same speed as the required turntable r.p.m. It is certainly not practical now when three speeds are involved. The problem, therefore, is to take the speed of the motor, pass it through a reduction-coupling assembly to reduce the speed and drive the turntable at the required r.p.m. The automatic record changer drive assembly, then, could probably be likened to a gear-driven automobile transmission.

### **Gear drive**

In the automatic record changer, gear coupling is used extensively only in the change-cycle mechanism. Used by the Thorens CD series (a Swiss make) in the drive assembly, it is considered

impractical by other manufacturers because of cost and noise. Our discussion of gear coupling is used for introductory purposes because it is probably the simplest form of reduction to understand.

Reduction in speed by gear coupling is brought about by the ratio of the number of teeth on the drive gear to the number of teeth on the driven gear, as shown in the formula:

$$\text{Speed Reduction} = \frac{\text{Number of Drive Gear Teeth}}{\text{Number of Driven Gear Teeth}}$$

Due to the gear meshing (Fig. 301), a movement of one tooth on the drive gear causes a corresponding movement of one tooth on

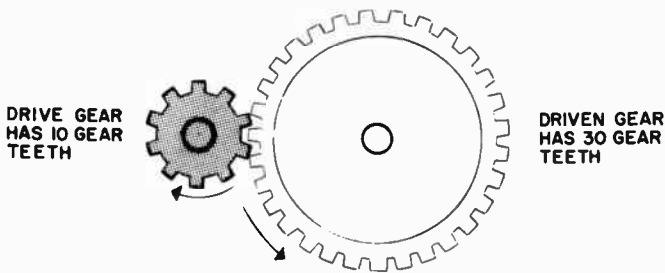


Fig. 301. Simple mechanical coupling using gears.

the driven gear. Therefore, since the drive gear is comprised of 10 teeth, one complete revolution of the drive gear will move the driven gear through a distance of 10 teeth. For the driven gear to be turned one complete revolution (or a total of 30 teeth) the drive gear will have to make three complete revolutions. Thus, as the formula shows,

$$\text{Reduction ratio} = 10/30 = 1/3$$

the reduction ratio is 1/3; therefore if the drive gear were running at 3,600 r.p.m. the driven gear would run at 1,200 r.p.m. On the basis of this, we could change the reduction ratio to 1/80 and the driven gear would operate at 45 r.p.m.

While gear coupling is desirable because it has no slippage problems, it does add difficulties in design and cost.

### **Belt (pulley) drive**

Rubber friction couplings were introduced to minimize the problems of design and cost. This type of coupling is desirable also because of its quieter operation; there is no metal-to-metal contact noise.

One method of obtaining a friction drive is to connect the drive wheel to the driven wheel by means of a rubber belt around the rims of both wheels (see Fig. 302). The operation of the belt drive is similar to that of the gear drive except that the difference in the wheel diameters, instead of gear teeth, determines speed reduction. The formula for the pulley reduction ratio, then, is

$$\text{Reduction Ratio} = \frac{\text{Diameter of Drive Wheel}}{\text{Diameter of Driven Wheel}}$$

Therefore, with the setup shown in Fig. 302, the reduction ratio would be 1/3 as it was for the gear-meshed wheels. With this

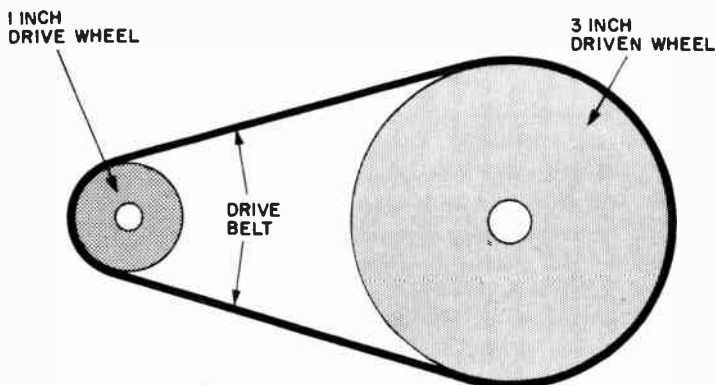


Fig. 302. Belt drive reduction ratio depends upon diameters of drive and driven wheels.

ratio, if the drive wheel is running at 3,600 r.p.m. the driven wheel would turn at 1,200 r.p.m. If we wanted to make the driven wheel rotate at 45 r.p.m. we would use a driven wheel whose diameter would be 80 times that of the drive wheel. The reduction ratio would be 1/80 and the driven wheel would run at 45 r.p.m.

The belt method of reduction coupling is used mainly in the drive assembly to couple the motor drive shaft to the drive wheels. There is a record player, however, that utilizes the drive belt to couple the motor drive shaft directly to the outer rim of the turntable. Although this player allows the motor to be mounted in any position away from the turntable, the impractical aspect of having to change the speed by shifting the belt by hand makes this drive method unpopular. The most practical way of turning the turntable is by the direct rim drive.

### Direct (rim) drive

This is the most popular method utilized in the drive assembly

at present. It is economical, has very little location problem, is easily serviced, is readily adaptable to any speed and is dependable. The direct drive, or rim drive as it is also called, is shown in Fig. 303. The coupling takes place in this unit with the outer rim of the drive wheel directly contacting the outer rim of the driven wheel. The reduction ratio is determined in the same way as it is for belt drive. Therefore, the ratio of the arrangement in Fig.

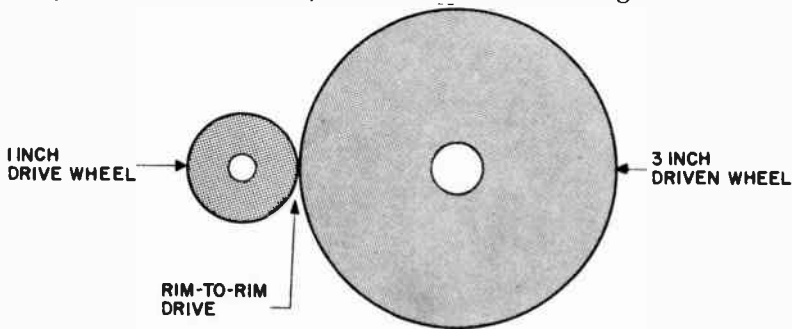


Fig. 303. Rim coupling makes use of rim-to-rim drive.

303 is  $1/3$ . The setup shown is the same as belt drive except that the wheels are moved together and the belt removed. The advantages of this method are that fewer parts are used (no belt) and the wheels are disengaged simply by separating them. The speed can then be changed by the insertion of a wheel of a different size.

Another direct-drive method now used promises to become very popular. In the standard direct-drive system, the drive wheel is coupled rim-to-rim with the driven wheel; with the newer method, however, the rim of the drive wheel is coupled to the top or bottom surface of the driven wheel. The innovation of this method of reduction coupling was brought about mainly because of its simplicity in changing speeds without disengaging the drive or driven wheel. Another important feature of this drive, which was mentioned earlier, is that it is continuously adjustable. By this we mean that it not only can be set to operate at 78, 45 or  $33\frac{1}{3}$ , but also at any other speed over a wide range. Therefore, when a new speed is devised that falls within its range, this unit will operate at that speed without any changes. This method will be more fully discussed later in this chapter under "Continuously Variable Drive."

Just using two wheels in a rim drive, as we have shown, is not an effective method of coupling because a rubber surface should be used to produce more rim friction. Also, the rubber surface

will absorb any noise developed in the drive assembly and prevent it from being transferred to the turntable. In our examples, up to now, the drive wheel actually represented the motor drive shaft, and the driven wheel the turntable. In actual practice, we cannot effectively cover the motor drive shaft with a rubber rim

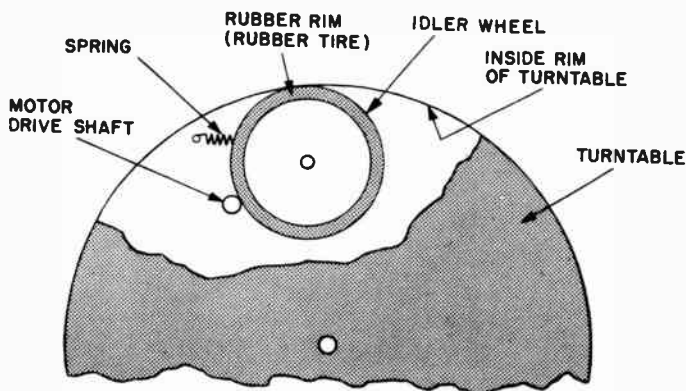


Fig. 304. Illustration above shows simple one-speed rim drive. The idler wheel is equipped with a rubber rim.

because of its small size. On the other hand, it would be impractical to cover the inside rim of the turntable because of its large size. However, a rubber-rimmed intermediate or—as it is more commonly called—*idler* wheel can be placed between the motor drive shaft and the turntable to make a simple, effective single-speed direct drive.

### Single-speed direct drive

In the previous paragraph we stated that a rubber coupling surface is required so that nonslip, noise-free operation can be obtained. To do this, a rubber-edged idler wheel is used between the motor drive shaft and the turntable. This is shown in Fig. 304. This extra wheel is called an idler wheel because it has absolutely no effect on the speed of the turntable. That speed is determined only by the diameters of the drive shaft and turntable.

This type of drive assembly was used extensively in the single 78 r.p.m. players and is still the basic method of most three-speed drives used at present. The idler wheel is mounted on a movable assembly so that it can be moved out of the way when the turntable is taken off or put back. When the assembly is engaged, a spring pulls the idler wheel tightly between the drive shaft and turntable, assuring tight coupling. The rubber surface of the idler wheel is made rough so that better gripping is obtained.

## Single-speed step-rim drive

This variation of the idler rim drive assembly achieves its noise-free reduction coupling in much the same manner as the idler rim drive, except that the wheel placed between the motor drive shaft and the turntable has two driving surfaces, each with a different diameter; and, unlike the idler wheel, this step-rim wheel

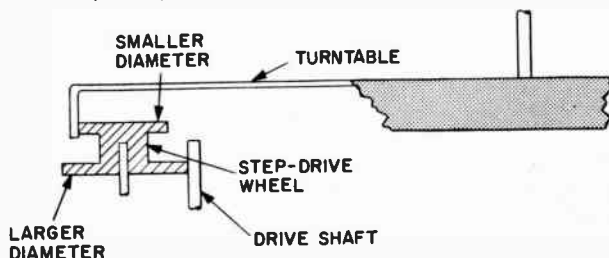


Fig. 305. *Single-speed step-rim drive. The step-drive wheel has two wheel diameters.*

does affect the speed of the turntable. This setup is shown in Fig. 305. Because this type of intermediate wheel does affect the turntable speed, it should not be called an idler wheel, although it is mistakenly referred to as such. Actually, it is a drive wheel.

The only advantage this method of driving has over the ordinary rim drive is that it permits the use of a smaller turntable and so is designed primarily for 7-inch record changers, such as the RCA 45 series. Its basic operation does not differ too much from the idler drive. The drive shaft, turning at 3,600 r.p.m. is coupled to the lower diameter of the drive wheel. The drive wheel, whose lower diameter is eight times as large as the drive shaft, is then rotating at 450 r.p.m. Therefore, the upper diameter, or step drive, is rotating at 450 r.p.m. Since the step drive diameter is one-tenth the diameter of the turntable, the turntable will rotate at 45 r.p.m. We can use a larger drive shaft and a smaller turntable and still be able to obtain the same speed. This, of course, permits the record changer to be more compact. And since we can use intermediate drive wheels that affect the turntable speed, then we can, naturally, use three wheels to get three speeds.

## Three-speed step-rim drive

When the drive assembly had to be designed to provide for three speeds, it was considered most practical to use three step-drive wheels between the drive shaft and the idler wheel. The assembly is set up so that, to change the speed, one wheel is disengaged while another is put in its place merely by shifting a

lever (speed control lever). A typical assembly of this type is shown in Fig. 306.

The larger diameter of each of the drive wheels is the surface that couples the drive shaft and is rubber-rimmed. These diameters are usually the same. The smaller diameters, however, are different; the  $33\frac{1}{3}$  wheel is the smallest, 45 next and the 78 wheel the largest. The three-speed step-rim drive operates in much the same manner as the single-speed step-rim drive. By

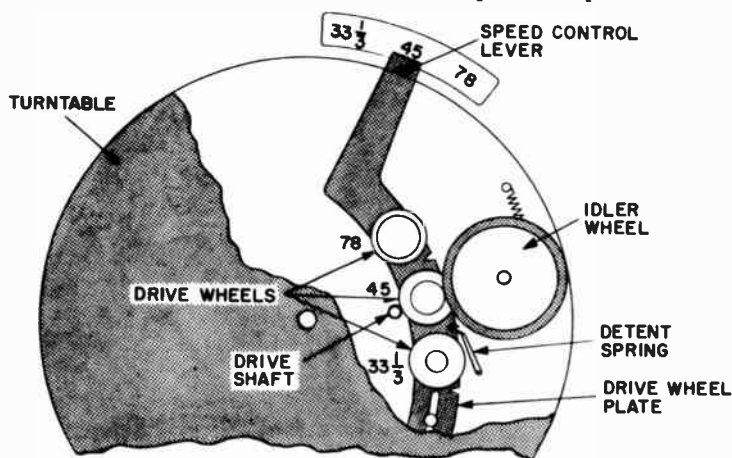


Fig. 306. Three-speed step-rim drive. Each drive wheel has a different upper diameter. The detent spring locks the drive wheel plate into position for any particular speed.

setting the speed control lever to some speed, such as 45, the drive wheel plate will shift in position so that the 45 drive wheel will be set between the drive shaft and the idler wheel. The lever plate usually has detent notches that lock the drive wheel in the proper position. This latching is necessary because the force applied by the drive shaft tends to push the drive wheel out of coupling. The action of the detent can be noted by the speed-control lever snapping into position when it is set. The three step-drive wheels are shown in Fig. 307. The larger diameters are identical; the smaller diameters vary and determine turntable speed.

### Speed shifting

The example shown in Fig. 306 is actually one of the simpler methods used in shifting the drive wheels to change the speed; this method is quite common in single players. In most record changers, however, the speed-shifting lever is linked to the selector knob. In linking the selector knob to the drive assembly, some record changers employ a lever shift while others use a cam shift.

## Lever shift

With the lever type of speed shift, shown in Fig. 308, the speed-selector lever is bolted directly to the selector-knob shaft. The selector lever, in turn, is linked to the speed-shifting lever at the

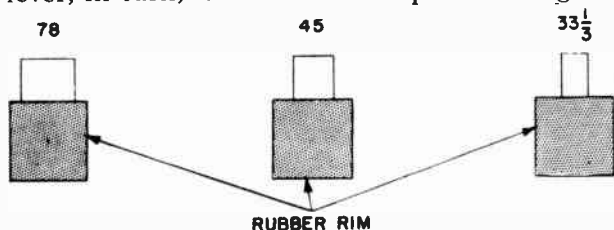


Fig. 307. Step-drive wheels for three different speeds of rotation.

drive assembly. When the knob is set at the desired speed, say from 45 to  $33\frac{1}{3}$ , all the parts will move in the direction shown by the arrows, moving out the 45 wheel and inserting the  $33\frac{1}{3}$  wheel between the drive shaft and the idler wheel. If the knob

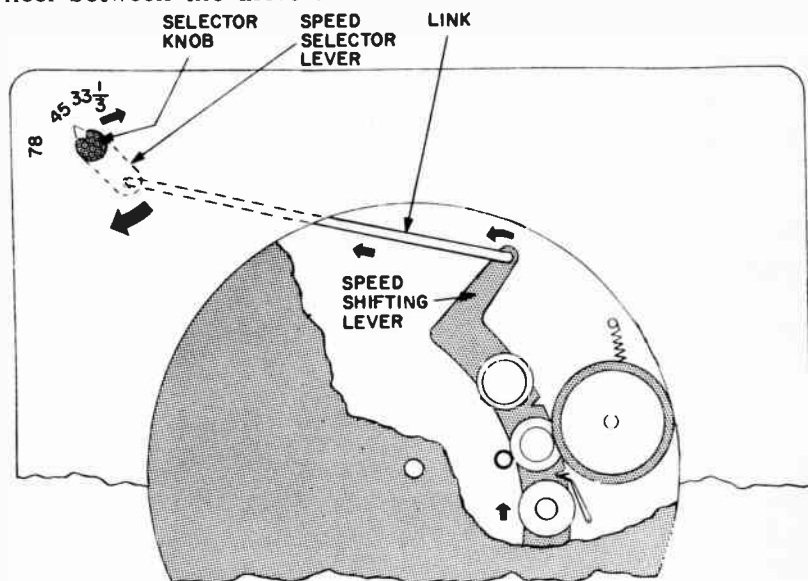


Fig. 308. Change in speed is obtained by a speed-shifting lever which is linked to the speed-selector knob.

is turned in the other way, the parts will naturally move in the opposite direction.

## Cam shift

With the cam type of speed shift, shown in Fig. 309, a speed-selector cam is bolted directly to the selector-knob shaft. The cam,



in turn, is connected by means of a sliding link to the speed-shifting lever at the drive assembly. This assembly operates similarly to the lever shift except that the sliding link is caused to move back and forth by the eccentric groove in the cam. The arrows show the movement of the parts when the selector knob is turned from 45 to  $33\frac{1}{3}$ .

### Three-speed belt-rim drive

This method of obtaining the different speeds is essentially the same as the step-rim drive. The difference is that the drive

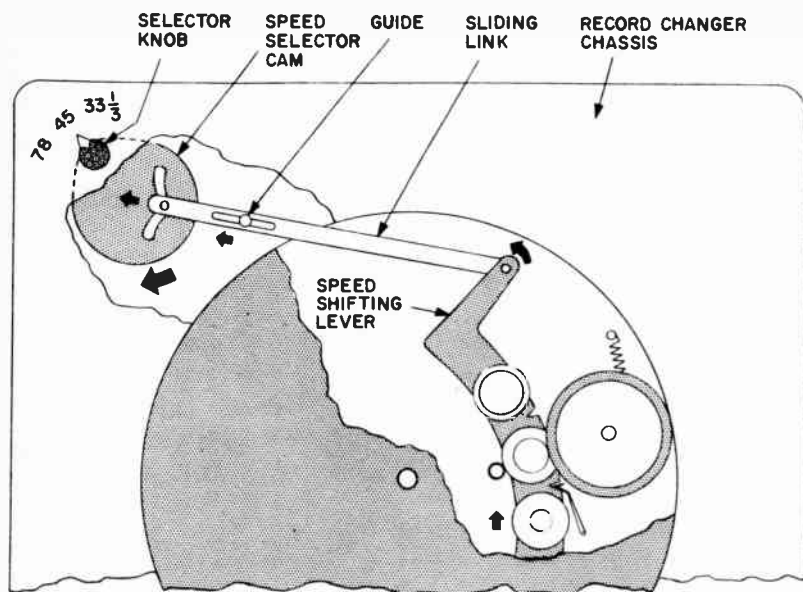


Fig. 309. In this changer the shift in speed is worked by means of a speed-selector cam.

wheels are not directly coupled to the motor drive shaft; the drive wheels are driven by the drive shaft by means of belts, as shown in Fig. 310. The method shown only uses two wheels, one for  $33\frac{1}{3}$  and the other for 45 r.p.m.; 78 r.p.m. is obtained by coupling the drive shaft directly to the idler wheel. Fig. 311 shows this drive assembly in the 45 and  $33\frac{1}{3}$  positions. With the belted three-speed drive, the step wheels are always rotating regardless of what speed is being used. This is because they are continuously coupled to the drive shaft with the belts. They have no effect, though, until they contact the idler wheel. Speed shifting in the belt drive is accomplished in the same way as for the direct drive.

## Three-speed step-diameter motor drive shaft

This method of obtaining turntable-speed control is probably the most economical way of getting three speeds. No extra drive wheels are required to change the reduction ratio. Instead, a step-diameter motor drive shaft is employed that has three different diameters. This drive is illustrated in Fig. 312. When the speed-control lever is moved to the required speed position, a speed-shifting plate also moves. The idler wheel mounting rides in a groove in this plate, and, since the groove rises in the plate, the

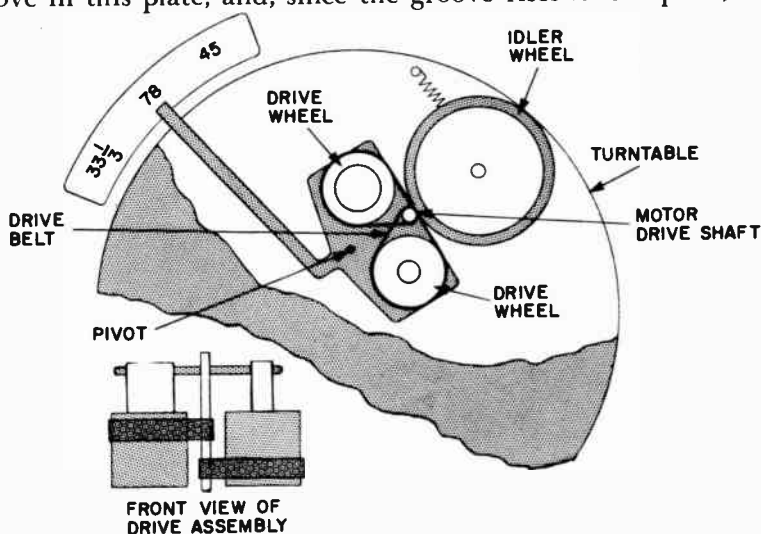


Fig. 310. Three-speed belt drive assembly. The unit is shown in the 78 r.p.m. position.

idler wheel mounting will move up or down whenever the speed lever is reset. As shown in Fig. 313, when the idler wheel is set in its lowest position, it couples the largest diameter of the drive shaft and drives the turntable at 78 r.p.m. In the middle position, it drives the turntable at 45 r.p.m. and in the high position, the turntable runs at  $33\frac{1}{3}$  r.p.m. A modification of this drive is used in some changers. In these, the speed is varied by moving the motor drive shaft and armature up and down.

## Four-speed drive

Some automatic record changers employ a four-speed drive so that the  $16\frac{2}{3}$  r.p.m. talking records can be played. These drives are just about the same as the three-speed drives. If step-rim drive wheels are used, a fourth wheel is placed in the drive to obtain the fourth speed. On the other hand, if a step-diameter drive shaft is used, the drive shaft has four diameters instead of three.

## Continuously variable drive

Because of the new recording speeds, and the increasing possibility that yet newer speeds may be used, it was considered advisable to devise a drive assembly continuously variable over a wide range. Then, if a new speed is introduced, the record changer that employs this drive will not have to be converted as would other record changers.

A drive assembly of this type is pictured in Fig. 314. As the illustration shows, the drive wheel is rather large and is rim-driven

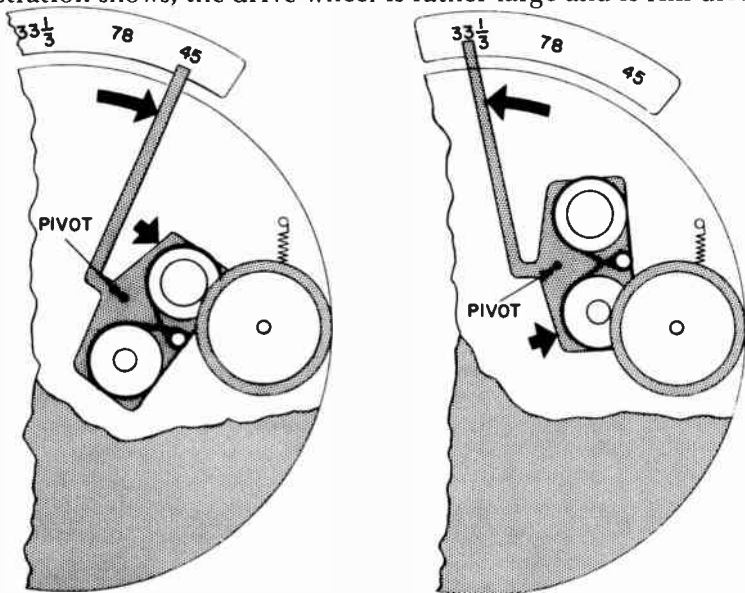
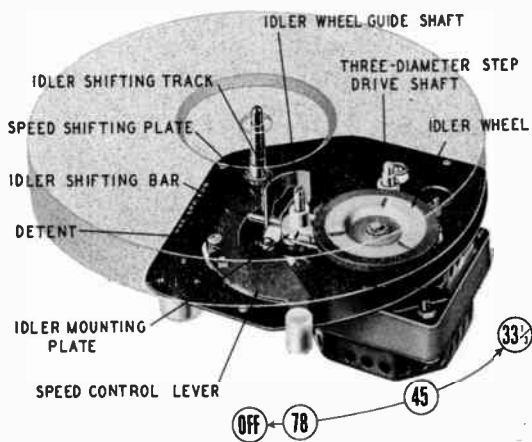


Fig. 311. Three-speed belt-drive assembly showing  $33\frac{1}{3}$  and 45 r.p.m. positions.

by the motor drive shaft. Contrary to other drive methods, though, the turntable is not driven at its rim. Instead, the top surface of the drive wheel is coupled, by means of a small idler wheel, to the underside of the turntable. Therefore, the biggest determining factors of the reduction ratio are the diameter of the drive wheel at the position of the idler wheel and the diameter of the turntable at the position of the idler wheel. If we set the speed-control lever at 78 r.p.m. the idler wheel will move to the position shown in Fig. 314. As the drive shaft turns the drive wheel, only diameter D1 is coupled by the idler wheel to diameter D2 of the turntable. This particular ratio would result in a turntable speed of 78 r.p.m.

However, when the speed-control lever is moved to the 45 position, the idler wheel is set at a new location between the drive

wheel and the turntable. As a result, D1 decreases and D2 increases and the turntable slows to 45 r.p.m. With the position of the



Courtesy General Industries Co.

Fig. 312. Phantom view of record changer showing three-speed drive shaft. Illustration shows major components of record changer.

idler wheel set for 33-1/3 r.p.m. the diameters D1 and D2 are again altered to bring about the proper speed. Another advan-

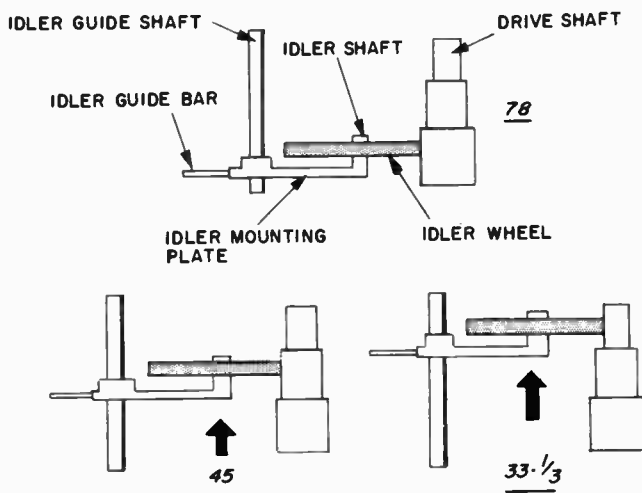


Fig. 313. Three-diameter drive shaft speed positions. The speed reduces as the drive-shaft diameter decreases.

tage of this drive system is that the position of the speed-control lever can be adjusted slightly if line-voltage variations tend to slow the turntable.

## Adjustment of continuously variable drive

This drive is the only one capable of providing an adjustment that compensates for minor variations that slow the turntable. Use the following procedure for this adjustment.

1. Operate the record changer with the speed control at 78 r.p.m.

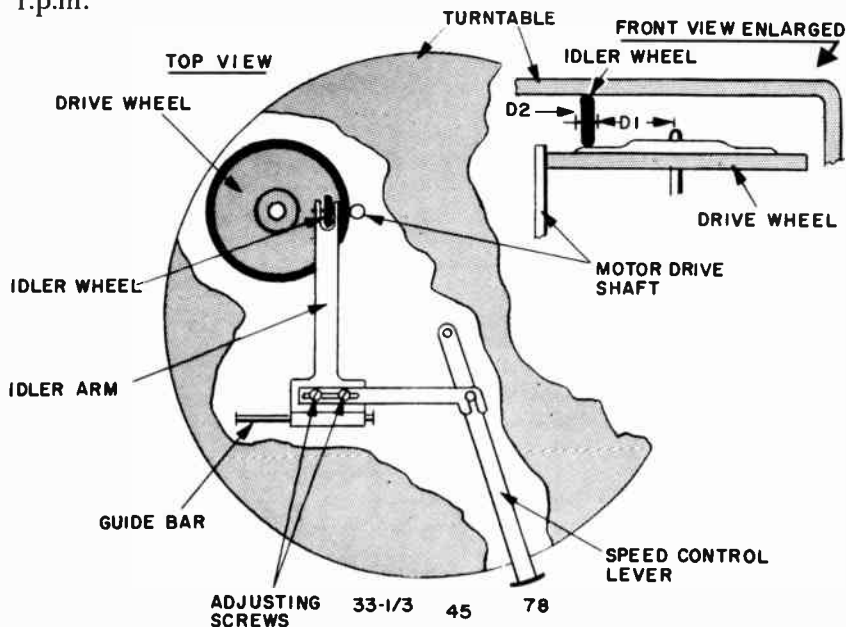


Fig. 314. Continuously-variable drive assembly shown in 78 r.p.m. position. Speed adjustment with stroboscope disc is described in the text.

2. Place a stroboscope disc on the turntable. (Note: The later Zenith automatic record changers provide a built-in strobe and so this step is not required if a changer of that type is being adjusted.)

3. Watch the disc under a 60-cycle light.

4. The series of dots or lines corresponding to 78 r.p.m. should appear to be standing still. If they seem to be turning, the turntable is revolving at an improper speed.

5. Move the speed-control lever until the dots or lines stand still.

6. Shut off the record changer and lift off the turntable without disturbing the position of the speed-control lever.

7. Without changing the position of the drive and idler wheels, loosen the speed-control lever adjustment screws (Fig. 314).

8. Still keeping the wheels in the same positions, move the speed

control lever so that it points directly at the 78 mark.

9. Tighten the adjustment screws and put back the turntable.

10. Check the turntable speed again.

### Servicing the drive assembly

Some troubles can be caused by either the motor, drive assembly or turntable. If you have determined that the fault lies in the drive assembly or turntable, then the only problem at this point is to determine which of these is defective. *The turntable very rarely causes trouble so it would be safe to say that the drive assembly should be serviced at this time.* However, if it is desirable

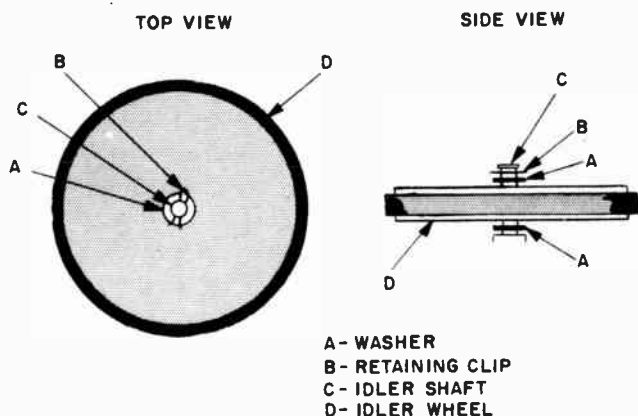


Fig. 315. Idler wheel mounting. The assembly is kept in place by a retaining clip.

to check the turntable first, then refer to Chapter 4. An important point to remember is that the dimensions of the drive assembly parts are fairly critical. If a slightly off-size part is used, improper speeds will result. Because of this, it is recommended that only direct replacements be used.

It is good service procedure to check the trouble in question on all speeds. This can usually help determine the exact part at fault. For instance, if the trouble is present at all speeds, you can suspect the idler wheel or drive shaft. If, however, only one or two speeds are affected, then it is associated with the drive wheel for that speed.

Troubles existing in the motor, such as the turntable rotating too slowly, mechanical noise, rumble, wow or the turntable not moving at all, are also caused by the drive assembly. The most common problem that will be encountered, though, is that the turntable will revolve at a normal rate while a record is being

played but will stop when a change cycle starts. Treat this as if the turntable did not rotate at all.

Most defects can be easily detected by simple inspection and usually the repair is accomplished by either cleaning, lubricating or a simple replacement. Since inspection is an important part of servicing, the drive assembly should be disassembled so that the detail parts can be examined more closely.

## Removal of drive-assembly parts

During servicing, it will most likely become necessary to take the drive assembly apart. This will not be difficult because it is

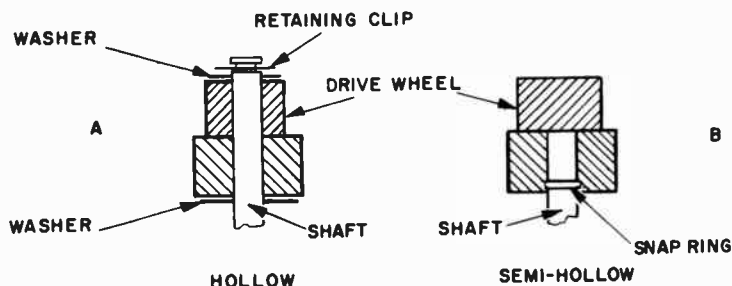


Fig. 316-a,-b. Drive-wheel mounting methods. Two different mounting techniques are shown here.

not too compact a unit. The following information should prove helpful for disassembly purposes.

1. The drive shaft is part of the motor and so should be checked with the motor.

2. The idler wheel (see Fig. 315) is mounted freely on a vertical shaft and is usually held in place by a retaining ring or clip. In most record changers, washers (usually felt) are used at the top and bottom of the wheel. The retaining ring or clip can be snapped out of the groove at the top of the shaft and the idler wheel can then be lifted off. Place the washers in a safe place so that they will not be lost.

3. On some assemblies, the drive wheels are mounted in the same way as the idler wheels (see part a of Fig. 316) and can be handled in the same manner. Sometimes, though, the drive wheel itself snaps onto its mounting shaft. The latter can easily be recognized because it has a solid top, as shown in b of Fig. 316. A slight upward pull will release this type.

4. The idler wheel spring is easily taken off after the idler wheel is removed. As part a of Fig. 317 shows, each end of the

spring merely hooks in a mounting hole. To remove the spring, stretch it slightly and slip it free. Do not stretch it too much or it will lose its tension and will have to be replaced.

5. The drive belts can be simply slipped right off the wheels.

### Turntable rotates too slowly

This is a very common trouble associated with the drive assembly. To prevent slippage, the drive assembly must present a tight coupling between the drive shaft and the turntable and

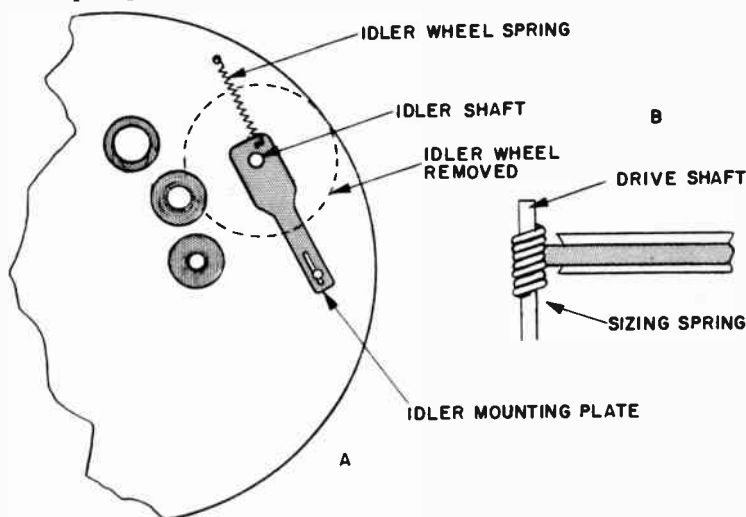


Fig. 317-a,b. *Idler-wheel spring and motor-drive shaft spring. Springs that lose their tension should be replaced.*

should be able to rotate freely. If slippage does occur in the drive assembly, then check the rim or belt surfaces to see if they are coupling properly; also make sure that the wheels do not bind because of wear, dirt or lack of lubrication.

Slowness is also caused if wrong-size parts are mistakenly put in the drive assembly. An important point to remember is that some manufacturers use a coil type spring attachment on the motor drive shaft to increase its effective diameter. This is shown in part b of Fig. 317. If this spring is missing, the drive shaft diameter will be too small and the turntable will rotate too slowly.

### Slippage due to poor coupling and binding

For the drive assembly to provide good friction coupling between the drive shaft and the turntable, the coupling surfaces must grip each other tightly. To supply a good coupling, manu-



facturers make the rubber-rimmed surfaces of the idler and drive wheels slightly rough in texture. The most common fault that occurs in the drive assembly is that this roughness wears down and becomes smooth. When this happens, the wheel loses its grip and does not follow the driving force properly. It slips, losing a few rotations, and causes the turntable to move slower than normal. The biggest offender with slippage is the idler wheel. Most idler wheels use a rubber tire seated in a grooved rim. In such instances, the rubber tire can be taken off, as shown in Fig. 318, and changed. When replacing, remember that various idler wheels employ different sizes. Use the model number of the changer when ordering a new tire. If the wrong tire is used, it may be too large or may not fit snugly in position, causing erratic or noisy operation.

Some idler wheels, and most drive wheels, have permanent rubber rims so the entire wheel must be replaced when the rim becomes smooth. If drive-wheel slippage occurs at only one speed and inspection shows that the rubber rim on the drive wheel for that speed is worn smooth, it would be wise to check the other wheels as well. Even though the other rims are not quite defective and so are still usable, they may last only a short time. Since drive wheels are not expensive and can be obtained as a set, it would be safer to replace them all at once rather than change one now and the others at some later time.

The same problem of slippage occurs with the rubber belt drive. Remove the belts and inspect their inner surfaces for smoothness; make sure the belts have not stretched or deteriorated. Some service technicians turn the belts inside out to make them usable a little longer. This is just delaying a repair and asking for a callback; the belts are inexpensive, so change them.

Another important factor that determines good drive coupling is the pressure of the idler wheel between the drive wheel and the turntable. The spring (part a of Fig. 317) holds the idler wheel firmly in position. If this spring loses its tension, the idler wheel will couple loosely and slip. When this happens, change the spring. Some service technicians cut this spring to make it shorter so that it will have more tension. When a spring starts losing its tension, however, it gets progressively worse. Making it shorter is only a temporary repair; change it.

Slippage due to binding occurs, though not too often, and it also causes a reduction in speed. The idler and drive wheels are mounted on fixed shafts so that they are capable of rotating freely.

If the bearing surfaces for these wheels are worn, scored, dented or damaged in any way, excess friction will be developed. This will retard the wheels and will make them slower. Inspect these points. The bearing surfaces should be smooth and round. Rotate the wheels to see that they turn freely. If necessary, polish the bearings with emery cloth. If the parts are beyond repair, replace

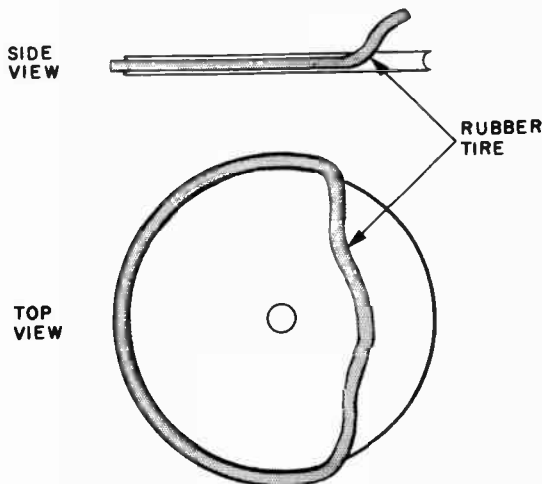


Fig. 318. *The rubber tire seated in the groove of the idler wheel can be removed quite easily.*

them. Binding can also be caused by dirt and lack of lubrication, so also check for these.

### **Cleaning drive-assembly parts**

If too much dirt accumulates at the bearing surfaces of the drive or idler wheels, wiping them clean with a soft cloth is probably all that is necessary to restore normal operation. However, it is important to note that, if this is all that is done, a thin film of grit and grime will still be left. This will serve as a base for new dirt to accumulate even faster than before. To prevent this, after the dirt has been wiped away, clean the surfaces thoroughly with a clean cloth dampened with carbon tetrachloride. Do not dump the cleaning solvent on the drive assembly. It should be kept away from the rubber surfaces because it has a deteriorating effect. The movable assembly that mounts the idler wheel should also be clear of dirt so that the idler wheel can be pulled in tightly by the spring.

### **Lubricating drive-assembly parts**

After a period of time, the lubricant present on the bearing

surfaces loses its value. Also, if the unit has been cleaned, the lubricant will have been taken off. Remove the idler and drive wheels and apply the lubricant sparingly to the mounting shafts. An adhering lubricant, such as Lubriplate, is best for this purpose. Do not allow it to contact the driving surfaces of the drive assembly. If a felt washer is used over the wheels, saturate it with oil. Apply the lubricant to the movable assembly holding the idler wheel so that it can be shifted freely.

### **Mechanical noise**

Since there are a considerable number of moving parts on the drive assembly, the problem of mechanical noise is always present. The first important point to note, for easier localization, is whether the noise being developed by the drive assembly has a metallic or a nonmetallic sound. If a metallic sound is evident, check all

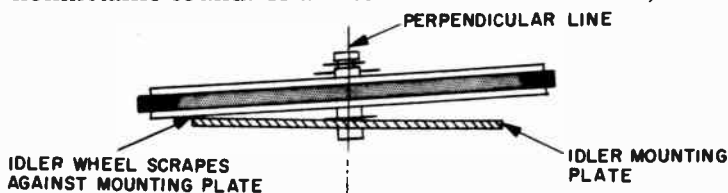


Fig. 319. *Idler-wheel mounting shaft may be tilted, producing condition shown above.*

metal-to-metal contacts for erratic operation. Make these simple checks:

1. The drive or idler wheels should not be mounted loosely on their shafts. Move the wheels from side to side to see if there is excessive free play. If the wheel mounting holes or their respective shafts are worn, scored or dented, noise will be developed.
2. The drive and idler wheels should be level. If the mounting shaft is slanted, the wheel will tilt (see Fig. 319) and the edge may scrape the assembly mounting. Straighten the shaft.
3. The retaining ring or clip should be present at the top of the shaft. This ring or clip prevents the wheel from rising as it rotates. If it is missing, the wheel will rise and scrape the underside of the turntable, as shown in Fig. 320.
4. The washer at the top of the wheel should be there to prevent the wheel from scraping against the retaining ring or clip. A washer under the wheel will also be helpful to prevent noise at this point if one is not now being used.
5. Another important item, often forgotten, is the secureness of the drive wheel mounting plate. If it is loose, vibration will occur, causing irritating noises. This plate must be movable be-

cause it shifts the drive wheels. However, sometimes bending it can make it tighter so that vibration will not occur. Grease can be used around the plate to dampen the noise.

6. Check to see that the body of the spring is not warped (Fig. 321), causing it to hit the idler wheel.

If the noise heard is nonmetallic, the repair is much easier to accomplish. The part that is usually at fault is the rubber rim of the idler wheel. The same trouble can also be caused by the drive

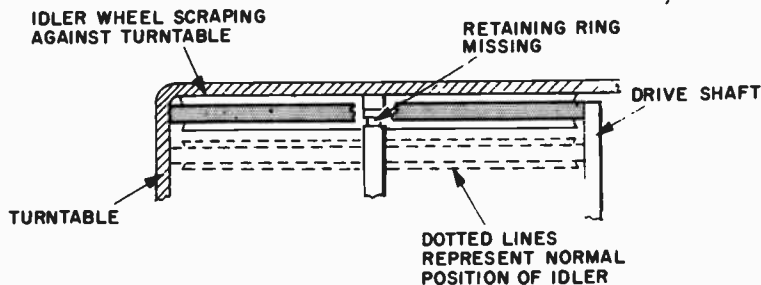


Fig. 320. If the retaining ring is missing, the idler wheel will rise and rub against the turntable.

wheels, so check these as well. Fig. 322 shows the defects that produce a noisy wheel. After a period of time, the rubber edge of the wheel will wear down, flats and indentations will develop. The indentations are usually caused by the idler wheel resting against the drive wheel over a somewhat prolonged time. The flat area on the idler wheel is caused by the turntable, and the drive shaft depresses the rubber surface on the drive wheel that is engaged. For this reason, it is recommended practice to remove the idler and drive wheels if the changer is not going to be used for a while. Merely separating the wheels may not be enough. Some of the better record changers, however, have the wheels completely disengaged in the off position so that these defects will be prevented.

Because of the formation of these worn sections, the wheels are no longer round and, when they are being driven, the worn sections thump against the other parts of the assembly. The rubber tire or wheels should be replaced.

### Rumble

The causes and effects of rumble have also been discussed in the chapter on motors. Rumble, in the drive assembly, is related to and caused by the same defects that bring about mechanical noise. However, the noise developed is not great enough to be heard at its source but, instead, is heard at the speaker. For this

reason, this trouble is difficult to isolate, and is sometimes taken care of by a method of trial and error. The idler and drive wheels should be the first parts to be replaced. After this, check the assembly using the information given under "Mechanical Noise."

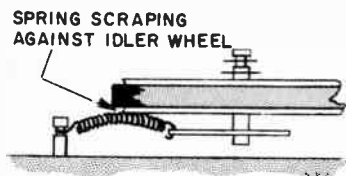


Fig. 321. A warped spring can produce noise by rubbing against the idler wheel. Do not attempt to push the spring into position, but replace it with one having greater tension.

### Turntable does not rotate

As explained earlier, this particular trouble is most common when the change cycle starts. While the record is being played, the changer may appear to be operating normally but at the end of the record, when the pickup arm is raised, the turntable stops. The part that most often causes this trouble is the rubber edge of the idler wheel. The idler rim may have worn smooth and, although there is still enough traction to operate the turntable while the record is playing, the extra pressure developed when the change-cycle mechanism is connected causes the wheel to slip altogether. Of course, the drive wheels, spring and belts can also become defective and cause this trouble.

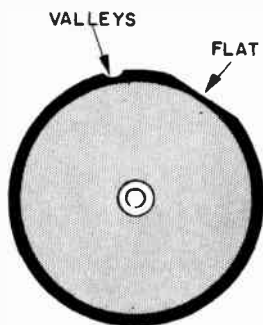


Fig. 322. Flats and valleys sometimes develop in the rubber edge or rim of the idler wheel. This can happen even if the record changer is not in use. Examine the wheel carefully to make sure that it is not out of round.

The turntable might not revolve even while the record is being played. This is just an aggravated form of the same defect and should be treated in the same way. A common trouble in the belt drive is that the belts fall off the wheels, disabling the assembly. If, when the belt is put back, it soon falls off again, then it has probably stretched and should be replaced. It will be found that most causes of slowness, if not repaired, will eventually keep the turntable from rotating at all.

# the turntable

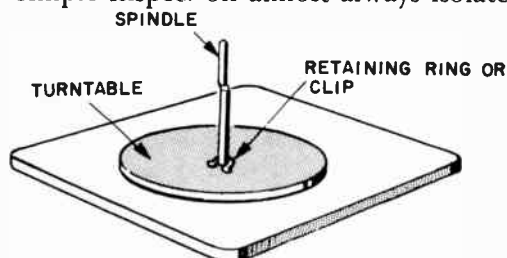
**T**HE turntable appears to be a simple device and gives the impression that very little trouble can occur to make it defective. This is true; the turntable very rarely goes bad by itself. But, due to a lack of understanding of its functions, it is often abused. It should be handled more carefully than it usually is. The first function of the turntable is to hold and rotate the record being played; this certainly needs no explanation. The second job is to rotate the record in a stable level plane. To do this, the face of the turntable must be flat so that the record will not bob up and down, causing the pickup arm to bounce. It must also be seated on the spindle so that it is level. If it is not, the pickup needle will track poorly.

A third important function of the turntable is to keep the record turning at the proper constant speed. The turntable is manufactured as a comparatively heavy mass so that it will introduce a "flywheel" effect to maintain speed even when slight intermittent discrepancies occur in the drive assembly, motor or power line. The turntable also maintains the speed by keeping the record from slipping under the weight of the pickup arm. To do this the turntable face is given a friction surface. This is accomplished by: (1) a felt pad attached to the face, (2) a rubber-tread pad cemented to the face and (3) most commonly, flock, a fur-like substance, is sprayed on the turntable. The friction surface on the face of the turntable also provides the fourth function of the turntable—cushioning records when they drop.

## Servicing the turntable

Because turntable operation is little understood, it is almost always mishandled. When a novice removes the turntable, there seems to be an irresistible urge to drop, slide or flip the rugged-looking device across the bench. Some service technicians even pound it into position on the spindle. Such abuse, naturally, affects the shape and surface of the turntable so that it will no longer function properly. The turntable should be handled with care.

Troubles caused by the turntable are easy to locate and repair. Simple inspection almost always isolates the cause of the trouble.



*Fig. 401. In this changer the turntable is held in place by a retaining ring. The ring, or clip, fits into a groove at the bottom of the spindle.*

A turntable defect can result in scraping sounds, wobbling of records, rumble, mechanical noise, slipping records, slow rotation, and wow. To inspect the turntable, remove it from the changer.

For the past few years, the turntable has been so mounted on all types of record changers that it is easily lifted off. On some changers, the turntable is held in place only by its own weight. With this method of mounting, grasp the turntable edge with the fingertips, on opposite sides, and lift it straight up over the spindle. On other types of changers, however, the turntable is held in place by a retaining ring or clip that snaps around the spindle, as shown in Fig. 401. Unclip the retainer by pulling it out of its groove on the spindle and then lift the turntable as described previously. On some older changers the main drive gear for the change-cycle mechanism is mounted on the turntable hub and prevents the turntable from being slipped out. This is shown in Fig. 402. Usually, just loosening one or two setscrews on the main drive gear will permit the turntable to be slipped out of the gear. In later record changers this main gear does not obstruct the removal of the turntable because the chassis hole around the spindle is made large enough. With some RCA 45 models, though, turntable removal is still somewhat of a problem. In these the spindle contains the record-dropping mechanism and is attached to the turntable. The parts of the change-cycle mechanism that actuate

the record-dropping mechanism, therefore, also hinder turntable removal. These parts can usually be located by simple visual inspection. Fig. 403 shows the arrangement in the RCA model

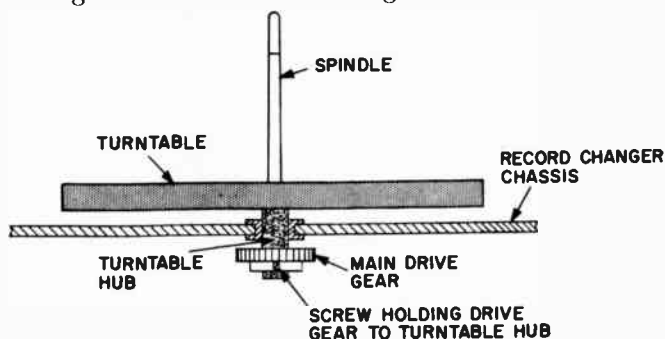


Fig. 402. The main drive gear is mounted on the turntable hub.

RP-190 Series record changer with the parts that should be loosened or removed before the turntable can be lifted off. To remove this turntable:

1. Pull out C clip. The washers, spring and ratchet wheel will come off.
2. Loosen recessed screw in friction collar and collar will come loose.

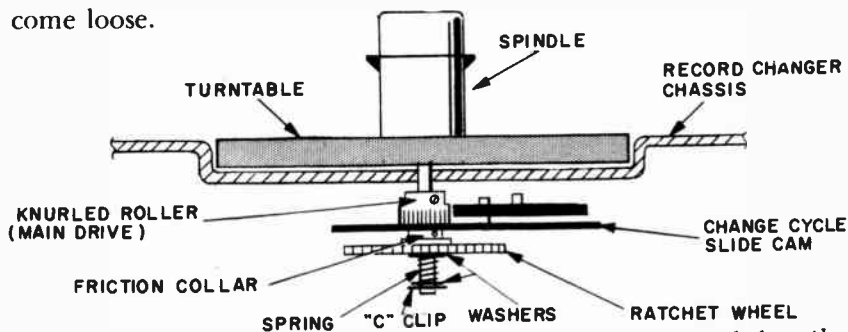


Fig. 403. The illustration shows the parts that must be removed before the turntable can be raised.

3. Loosen recessed screw in knurled roller, and turntable with spindle can be slipped out.

The standard turntable usually rides on shims or washers and on a thrust bearing, as shown in Fig. 404. If these can slip off, remove them and put in a safe place. The thrust bearing provides the turntable with smooth, low-friction rotation. The shim, or spacer as it is sometimes called, keeps the turntable at the proper height. If any of these are lost, the turntable may bind or scrape the chassis.



## Scraping and record wobble

Turntable scraping against the record changer chassis will develop not only if the thrust bearing or shim under the turntable hub is missing, but also if the turntable is not seated parallel to the changer chassis. This condition is shown in Fig. 405. It can occur if the bearing portion of the turntable center hole is worn or distorted, causing the turntable to mount loosely. It can also happen if the bearing portion of the spindle is worn or if the spindle is bent. The defective part should be replaced to make an effective repair. However, a temporary repair can sometimes be accomplished by putting an extra washer or two under the turntable hub to raise the turntable away from the changer chassis.

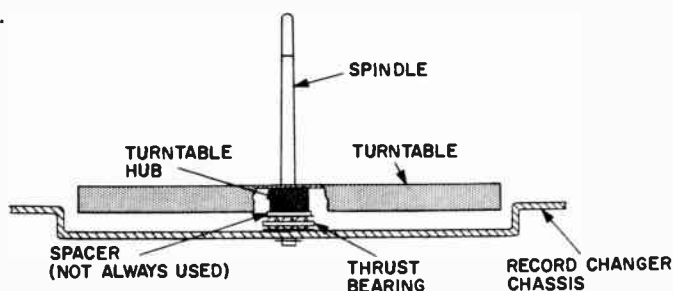


Fig. 404. *The thrust bearing permits the turntable to turn smoothly.*

Wobble usually occurs if there is foreign matter on the turntable face or if the rubber or felt pad on the turntable is distorted in some way. Keep the turntable face free of any foreign matter by continual cleaning. If the face pad is defective, try to glue it back into its normal position. However, if it is beyond repair, remove it. Sand the face of the turntable smooth and cement on a new felt or rubber pad. Remember, that warped records will wobble of their own accord, so first check the records being played.

## Rumble and mechanical noise

These troubles can occur if either the inside rim of the turntable or the bearing portion of the turntable mounting hole, is worn, scored, dirty or contains burrs. If wear is evident, install a new turntable. But, if the trouble is not due to wear, clean these surfaces with carbon tetrachloride and polish them smooth with emery cloth. Check and treat the spindle in the same manner. In most record changers the turntable hub rides on a thrust bearing. Inspect this bearing to see if it is defective in any way, and

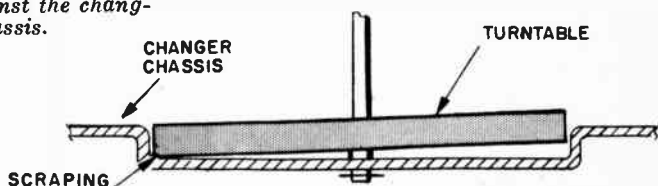
each ball bearing for worn or flat spots. Run a finger across the ball bearings to see if they rotate freely. Examine for dirt, and clean with carbon tetrachloride if necessary. See if the bearing needs lubrication.

Rumble, mechanical noise and binding can also be caused by lack of lubrication of the turntable bearing surfaces at the spindle. Lubricate these surfaces, shown in Fig. 404, with a light non-flowing grease such as Lubriplate. Be careful not to allow any of the lubricant to contact the inside rim of the turntable. This surface must be perfectly dry and clean so that it will couple the drive assembly properly.

### Records slip

This defect is rare and occurs mostly with older changers. The records slip under the weight of the pickup arm because the face

Fig. 405. A tilted turntable can scrape against the changer chassis.



of the turntable has lost its traction. This develops when the flock or pad on the turntable is worn. The unknowing layman sometimes removes this pad and doesn't bother to replace it, thinking it is only a decorative piece. Felt and rubber pads are sold for replacement purposes by most parts distributors and are easy to apply. If the turntable in question uses flock, there are two ways to repair it. Some parts distributors sell flocking kits that can be used to reflock the turntable. Most technicians, however, consider this method unnecessarily troublesome and would rather not carry the extra equipment. The turntable, then, is sanded smooth and a new pad, either felt or rubber, is cemented to its face. The easiest thing to do, of course, is to replace the turntable. Slipping of records can also be caused if the needle is worn so badly that it cuts into the record or if the pickup arm is adjusted so that it is too heavy.

### Turntable turns too slowly or causes wow

These troubles usually happen when someone inadvertently allows a lubricant to touch the inside rim of the turntable. The first thing that should be done is to clean the inside rim thor-

oughly with carbon tetrachloride. These problems can also come about because of the defects that cause other symptoms, such as rumble and mechanical noise. Therefore, if cleaning the inside rim of the turntable does not help, inspect the turntable, using the information given previously.

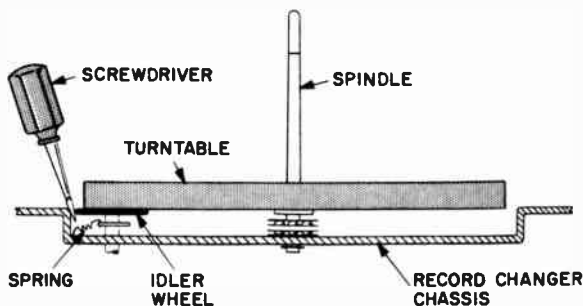


Fig. 406. *Technique for moving idler wheel when replacing turntable.*

## Replacing the turntable

Before putting the turntable back, make sure the parts it rides on, such as the shim and thrust bearing, are in place. Do not drop the turntable down the spindle; carry it down into position. Try not to force the turntable into its seating. If it will not ease in, it is probably being obstructed. Excess pressure will damage some part.

One obstruction, that will almost always be present, is the idler wheel on the drive assembly. As explained in the chapter on drive assemblies, the idler wheel is pulled against the inside rim of the turntable by a spring. When the turntable is taken off, the spring pulls the idler wheel out even farther. Therefore, when the turntable is put back, the idler wheel will be in the way. This is shown in Fig. 406, which also shows how to move the wheel clear of the turntable so that the turntable can drop into position. When moving the wheel in with a screwdriver, use the flat portion so that the rubber edge of the wheel will not be damaged.

A turntable that has a main drive gear attached to its hub may not be able to drop right into its seating because of gear mesh. Move the turntable slightly, clockwise or counterclockwise, until the gears mesh; the turntable will then slide down. If any retaining ring or clip was used to hold the turntable down put it back.

# cartridge and pickup arm

**M**ANY a service technician has voiced disgust over a callback on a repair which had seemingly been properly done, but with the customer completely dissatisfied. Service technicians are often too quick to characterize some of their customers as habitual cranks. However, even chronic complainers may sometimes be right.

The pickup arm, cartridge and needle play the most important role in the reproduction of recorded sound. If these parts do not operate well, low sound output, distortion, excess surface noise, needle-talk or needle-hopping can result. Besides the reproduction problem, there is also the expensive, premature wear of needle and records. The most important condition necessary for good reproduction and longer needle and record life is that the needle must track the record's grooves properly.

## Tracking

Tracking is the term that denotes the manner in which the needle rides in the record's grooves. The needle tracks properly only when it applies equal pressure to both walls of the groove, does not touch bottom and follows the groove excursions faithfully. A needle point properly tracking the groove is shown in Fig. 501-a. Note its even seating; a needle riding a groove in this manner will provide good reproduction and longer life for the needle and records. If the needle tracks as shown in Fig. 501-b and Fig. 501-c, however, needle-talk, distortion and surface noise

will result, and needle and records will be short-lived. The manner in which a needle tracks is dependent mainly on three things: (1) tangency, (2) lateral freedom, (3) turntable leveling.

### Tangency

This is by far the biggest problem associated with tracking. Although a design problem for the manufacturer, it has also

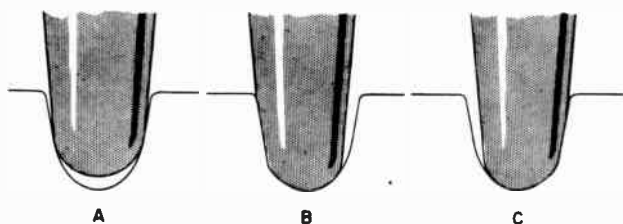


Fig. 501-a,b,c. Proper needle tracking (a) and incorrect tracking (b and c).

become a great consideration of the hi-fi enthusiast who sets up his own record player. If you have sometimes wondered why pickup arms have such varied sizes and shapes, it is because of the attempts of manufacturers to achieve better tangency. There

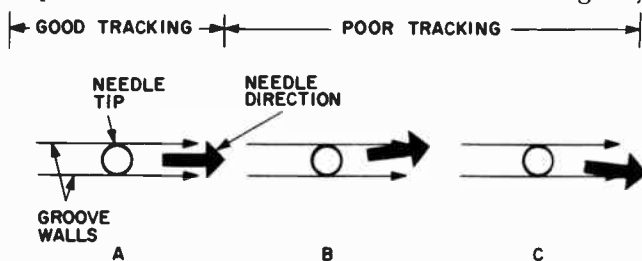


Fig. 502-a,b,c. Correct needle tangency (a) means good tracking. Poor tracking results from the conditions shown in b and c.

is a definite reason why this problem of tangency is so great. The only time a pickup needle can be properly seated in a moving groove is when the needle is facing in a direction tangent to the record's groove. Any rotating point applies a force in the direction of its tangent and so also do both walls of a turning groove. If the needle is in tangency, as shown in Fig. 502-a, the force of each wall is applied equally and slightly to each side of the needle. If the needle direction differs, as shown in Fig. 502-b and Fig. 502-c, a heavy force is applied by the wall it is opposing. The conditions of Fig. 502-b,c bring about the seating shown in Fig. 501-b,c.

The needle direction can be obtained by drawing a hypothetical line from the pickup arm pivot through the needle tip, as shown in Fig. 503. When this line is perpendicular to the radius of the record, it coincides with the tangent of the groove. Unfortunately, this line can be perpendicular only at one point because the pickup arm swings an arc from the start to finish on the record. Therefore, we cannot attain perfect tangency with a pivoted pickup arm. Proper design can minimize the tracking-error angle to a point where it may be considered negligible. As shown in Fig. 503, tracking-error angle is the angular difference between needle direction and the tangent of the groove.

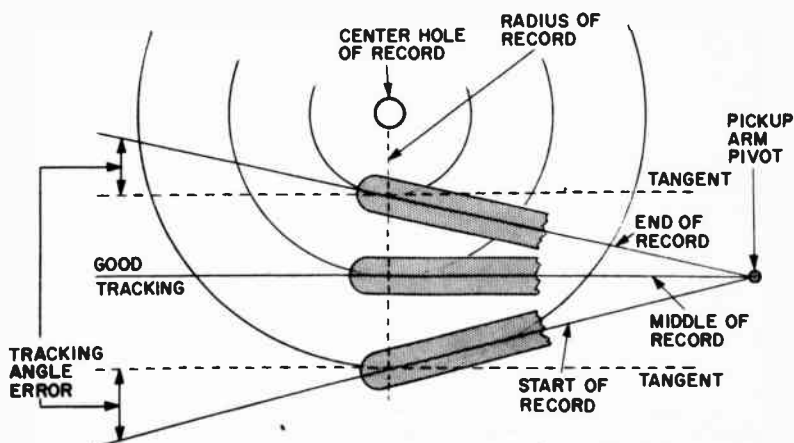


Fig. 503. Illustration above shows how tracking angle error is measured.

The first method used to keep the angle small is to pivot the arm properly. If the pickup-arm swing across the record produced a tracking-error angle change of  $5^\circ$  and the arm was set in tangency at the start, there would then be a  $5^\circ$  tracking error at the end of the record. With a simple design change this error can be cut in half. If the pickup arm is pivoted so that it is in tangency at the middle of the record, there would be a  $-2\frac{1}{2}^\circ$  tracking error at the start of the record and a  $+2\frac{1}{2}^\circ$  error at the finish. Although there is still a  $5^\circ$  change across the record, the maximum error was reduced to  $2\frac{1}{2}^\circ$ —certainly much more desirable.

Another method of reducing the error is the use of a long pickup arm. With a longer arm, the needle travels a smaller arc across the record and so produces a smaller tracking-angle change. An offset cartridge and an "overhang" are two other methods of reducing the arc and, therefore, the tracking error. Fig. 504 shows

a pickup arm with an offset head and the amount of overhang normally used (around  $\frac{3}{8}$  inch). The pickup arm shown in Fig. 504 is one method of offsetting the cartridge. Sometimes the entire arm is curved to produce an offset or a straight arm can be used with the cartridge mounted in an offset position.

Although it is not always practicable, some service technicians attempt to use a substitute pickup arm, either to save time or money. Usually the result is the introduction of excessive tracking error which causes distortion, needle-talk and an overly amount

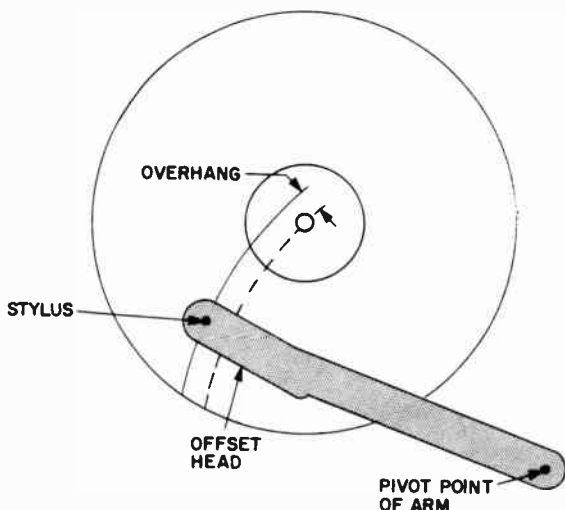


Fig. 504. *Pickup arm with an offset head.*

of record and needle wear. The pickup needle also affects the tangency problem from the aspect of overhang.

### **Lateral freedom**

We have previously explained that both walls of the groove must carry the needle for perfect tracking to exist. Therefore, the pickup arm should follow the groove with ease; it should not resist the carrying force of the groove. Fig. 505 gives a simplified basic example of how every pickup arm is pivoted. The arm is attached to a shaft which serves as its pivot. This shaft, turning with the arm as the arm travels across the record, is round and smooth; it rotates within a bearing surface so that friction is minimized. These surfaces must be kept smooth, clean and lubricated to keep friction at a minimum. If the arm did resist the

carrying force of the groove, the needle tip would ride up the groove wall as shown in Fig. 501-c. To prevent this, clean and lubricate the pickup arm shaft regularly and keep it clear of foreign matter.

Sometimes a tight tripping mechanism can retard the arm movement and even cause it to skip back a groove or two. How-

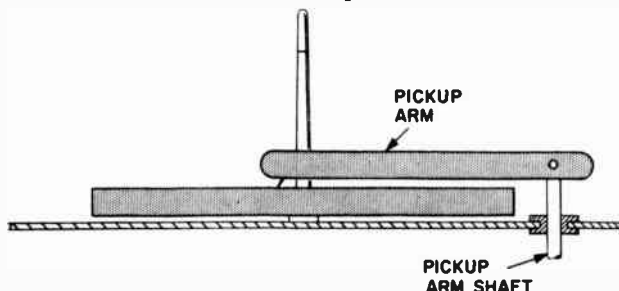


Fig. 505. The pickup arm must follow the carrying force of the grooves.

ever, this trouble is usually present over only the last half of the record and will be accompanied by erratic tripping operation.

### Turntable leveling

The pickup needle can be properly seated in a groove only when its downward pressure is applied perpendicular to the plane of the turntable. For this to happen, the turntable and record changer chassis must be level. If they are not, the needle will

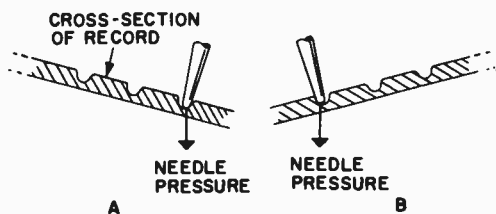


Fig. 506-a, b. The pressure of the needle should be perpendicular to the plane of the record.

ride the grooves as shown in Fig. 506. This will also bring about the improper seating shown in Fig. 501-b, c. A standard bubble level should be used across the record changer width and depth to see that it is horizontal. If it is not, adjustments can be made to level it.

When the changer is shipped from the factory, the chassis is usually secured to the mounting base with three bolts and spiral springs, as shown in Fig. 507. When it is first installed, unscrew these bolts so that the springs are completely free to act as shock absorbers. The changer chassis is thus float-mounted so that it



will not pick up vibrations. On some changers the bolts must be removed entirely for the springs to act properly. On others the threads do not cover the entire bolt so the bolt is turned until it has no effect. Fig. 508 shows three other methods of shipping the record changer.

After the changer is float-mounted, though, it may not be level. Fig. 509 shows one method of adjusting turntable leveling. After

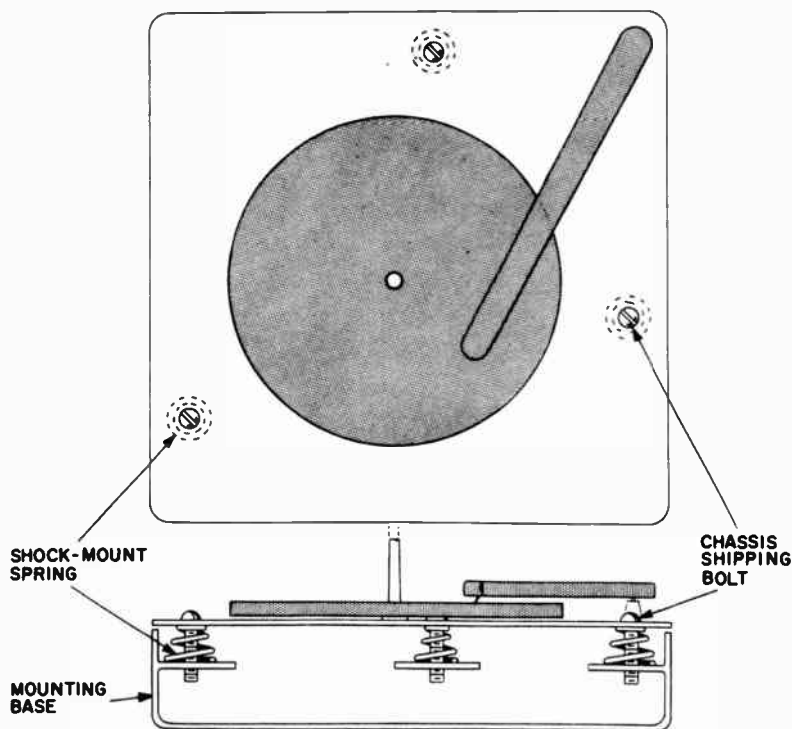


Fig. 507. This illustration shows how the automatic record changer is ordinarily shipped by the manufacturer. The chassis is fastened to the mounting base by bolts and springs.

using the bubble level to determine which side is low, raise that side the proper amount. As Fig. 509-b shows, shim washers can be placed at the top or bottom of the spiral spring to raise the side. Some people have recommended stretching or compressing the springs to adjust the position of the changer chassis, but doing this to spring steel is easier said than done. If the record changer is a "portable," shims can be placed between the base and the surface it rests on. With larger units, shims can be placed under the corners of the cabinet.

## Weight (needle pressure)

Needle pressure is another factor in reproduction and record and needle wear. All pickup cartridges require a definite pressure to give optimum performance. (Different cartridges require different needle pressures; this information can be obtained from the manufacturer. By using the cartridge model number, the required pressure can also be found in distributors' catalogs.)

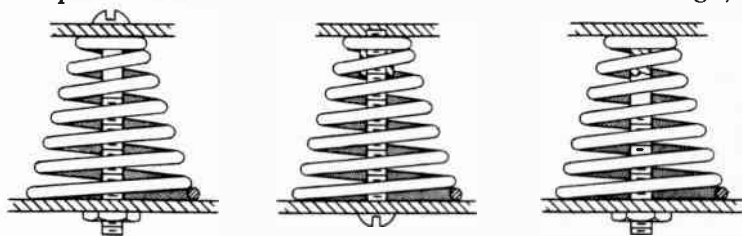


Fig. 508. Three different methods used for fastening the changer preparatory to shipping.

The weight of the pickup arm affects cartridge output. Too much pressure causes signal amplitude distortion since the needle, under high pressure, attains a high-inertia characteristic and cannot follow the groove swings faithfully. If, on the other hand, the arm is too light, not enough force will be applied to the needle by the groove for it to excite the cartridge sufficiently; this will bring about reduced signal output.



Fig. 509-a,-b. If one or more corners of the chassis are not high enough (a) shim washers can be added (b).

Excess weight will also cause the needle tip to apply too much pressure to the groove walls. If a hard-point needle such as diamond is used, records will wear prematurely. However, if a short-life needle is employed, both the needle and record will wear excessively. If the arm is too light, it will not be able to ride over any vertical modulations that may exist on the groove; it might bob up and down and could skip grooves.

With ideal conditions there should be no vertical modulation

on a popular recording; the record's grooves contain lateral modulation. However, due to the physical shape of the cutting stylus, a vertical modulation is produced in the form of a changing groove width, commonly called *pinch effect*. See Fig. 510. The cutting stylus has a flat edge that cuts the groove. This cutting edge always faces in the same direction, even when the stylus swings laterally. When the edge is facing in the same direction as the groove travel, as shown in Fig. 510-a, the width of the groove will be the same as the width of the cutting edge. If, however, the cutting stylus swings laterally, the edge will not be facing in

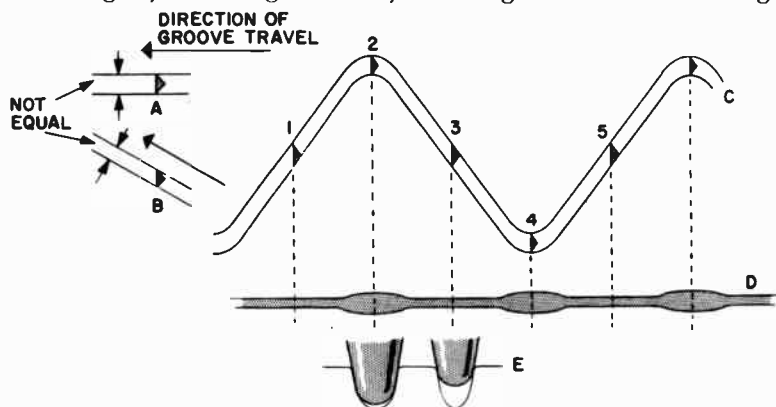


Fig. 510 a to e. The shape of the record cutting stylus produces vertical modulation.

the same direction as the groove travel. The width of the groove then decreases, as shown in Fig. 510-b. When the stylus is cutting a modulated groove, it swings laterally from side to side, as shown in Fig. 510-c, continually changing the direction of groove travel. When cutting this sine wave, it produces two width changes, as shown in Fig. 510-d. (The groove in Fig. 510-d is shown straight so that the width change will be demonstrated more clearly.) When the needle rides this groove, it will rise and fall, as shown in Fig. 510-e. Because this width change occurs twice to every sine wave it will produce second-harmonic distortion if the pickup arm is heavy enough to compel the cartridge to reproduce it. Better cartridges are designed to discriminate against pinch effect, but, even if the cartridge did not produce the unwanted signal electrically, needle-talk would probably be caused or, perhaps, pickup arm vibration.

The ability of the arm to ride over the vertical modulation of the groove is known as *vertical compliance*. A factor affecting

vertical compliance is pickup-arm hinging (also known as *swiveling*.) The pickup arm is hinged at its shaft so that there is minimum friction, allowing the arm to move up and down freely with the pinched grooves. If there is excessive friction at the hinged point, the tendency of the arm to rise will be retarded and the arm will act as if it were too heavy.

To sum up: the weight of the pickup arm affects automatic record changer operation in the following ways:

If the arm is too heavy, causing excessive needle pressure, (1) signal amplitude distortion will result, (2) second-harmonic distortion will develop, (3) needle-talk and arm vibration may be caused and (4) records and needles will wear prematurely.

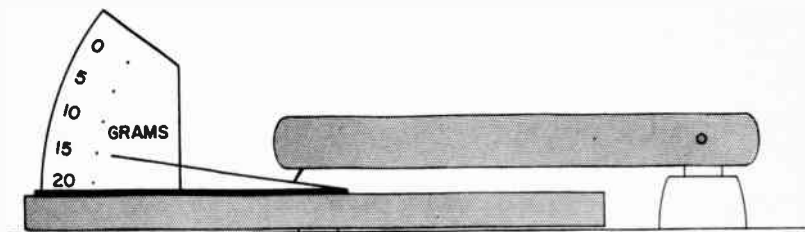


Fig. 511. Technique used for measuring needle pressure.

If the arm is too light, causing insufficient needle pressure, (1) signal amplitude will be too low and (2) the arm may bob up and down, skip grooves or slide across the record.

### Adjusting needle pressure

Since improper needle pressure has such a damaging effect, check it at every opportunity and certainly when any repair or replacement is made that is associated with the arm; specifically when the pickup cartridge is replaced. Needle-pressure gages are sold by parts distributors for just this purpose. These gages normally indicate pressure in grams though some also give it in ounces. Cartridges, however, are usually rated in grams: about 10 to 15 grams for standard-speed and around 5 grams for long-playing cartridges. Dual-speed cartridges try to strike a happy medium, usually around 8 grams. The needle-pressure gage is simple to use, as illustrated in Fig. 511.

Up to 15 grams is considered very little pressure. The ordinary pickup arm and cartridge, when hinged to the pickup arm shaft, will apply more pressure than that if not counterbalanced. A plain, simple hinge arrangement is shown in Fig. 512. The

hinge pin (sometimes called the *swivel pin*) passes through the pickup arm and the arms on the hinge bracket. The pickup arm, as the arrows in Fig. 512 show, is then able to move freely around this hinge. Some of the inexpensive phonos use the setup shown in Fig. 512 without compensating for the excessive weight of the arm with a counterbalancing device. As a result, the arm is much too heavy. To counterbalance the arm, either springs or weights are employed by manufacturers. The advantage in using a weight to obtain proper needle pressure is that there is very little chance of the weight changing; with a spring, tension changes with time. On the other hand, spring counterbalancing has the advantage

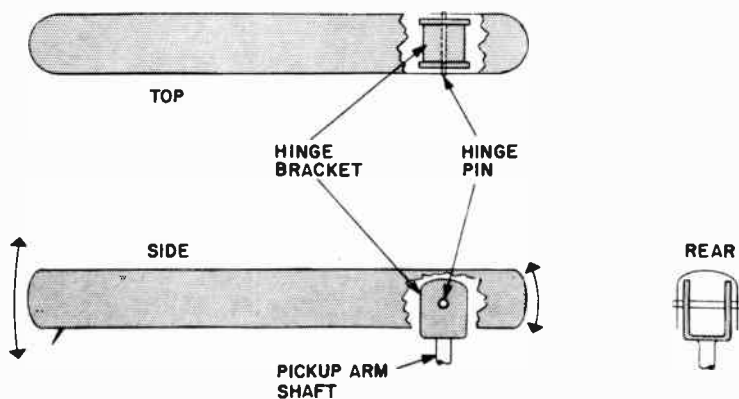


Fig. 512. Typical arrangement for hinging pickup arm to pickup arm shaft.

of being more easily adjustable. This is of particular importance when the cartridge is replaced with a new type that alters the required needle pressure considerably.

On some changers and single-record players, the arm is so designed and hinged that proper needle pressure is produced by a static balanced condition. Extra weights are not used. If the cartridge in this arm is replaced with a type that causes an improper needle pressure to exist, then the problem of producing the right pressure is a difficult one. Small weights (lead or a similar metal) can be put at various locations on the arm so that it will be properly counterbalanced, but mounting them definitely is a problem. If a weight is attached to the arm in front of the hinged point, more needle pressure will be applied. If it is placed after the hinge, less needle pressure will result. To find the proper point, the pickup arm should be set on a needle-pressure gage; as shown in Fig. 511, so that existing pressure can be observed.

The weight should then be placed on top of the arm and moved back and forth to increase or decrease the pressure until the proper amount is approximated. Mark off this point and attach the weight under the arm with a good adhesive; then check the weight again.

The previous procedure can also be used with pickup arms that are designed with counterbalance weights. A simplified version of

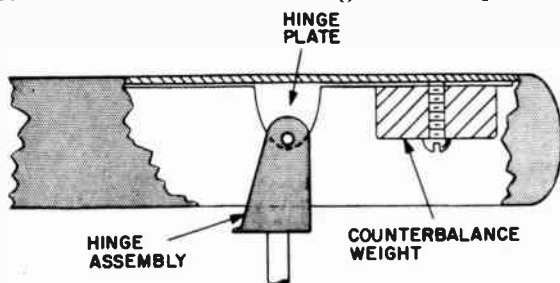


Fig. 513. Counterbalance is positioned as shown above.

the Admiral RC600 changer, which utilizes a weight, is shown in Fig. 513. The RCA 45 series employs a similar weight. Although the problem is still difficult if a large adjustment is required, smaller adjustments are easier to make. Adding a little more

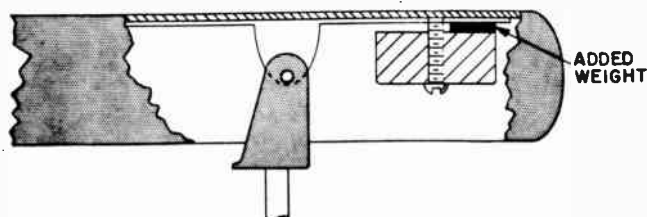


Fig. 514. A weight can be added to reduce needle pressure.

weight to the counterbalance will make the pickup arm lighter; adding the weight to the cartridge will make it heavier. For example, if we change the cartridge and the needle pressure becomes too heavy, we can take out the screws holding the counterbalance and place an additional weight over the counterbalance. Securing it back in place with the screws, the added weight will also be held firmly. At times, longer screws may be required because of the added thickness of the new weight. This can be seen in Fig. 514. If a slight increase—say, about a gram—in pressure is desired, a washer or a combination of washers can be added above the cartridge in the same manner.

Because of its hit-or-miss nature, adjusting the needle pressure of an arm that is counterbalanced with weights can be somewhat of a tedious job. Hence it is recommended practice to use the same type of cartridge so that counterbalancing will not be upset.

To simplify the problem of obtaining proper needle pressure for so many different cartridges, spring counterbalancing is employed. Despite a few variations, its basic operation is the same: the spring pulls or pushes the arm in opposition to the weight, cancelling just enough to obtain proper needle pressure. If we increase or decrease the tension of the spring, the pickup arm weight and needle pressure will be changed.

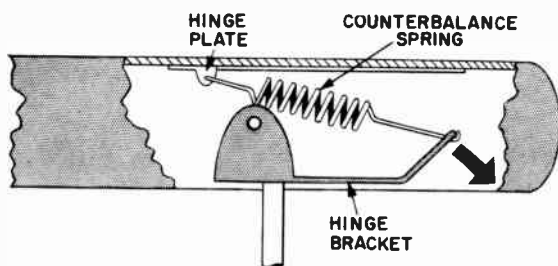


Fig. 515. *Spring counterbalancing technique.*

The spring method commonly employed in single players is shown in Fig. 515. Hinging here is the same as shown in the basic arrangement of Fig. 512, except that the hinge bracket has an extension lip that holds one end of the spring. The other end is connected to a plate firmly attached to the pickup arm. This spring counteracts the weight of the arm. The resultant arm weight or needle pressure is the difference between the actual weight and spring tension. If we bend the lip on the hinge bracket in the direction shown by the arrow in Fig. 515, spring tension will increase and needle pressure will decrease. Bending the lip in the other direction will raise needle pressure. It takes a very slight bending to cause considerable change in needle pressure. Make the bends *very slight*, in successive steps, until the proper pressure is obtained.

A variation is shown in Fig. 516. The main difference is the placement of the spring. Its operation is exactly the same as the one illustrated in Fig. 515. The arrow indicates the direction to bend the lip to increase spring tension and reduce needle pres-

sure. The hinge arrangement in Fig. 516 is different. Instead of using a hinge pin to pass through the pickup arm and hinge bracket, two cone-point screws are used. (These are sometimes

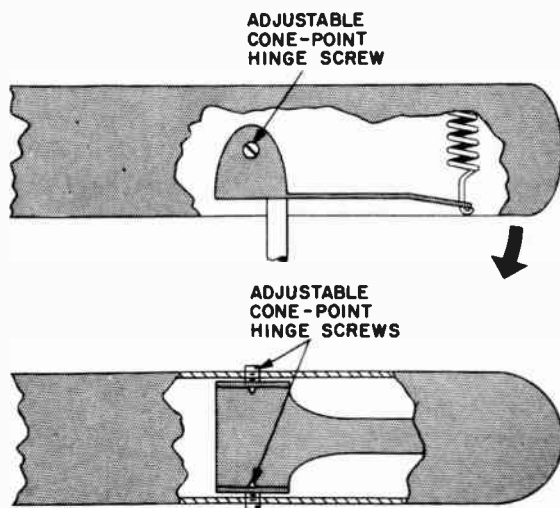


Fig. 516. This arm uses adjustable hinge screws.

called *cone-point pivot studs*.) These screws thread into the arm and their cone points seat in holes in the hinge bracket. The arm swivels around the points. These screws are adjustable so that

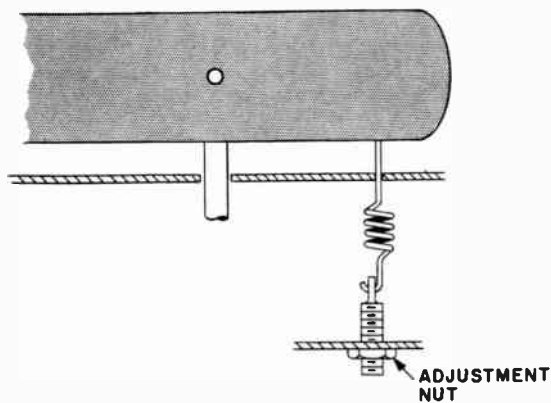


Fig. 517. Adjustable spring counterbalancing method.

freedom of movement of the pickup arm on the hinge assembly can be more accurately set. They are adjusted so that the arm can move freely up and down without too much play. Excessive play



will result in arm tilt and improper needle tracking. If these screws are turned in too far, they will press too tightly against the hinge bracket and prevent the arm from riding over the grooves' vertical modulation.

The spring counterbalance arrangement of Fig. 517 places the spring tension between the rear of the pickup arm and the record changer chassis. From the arm, the spring passes through a hole in the chassis to a threaded lug attached to a mounting with a nut. Pulling down on the lug and turning in the nut, increases spring tension and decreases needle pressure. If we back

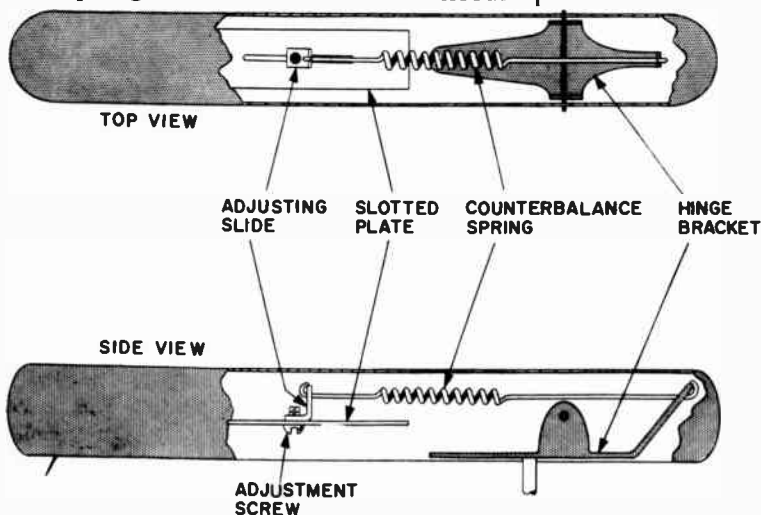


Fig. 518. Another adjustable spring counterbalancing method.

off the nut, an increase in needle pressure results. This method of counterbalance is desirable because adjustments can be made more accurately and simply; there is no need to bend a part back and forth until the proper pressure is obtained.

Another method of spring counterbalancing that facilitates adjustment is shown in Fig. 518. The rather long counterbalance spring passes from the hinge bracket to a mounting lug (called an *adjusting slide*) toward the front of the arm. This mounting lug is held to a slotted plate by a screw. In some changers, this plate also serves to strengthen the arm. The screw holding the adjusting slide in place can be loosened so that the slide can be moved back and forth along the slotted plate. Moved toward the front of the arm, the spring tension will increase and the needle pressure will decrease. Moving it to the rear causes the opposite to occur. The hinging in Fig. 518 shows a hinge pin being used; in

some changers a cone-point pivot screw is used so that hinging can be adjusted.

Webster-Chicago (Webcor) employs a spring counterbalance which differs considerably from other types. Previous methods used spring tension to pull against the arm weight whereas, as shown in Fig. 519, Webcor has the spring push against the arm to obtain the proper needle pressure. This spring is coiled and is part of a shaft assembly that attaches to the hinge bracket. The spring has an extension that connects to a hinge plate firmly attached to the arm. Therefore, when the arm weight pushes down, it is opposed by the extension of the spring which pushes back, thus

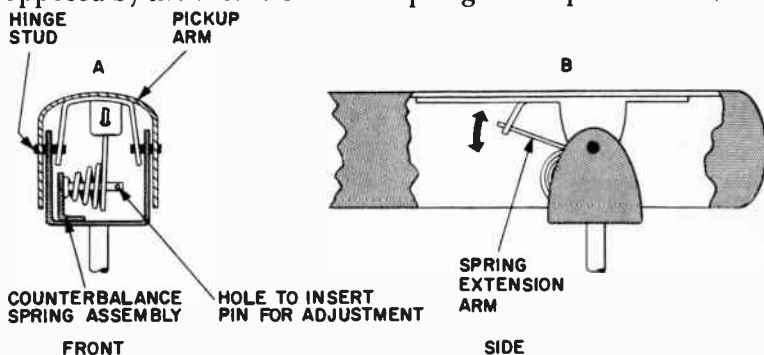


Fig. 519-a, b. Front and side views of pickup arm showing counterbalance spring adjustment.

counterbalancing the arm weight. The spring assembly shaft can be turned, providing a means of adjusting the spring pressure. A thin metal rod can be placed in a hole (Fig. 519-a) to turn the shaft in either direction. This will move the spring extension up or down as shown by the arrows. If moved up, needle pressure will be reduced. Moving it down will increase pressure. The hinge arrangement is also somewhat different. Instead of a single hinge pin, two separate hinge studs are used. On some models an adjustable cone-point screw is used on one side so that hinging is adjustable.

### Pickup cartridge

The cartridge is the element that produces the electrical signals to be used by the amplifier and is responsible to a large extent for the lifelike quality of the sound. The value of the cartridge is determined mainly by two factors—output and frequency response. Unfortunately, these are generally inversely proportional; that is, a cartridge with wide response has low output and one with high output has poor response.

There are many forms of pickup cartridges—crystal, magnetic, ceramic, strain-sensitive, frequency modulation, etc. The first three are the most popular. The crystal, probably the most common type, enjoys extensive use with inexpensive single-record players because its output is on the order of a couple of volts, permitting the use of a low-gain amplifier. Such cartridges have poor treble response, limiting their use with better music systems. The magnetic pickup has a very good treble response (some magnetic cartridges extend beyond the audio range), but its output is low, generally rated in millivolts. Because of this, the audio amplifier must have high gain (invariably, a preamplifier stage is employed). The ceramic cartridge, relatively new, is gaining in popularity because it strikes somewhat of a happy medium. It has a frequency response that goes up to between 10 to 15 kc and produces an electrical signal of around 0.5 volt.

Another factor determining the desirability of cartridges is their response to vertical modulation. We do not want the cartridge to reproduce such modulation and efforts are made in most cartridge designs to minimize this problem. Crystal and ceramic cartridges employ a viscous damping agent between the needle and the sensitive element to prevent the torque from being applied to the element. This does help but the difficulty still exists. Some magnetic cartridges, such as the variable-reluctance type, eliminate this problem almost entirely.

Cartridges are rated to operate with specific needle pressures. It deserves repeating that this pressure should be checked periodically. With crystal and ceramic cartridges, the lateral motion of the needle applies a torque to the sensitive element which, in turn, because of piezoelectric effect, produces a corresponding electrical signal. Too much pressure will cause the needle to overdrive the element producing distortion. Too little pressure, though, will present a low torque to the element resulting in low signal output. Magnetic cartridges employ the needle to control a magnetic field to induce the signal voltage in the cartridge windings; too little or too much needle pressure, however, has the same effect.

When replacing the cartridge, either because it is defective or improved performance is desired, check the characteristics of the new unit to see that it will perform as well or better than the old one. If you use an exact replacement, no problems should be encountered. If another type is used, watch the following: (1) signal output, (2) frequency response, (3) output impedance,

(4) needle pressure required and (5) mounting considerations.

### **Signal output and frequency response**

If the new cartridge has a higher output than the old one, no trouble should develop. If the output is lower, though, trouble may result, depending on how much lower it is. If the loss is slight, turning up the volume control should make up for it. If the output is considerably lower—as when a magnetic cartridge is used in place of a crystal cartridge—check the amplifier gain characteristic to see if it can handle the small signal. Most often a preamplifier stage will have to be added. Separate preamplifiers are sold for this purpose and usually a matching unit can be obtained for the magnetic cartridge in question.

The frequency response is improved most when a magnetic cartridge is used. Of course, the strain-sensitive and FM pickups also give good results, but they are considerably more expensive to use because of the auxiliary circuits required. It does no good to use a cartridge that has a wider frequency response than the amplifier, so the amplifier response can be used as a guide. Many cartridges are rated for frequency responses that are produced only with the proper equalization circuit. These circuits correct the cartridge response curve to that of the recording curve so that a relatively flat response is obtained. Some preamplifiers themselves perform the equalization function. If not, attachments can be obtained that provide different settings for the various recording standards. If, for some reason, a crystal or ceramic cartridge is used to replace a magnetic cartridge, these equalization circuits will have to be altered or bypassed else the frequency response will be greatly changed.

### **Output impedance**

The output impedance of the cartridge is important because it must match the amplifier's input impedance to get an efficient transfer of signal. Crystal and ceramic cartridges are high-impedance devices; the magnetic cartridge, however, has a low output impedance. Usually, when a magnetic cartridge and preamplifier are used to replace the crystal cartridge, the preamplifier matches the impedance of the new cartridge to the amplifier. When a crystal or ceramic cartridge replaces a magnetic unit, though, the input impedance of the amplifier should be increased. This can be done by changing the grid resistor of the input stage to around 250,000 ohms. Since this input stage may be a preamplifier with equalizing networks, it may be wiser to bypass the preamplifier

and connect the signal directly to the following stage, which usually has a high-value grid resistor.

### Needle pressure

Whenever the cartridge is replaced with a new type, the needle pressure will almost always have to be adjusted. Even if the substitute is rated for the same needle pressure as before, its weight is probably different and so the counterbalance will be altered. It is safest to use an exact replacement if the pickup arm does not provide a needle-pressure adjustment.

### Mounting considerations

Not all pickup cartridge mounts are the same. Fig. 520 illustrates a typical cartridge mounted in a pickup arm. The two

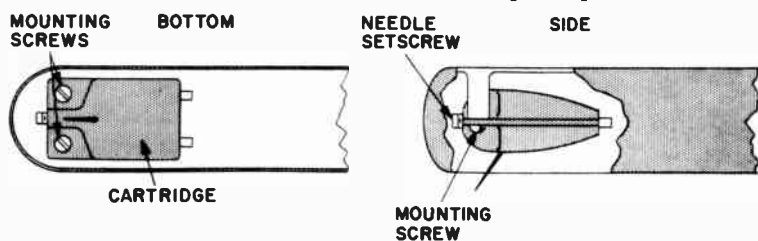


Fig. 520. Cartridge mounted in a pickup arm.

screws thread into the arm to hold the cartridge securely. Turning out these screws permits the cartridge to come out. The two mounting holes in the arm are a definite distance apart; the holes in the new cartridge should be spaced the same distance. Some replacement cartridges are designed for use with a couple of mountings; an adapter plate is supplied to solve the problem of the holes in the cartridge not matching the arm. This plate attaches to the arm, and the cartridge, in turn, is secured to the plate.

The miniature type setscrew shown in Fig. 520, locks the needle in place. Some cartridges are supplied instead with a long thumbscrew that protrudes through an opening in the front of the arm. If an arm does not have this opening, the thumbscrew can be taken out and a small setscrew put in its place. Some cartridges will be too large to use, while others may mount too deep in the arm and prevent the needle from reaching the record.

Dual-stylus cartridges present replacement problems because of the different methods used. Fig. 521 shows three methods of changing from the 78 to the 33-1/3 and 45 needles. Fig. 521-a

is the popular turnover cartridge that has two separate needles, one on top and one at the bottom. Turning the lever turns the entire cartridge over. Fig. 521-b is an example of a dual-point cartridge. When the knob is pressed and turned, the needle point at the rear of the cartridge is swung around to the front, and, since the other needle point is diametrically opposite, it is moved to the rear. Fig. 521-c shows a dual-point cartridge with both needle points at the front. Shifting the lever in the direction of the arrow tilts the cartridge so that the forward point is lower

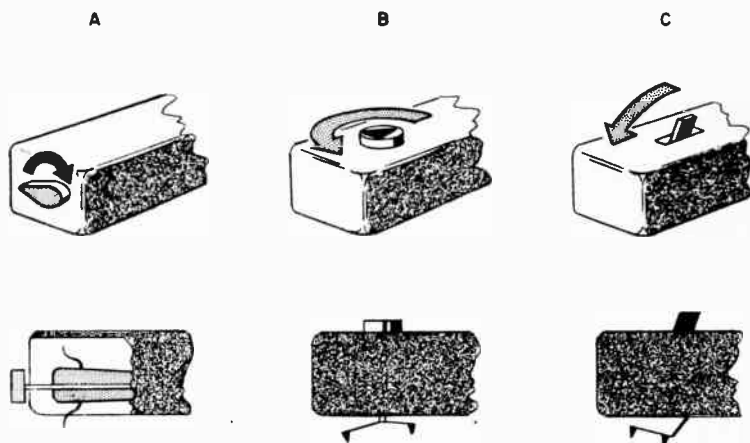


Fig. 521-a,-b,-c. Three methods of changing from 78 to 45 and 33½ needles.

and contacts the grooves. When the lever is tilted back, the second point will be lower. These three cartridges will not readily replace each other unless holes are drilled in the arm.

### Pickup needle (stylus)

The pickup needle transfers the record's groove swing to the cartridge, which then produces a corresponding electrical signal. The quality of the signal is dependent as much, if not more, on the condition of the needle as on any of the factors previously discussed. The needle must faithfully track the record's grooves to obtain good tonal quality. But, the needle cannot do this if worn out of round and unfortunately the ordinary needle wears down rather rapidly. Although not too evident, the needle tip handles a comparatively tremendous pressure during record playing. The tip travels about a half mile during the playing of a 12-inch LP record and, although the actual pressure applied by the arm may be about 5 or 6 grams, the contact area of the needle is

so small that the equivalent of a few tons of pressure is present. Under this pressure, both needle and record will wear. The pressure, however, is distributed over the entire record whereas only the small contact area of the needle tip must carry the burden.

Under this great pressure, the needle tip will soon wear so that it is no longer symmetrical. When this happens, it increases its wear on the record, deteriorating the sound. Since reduced sound quality does not become noticeable until the needle is in poor condition, the records it rides on can be worn to such an extent that they become the weak link in a hi-fi setup. Because of this, check the needle periodically. A needle tip may look good to the



Fig. 522-a,-b. Good needle (a) and worn needle (b).

naked eye, but badly worn spots may be evident under a magnifying lens. Both a good and a worn tip are shown in Fig. 522. The needle manufacturers recommend that the osmium-tipped (metal) needle be replaced after around 15 hours of playing time and that the sapphire-tipped (jewel) needle be used only for about 40 hours. The diamond-tipped needle can be used for over 1,000 hours. Although the diamond is initially much more expensive, it is economical in the long run.

The standard (78) needle has a 3-mil tip, and the microgroove (33-1/3 and 45) a 1-mil. Some service technicians have been known to interchange these needles. The result is shown in Fig. 523. The microgroove needle rides the floor of the standard groove and does not follow the groove walls faithfully; this results in distortion, needle-talk and surface noise. The standard needle rides too high on the microgroove walls and has a tendency to skip or skate grooves. This improper use of needles is particularly associated with record changers that utilize only one needle for all three speeds. This needle is neither 1- or 3-mils; it is a compromise (2 or 2.3 mil) or a truncated needle. Using a standard or microgroove needle in its place will bring about one of the conditions shown in Fig. 523. The truncated needle is shown in a standard groove and microgroove in Fig. 524.

## Needle alignment and replacement

A misaligned needle can cause the same trouble as an off-level turntable. Alignment can be checked as shown in Fig. 525. A mirror is placed on the turntable and the pickup needle is placed on the mirror. The needle and its mirrored image will form a

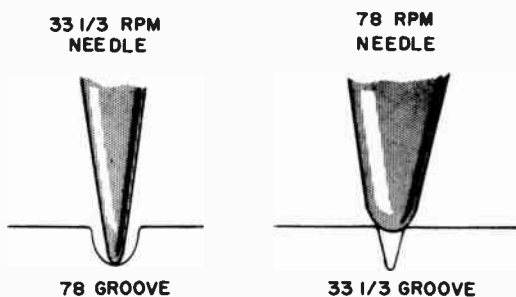
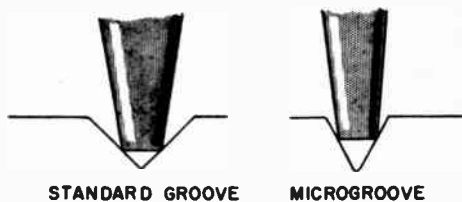


Fig. 523. *Effect of incorrect use of styli.*

straight line if properly aligned. If the line is not straight, check for a bent or loosely mounted needle. Straighten the needle or use a new one. Loosen the needle-mounting setscrew and reposition the needle. If the needle is good, check the pickup arm hinging. If adjustable cone-point hinge pivots are used, they may be loose, causing the arm to tilt. Adjust the points so that they hold

Fig. 524. *Some cartridges do not have provision for interchanging needles and use, instead, a single needle for all three speeds. This is a truncated needle, as shown in the illustration at the right.*



the arm more firmly (do not make them too tight). If this cannot be done, use paper or thin cardboard shims between the cartridge and the pickup arm to tilt the cartridge and align the needle.

The replaceable needle is attached to the cartridge in three basic ways. The most popular (Fig. 526-a) is the needle that is locked in place with a setscrew. These screws come in a variety of sizes and are sometimes long thumbscrews. Loosening this screw permits the needle to be slipped out. The push-in type is shown in Fig. 526-b; the needle shank is merely pushed into a tube (chuck). A slight pull will release it. A variation of this is the slip-on needle that has a tubular shank that slips onto a stem. The



needle shown in Fig. 526-c has a threaded end that protrudes through the top of the cartridge. A nut secures the needle in place. To remove this needle, the cartridge must first be taken out of the arm and the nut then taken off.

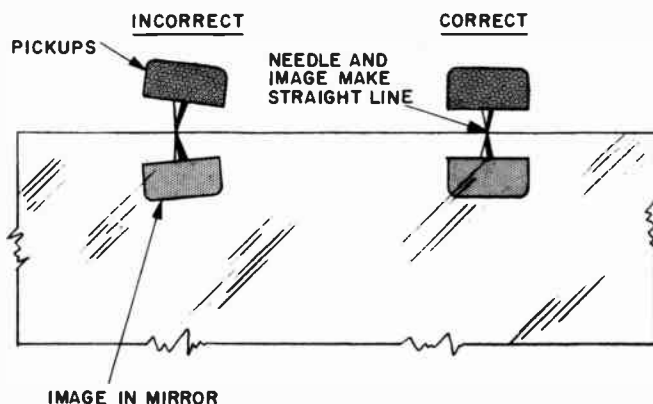


Fig. 525. Technique for checking needle alignment.

Some cartridges are designed with a permanently attached needle. The entire cartridge must be replaced if the needle is

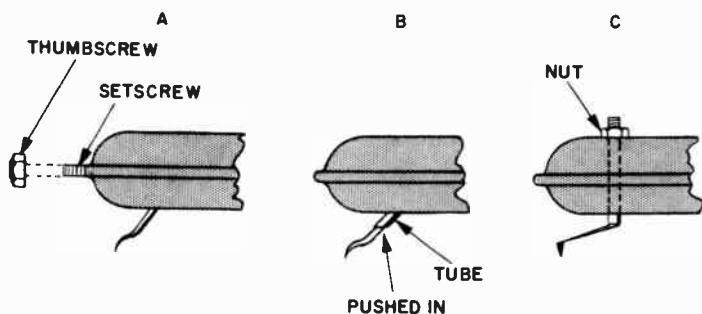


Fig. 526-a,-b,-c. Three methods of replacing a needle.

defective. An important point to consider when the needle is replaced is overhang. If the new needle is of a different shape overhang can be changed to the degree where it may increase tracking error. This is illustrated in Fig. 527.

### Servicing pickup arm, cartridge and needle

Here is a summary of previously analyzed defects and servicing considerations. When a record changer or player: (1) causes the record or needle to wear excessively, (2) causes the pickup needle to skip or skate grooves, (3) causes annoying needle-talk, (4) has

excessive surface noise, (5) has poor sound quality or (6) has low sound, do the following:

1. Check the needle point to see if it has worn beyond usable limits. Use a magnifying lens for a more accurate inspection. Clean the needle point.

2. Make sure the needle is held properly and securely in the cartridge and that the needle is aligned. The cartridge itself should be mounted firmly.

3. See that the proper needle is being used. Use a 1-mil needle for microgroove records, a 3-mil for standard records, and a com-

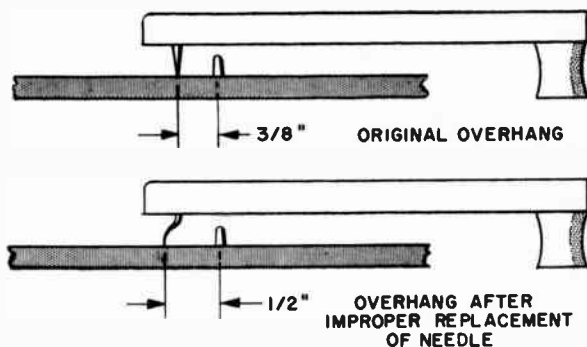


Fig. 527. *Incorrect needle replacement can result in change of overhang.*

promise (2- or 2.3-mils) or truncated needle for all speeds. Needle size can be determined by comparing it to a stocked needle under a magnifying lens.

4. Check and adjust needle pressure according to the cartridge being used.

5. Check and adjust turntable leveling.

6. Lubricate the pickup arm shaft to obtain maximum lateral freedom.

7. Check pickup arm vertical compliance. Adjust the cone-point pivot hinge screws if the arm binds. If cone-point screws are not used, lubricate the hinge pin.

8. Low sound and poor sound quality (assuming that the amplifier is in good order) can also be caused by a defective pickup cartridge. The only way to check this is to substitute a new cartridge.

These troubles can be considered, in most part, to be associated with the mechanical aspects of the pickup arm, cartridge and needle. Electrical troubles, though, that also require attention are (1) no sound output and (2) hum.

## No sound output

The sound signal is taken off the cartridge at two rear pins. Two push-on terminals are usually employed to connect the phono wires to the cartridge pins. (Contrary to modern practice, some older cartridges had the wires soldered directly to the cartridge output.) The wiring from the cartridge output is, in most changers, shielded wire to prevent hum pickup. (In cheaper single-record players, two twisted wires are sometimes used.) The shielded wire passes through the pickup arm and then goes down under the chassis at the pickup arm shaft. The wire goes to a phono plug that is pushed into a jack on the amplifier. The pickup signal circuit is shown in Fig. 528.

The first thing to do when a record changer has no sound output is to make sure that the slip-on terminals are firmly in place on the cartridge output pins. To check the circuit between the cartridge and the amplifier, inject a signal at the "live" terminal at the rear of the cartridge. This is done by holding the metal shaft of a long, thin screwdriver and touching the end of the screwdriver to the live terminal. (The human body picks up enough of a 60-cycle signal, radiated by the power lines, to use in this manner.) Note that touching the terminal connected to the shielding braid of the wire will have no effect because it is at a.c. ground. If, when the live terminal is touched, a 60-cycle signal can be heard at the speaker, then the circuit from the cartridge to the amplifier is good. This means that the only part that can be faulty is the cartridge itself and it must be replaced.

If no signal is heard, then the wiring may be defective. To check further, pull the phono plug out of the amplifier jack and hold the screwdriver inside the jack. If a signal is now heard at the speaker, then the shielded wire from the cartridge is defective—either open or shorted. But, if the signal is not heard at the speaker then the amplifier itself is at fault.

On some record changers a muting switch is used in the sound circuit to shut off the sound while a record is being changed; this is done so that the mechanical vibrations of the change-cycle mechanism will not be heard through the speaker. This muting switch can be located easily by tracing the shielded wire from the pickup arm and is usually constructed of long, thin spring contacts that are actuated by the change-cycle mechanism. The switch can sometimes go bad and cause no sound (this, however, is a very infrequent trouble). Usually, the repair consists only of straightening a bent spring contact.

## Hum

Hum can be put in two categories, (1) dominant and (2) background. Dominant hum, by far the most annoying, overrides the cartridge signal and usually distorts it beyond recognition. This hum is picked up by the signal wiring from the cartridge to the amplifier. This wiring is shielded so that under normal operation the shield braid (around the live wire) prevents hum pickup by grounding it. Hum will be caused if the shielding braid does not ground the hum pickup. First, see that the phono plug is all the way in the jack at the amplifier. Next, make sure that the shielding braid is not broken off the slip-on terminal and that the terminal is firmly in place on the cartridge pin. If these connections

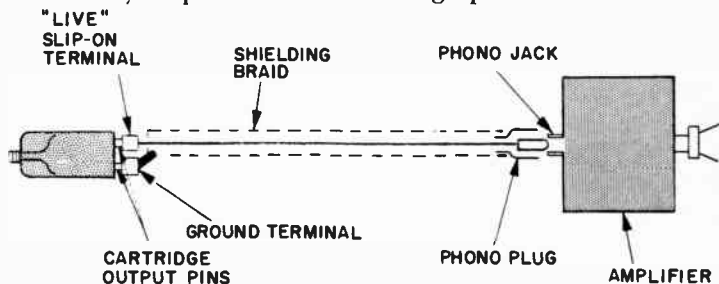


Fig. 528. The audio voltage developed across the cartridge output pins is fed to the amplifier input.

are satisfactory, then the shielding braid is probably open-circuited and the wiring should be replaced. Hum can also be caused by a defect in the amplifier. To determine this, pull the phono plug out of the amplifier; if the hum is still present, it is due to the amplifier.

Background hum does not seriously distort the sound output, but is annoyingly evident. It is produced when a magnetic cartridge is used with a record changer whose motor radiates the power frequency. Some record changers are designed without considering this and, when a magnetic pickup is put in the arm, background hum is developed. The magnetic cartridge is an induction device and is very susceptible to radiated hum pickup. In general, record changers with a four-pole motor do not have this trouble because such motors are nearly always shielded. This is not an unbreakable rule. Some four-pole motors are not shielded and if a record changer is properly designed, a two-pole motor will work as well. To determine whether a record changer will work well with a magnetic cartridge:

1. Turn on the record changer and amplifier.

2. Have the turntable rotating and keep the arm at or near its rest position.

3. Set the amplifier's volume control slightly higher than normal listening level.

4. Pick up the arm and move it slowly toward the center of the turntable. Note: If the record changer employs a velocity trip mechanism, the change cycle will start when the arm gets about half-way across. If the record changer can be set for manual operation, set it on manual so that the arm can be moved freely.

5. If a hum develops and increases when the arm is moved across the turntable, then the record changer is not designed for magnetic cartridges.

Referring to the interference of the trip mechanism on this test, some technicians remove the turntable to prevent the change cycle from taking place. This will give false results. A changer may cause hum pickup with the turntable removed but may not cause it with the turntable in place. The turntable has a shielding effect on the motor's magnetic field to some extent and so removing the turntable will increase the motor's radiated hum.

# change-cycle drive

**A**T this time the pickup arm is traversing the record and the cartridge is reproducing the groove modulation. Records are stacked on the spindle above the arm, each waiting its turn to be played. The change-cycle mechanism at the underside of the record changer is waiting for a signal that indicates the end of a record so that it can go into operation and put the next one in playing position. The change-cycle mechanism is held at bay by the trip mechanism, the "brain" of the automatic record changer. This trip mechanism automatically determines when the record being played is finished and triggers the change-cycle mechanism into operation. The trip mechanism will be easier to understand after the basic methods of driving the change-cycle mechanism have been discussed.

When the change-cycle mechanism of a completely automatic record changer is set into operation, it will (1) raise the pickup arm, (2) swing it out clear of the next record, (3) drop the next record, (4) determine the record's size, (5) swing the arm in, (6) set the arm down at the beginning of the record and (7), after the last record has been played, the changer will automatically shut itself off.

To perform these functions, levers and cams are used to actuate the operating assemblies. These cams and levers are set into operation by the change-cycle drive. The manner in which the operating levers and cams accomplish their purpose will be discussed in the following chapters. At this time the discussion deals only with the operation of the change-cycle drive.

## Operating the change-cycle drive

The easiest method to use for operating the change-cycle drive is to tap the motion of the turntable, although the drive assembly can also be used. Most record changer manufacturers use the turntable hub to rotate the change-cycle drive. Some, however, use the turntable rim to drive the mechanism. The overall operation, whether rim- or hub-driven, is the same. There are five basic ways to operate the change-cycle. These drives are: (1) gear, (2) rim, (3) pulley, (4) dog latch, and (5) pawl latch.

The first three listed were discussed in detail in Chapter 3 and so need no detailed explanations here. With gear drive, the hub of the turntable has gear teeth cut into it or else it has a gear

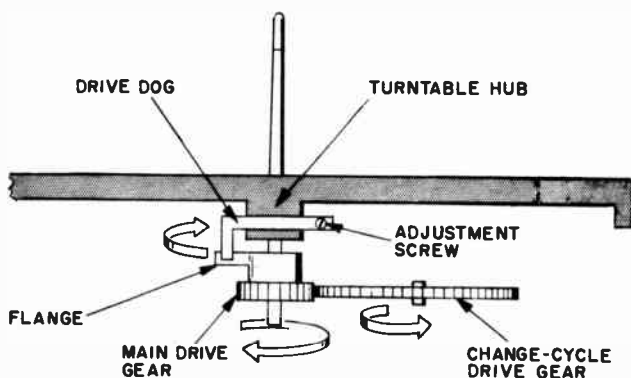


Fig. 601. Illustration shows dog-latch drive.

attached. The turntable hub, then, is gear-meshed to the change-cycle drive gear. With rim drive, the hub of the turntable is knurled or else has a knurled drive wheel attached to it. The knurled drive wheel rim-drives the rubber-rimmed change-cycle drive wheel. With pulley drive, a drive belt couples the turntable hub to the change-cycle drive wheel. Gear drive is the most popular method of rotating the change-cycle drive, and the rim drive is next in popularity. Pulley drive was used in earlier record changers. The dog-latch and pawl-latch methods of coupling are not used too frequently, but since they are unique they will be discussed in detail.

### Dog-latch drive

The dog-latch drive merely utilizes a drive dog to couple an extension flange firmly on a drive wheel, which is usually a gear. The drive dog shown in Fig. 601 is part of a unit that straps around

the turntable hub. A screw and nut are used to tighten the unit. If the screw is loosened, the drive dog can be moved up or down for adjustment purposes. As the turntable revolves, the

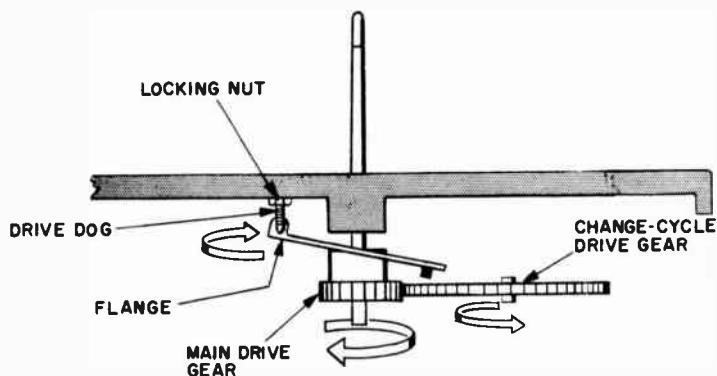


Fig. 602. Another example of dog-latch drive.

drive dog turns with it. The end of the drive dog contacts the flange on the main drive gear and the drive gear is pushed around with it. The main drive gear, in turn, rotates the change-cycle drive-gear.

Another form of dog-latch drive is shown in Fig. 602. This

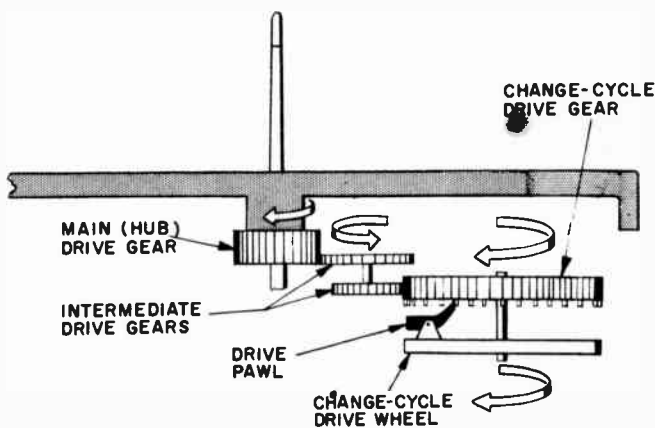


Fig. 603. Typical operation of pawl-latch drive.

setup is fairly similar to the previous example. The main difference is that the drive dog is screwed into the underside of the turntable and locked in place with a nut. When the nut is loosened, the drive dog can be turned to move it up or down for adjustment purposes. The setups shown in Figs. 601 and 602 will



revolve continuously. But, since the change-cycle mechanism should not operate during a record playing, the drive dog and flange must be disengaged. This is accomplished by a clutch.

### Pawl-latch drive

The pawl-latch drive is quite similar to the dog-latch drive. The difference is that the drive dog is fixed to its mount whereas

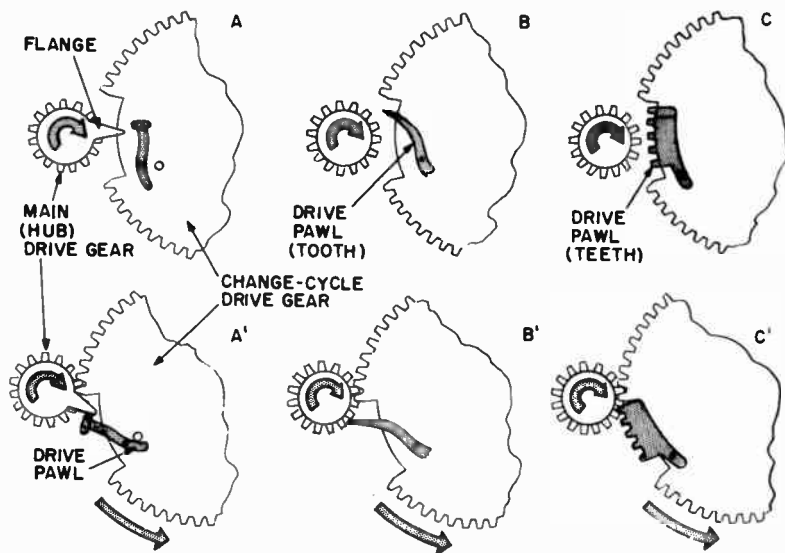


Fig. 604-a, -b, -c. Three fundamental techniques for gear-drive control.

the drive pawl is pivoted to its mount. An example of the pawl-latch drive is shown in Fig. 603. The turntable hub gear drives the change-cycle drive gear by means of two intermediate gears. At the underside of the change-cycle drive gear, there are a series of latching bosses all around the gear. The end of the pawl is latched to one of these and is pushed by it, thereby rotating the change-cycle drive.

The arrangement shown in Fig. 603 will cause continuous rotation of the change-cycle drive. It must, however, be disengaged during a record playing. To do this, a clutch device will be required. This is necessary for any form of drive—gear, rim, dog-latch or pawl-latch. The clutch device must be able to engage firmly and quickly and should be able to disengage easily.

### Gear-drive clutch

There are three basic methods used to control the operation

of the gear drives. In Fig. 604-a, a type of pawl latch is used as the clutch. A small segment of the change-cycle drive gear has no teeth and so cannot mesh with the main drive gear while a record is being played. A drive pawl, though, shown in the disengaged

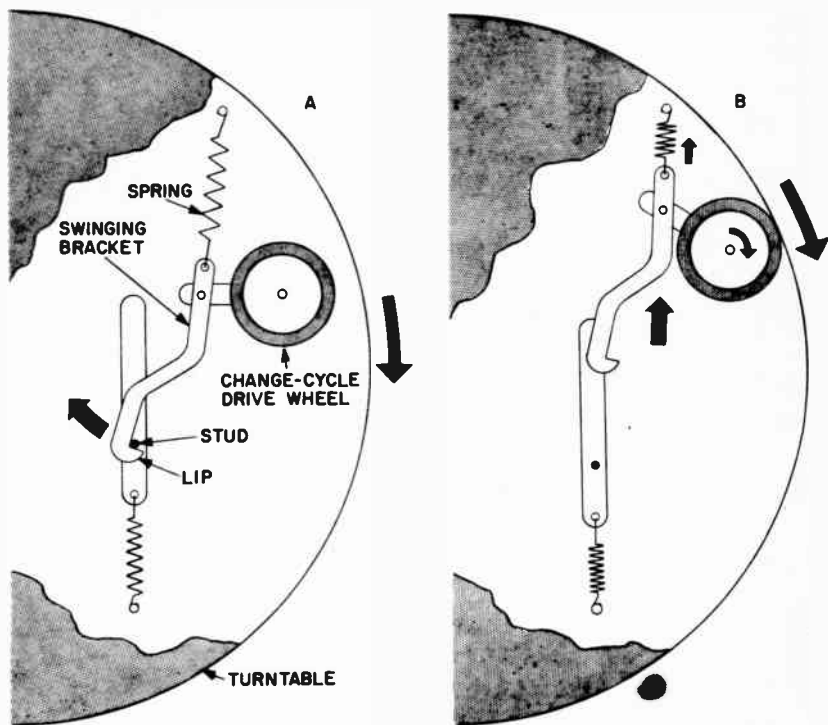


Fig. 605-a,-b. Illustrations show operation of rim-drive clutch.

position, is ready to couple the flange on the main drive gear when the record is finished. After the end of the record, when the pickup arm enters the runoff grooves, the trip mechanism turns the drive pawl so that it latches with the flange on the main drive gear. When this happens, the change-cycle drive gear turns and the teeth on the main drive gear mesh with those on the change cycle drive gear so that the change cycle continues. The drive pawl then moves back to the disengaged position and the change-cycle drive gear turns until the gears unmesh as shown in Fig. 604-a.

The setup shown in Fig. 604-b functions in a similar manner except that the drive pawl acts as a gear tooth and not a pawl latch. The trip mechanism turns the pawl so that its end meshes

with the teeth on the main drive gear to start the change cycle. The setup shown in Fig. 604-c' is actually the same as that of Fig. 604-b except that the pawl has a number of teeth for firmer mesh. The former illustration shows the unit engaged.

### Rim-drive clutch

With rim drives, the method of clutching is somewhat different. With the drive shown in Fig. 605, the swinging bracket holds the change-cycle drive wheel away from the turntable rim. The lip on the end of the swinging bracket is held by the stud on the sliding bar. When the record being played is finished, the trip

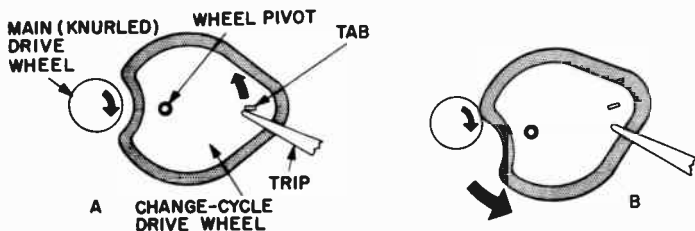


Fig. 606-a,-b. Turntable hub rim-drive clutch.

mechanism causes the swinging bracket to move in the direction of the arrow shown in Fig. 605-a. When this happens, the lip of the swinging bracket is released from the stud and the spring pulls the assembly until the change-cycle drive wheel couples the rim of the turntable, as shown in Fig. 605-b. The wheel then revolves and drives the change-cycle mechanism. When the change cycle is completed, the sliding bar moves forward until the stud again hooks the lip of the swinging bracket. Then the sliding bar moves back and pulls the swinging bracket with it. The change-cycle drive wheel is then disengaged as shown in Fig. 605-a.

The setup of Fig. 606 accomplishes the clutch action in a much simpler manner. No brackets or levers are required to hold the wheel disengaged and a much simpler action starts the change cycle. The drive wheel is eccentrically shaped and pivoted. During the playing of a record, the indented portion of the change-cycle drive wheel faces the knurled wheel so that no contact is made. When the record is finished the trip mechanism contacts the tab on the change-cycle drive wheel. This causes the wheel to turn slightly, enough to couple the knurled wheel so that it is rim driven. The change cycle then starts; the drive wheel will turn until its indented portion again faces the knurled wheel. The wheels are then disengaged and the change cycle stops.

## Dog-latch clutch

Since the dog-latch drive involves a drive dog latching a flange from above, the best way to obtain disengagement during a playing period would be to move the flange down clear of the drive dog. As Fig. 607-a shows, the flanged main drive gear rests

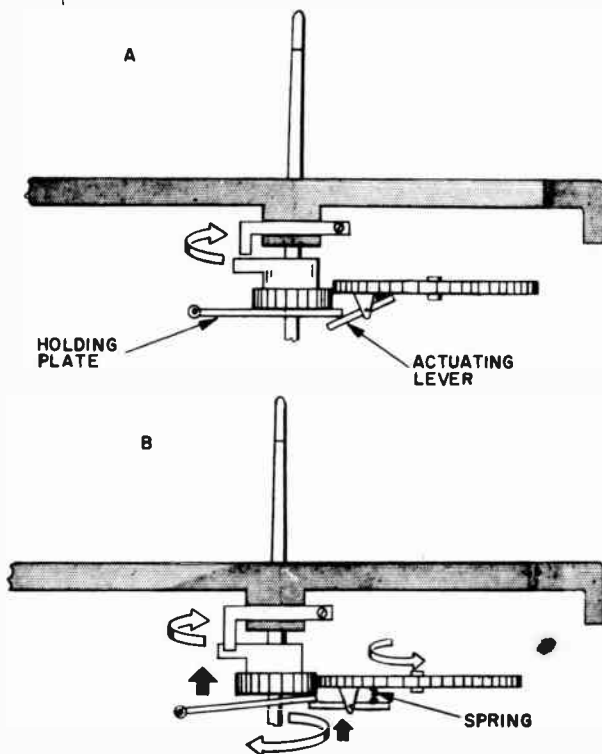


Fig. 607-a,-b. Dog-latch holding plate clutch.

on a plate in a low position that prevents the drive dog from contacting the flange. In this position, while a record is being played, the change-cycle drive gear will not be rotated. After the record is finished, the trip mechanism releases the actuating lever which, as shown in Fig. 607-b, pushes up the holding plate. The holding plate lifts the main drive gear so that its flange is driven by the drive dog. The change-cycle drive gear is then rotated to start the change cycle. Because of its construction, the holding plate locks itself in holding position to keep the main gear up during the change cycle. While the cycle takes place, the actuating lever resets itself and at the end of the change cycle an extension on the change-cycle drive gear releases the holding

plate so that the main drive gear is lowered and disengaged from the drive dog.

In another dog-latch clutch, shown in Fig. 608-a, the trip mechanism holds up one end of the drive clutch lever so that its flange at the other end is too low to couple the drive dog.

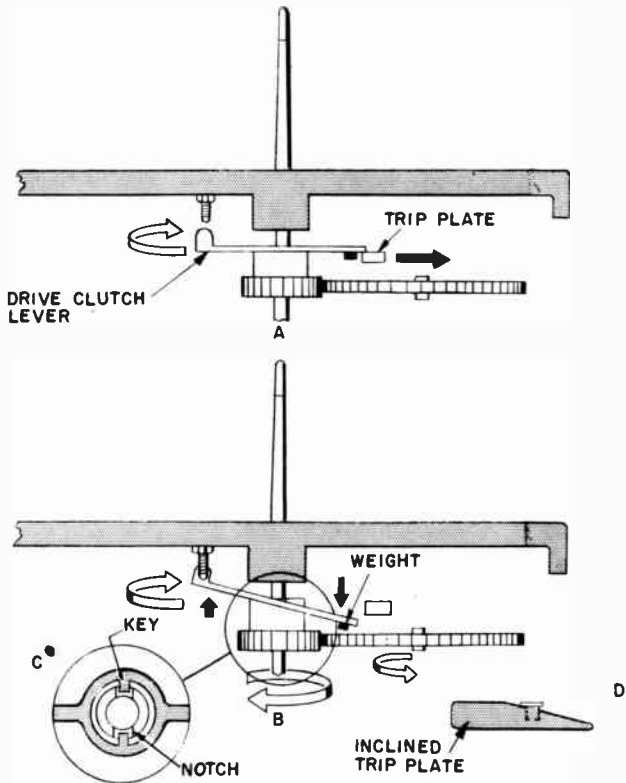


Fig. 608-a,-b,-c. Dog-latch keyed-lever clutch.

At the end of the record, however, the trip mechanism is pulled back in the direction of the arrow. The weighted end of the drive clutch lever then drops and causes the flanged end to move up and latch with the drive dog. This is shown in Fig. 608-b. The drive dog then turns the clutch lever which, in turn, drives the main drive gear to start the change cycle. The encircled drawing in Fig. 608-c shows how the drive clutch lever is coupled to the main drive gear. The inner circumference of the clutch lever has two keys that seat in notches at the top of the drive gear. This arrangement permits the clutch lever to tilt and still engage the main drive gear.

When the change cycle ends, the trip plate is moved back in position. The trip plate is inclined, so that as the clutch lever comes around, an extension at the weighted end contacts the trip plate and rides up the incline, as shown in Fig. 608-d. This levels off

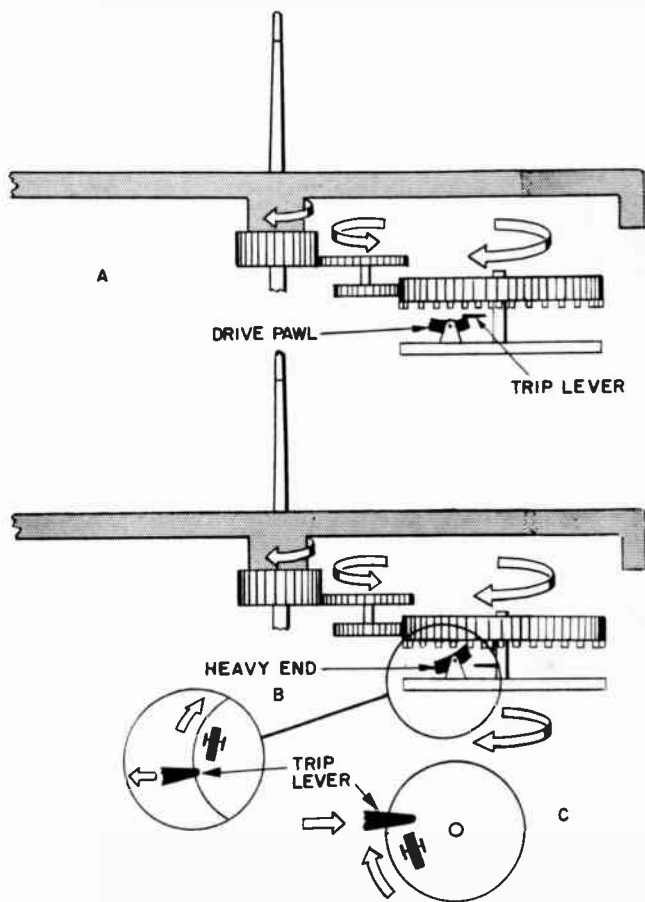


Fig. 609-a,-b,-c. Basic pawl-latch clutch method.

the drive clutch lever so that the flange is disengaged from the drive dog, and the change cycle stops.

### Pawl-latch clutch

Since the pawl latch is a rotating part, the best way to have it disengage would be to turn it so that it will not contact the bosses. This setup is illustrated in Fig. 609. The pawl latch is also

made with a heavy end that tends to drop. However, a trip lever pushes on the other end to keep the pawl approximately level. In this manner, as shown in Fig. 609-a, the drive wheel is disengaged from the drive gear while a record is being played. But when the record playing is completed, the trip lever is moved away from the pawl, as shown in Fig. 609-b, and the heavy end of the pawl drops so that the pawl turns. The top end of the pawl latches to one of the bosses at the underside of the drive gear and the drive wheel revolves with the gear to start the change cycle. During the cycle, the trip lever is returned to its position (see Fig. 609-c). This puts the lever directly in the path of the pawl so that, when they contact, the trip lever pushes down on the pawl to disengage it from the drive gear. This completes the change cycle as shown in Fig. 609-a.

### **Change-cycle actuating methods**

Up to now, the discussions have explained the basic change-cycle driving methods and the most popular clutch methods employed. The change-cycle drive, though, once it has been set into motion, must actuate various lever and cam arrangements to set the arm control and record-dropping assemblies into operation. The change-cycle drive must be made so that as it rotates it can move the parts at the proper time to perform the proper functions. The drive accomplishes these motions in three basic ways: (1) reciprocation, (2) cam action, and (3) groove tracking.

With reciprocation, a lever (or levers) pivots on the change-cycle drive off center so that, when the drive rotates, it moves the pivoted lever back and forth. This setup is similar to the way a locomotive's wheels are connected. With cam actions, the lever rests on an irregular or eccentric surface so that, as the drive rotates, the cam pushes the lever to move it. The cam surface can be either incline or lateral. With the groove-track method of motion, a groove track is used that usually runs from close to the center of the drive wheel toward the outer rim. As the drive turns, the groove carries a lever across its surface to obtain the proper motion.

These actuating methods are not unique to any particular changer nor does any record changer usually employ only one method. In the great majority of cases, combinations are used. Some drive wheels reciprocate a lever while using their eccentricity to cam-drive another lever. Other drive wheels have a couple of cams on their topside, still others have cams on top and bottom

as well as a groove track. Drive wheels can also reciprocate a slide cam to do the job. In the following paragraphs, therefore, some specific drives are discussed that represent the basic overall methods employed by the industry. Studying and understanding these will prepare the reader for any changer he may contact.

### Reciprocating drive

This type of setup is shown in Fig. 610. Fairly straightforward,

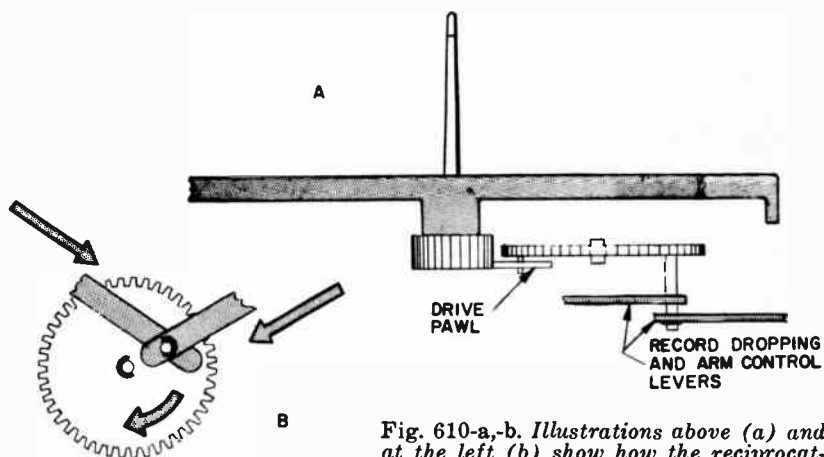


Fig. 610-a,-b. Illustrations above (a) and at the left (b) show how the reciprocating drive works. This is a very simple change-cycle technique.

it is probably one of the most simple change-cycle methods employed by record changers. It employs a main drive gear on the turntable hub that meshes with a change-cycle drive gear during the change cycle. A drive pawl that acts as a gear tooth starts the change cycle. The two levers, shown in Fig. 610-b, are actuated by the drive gear during the cycle. As the gear rotates, the levers follow the rotary motion and move back and forth. The levers, pivoted on a stud, are usually held in place by retaining rings and washers.

### Reciprocating and lateral-cam drive

An example of this drive is shown in Fig. 611. Here, too, the turntable hub is the main drive gear. It meshes with a change-cycle drive gear which uses a drive pawl latching to a flange on the turntable hub to start the change cycle. Connected to the same shaft as the change-cycle drive gear and rotating with it is a change-cycle cam wheel. As shown in Fig. 611-b, as the cam wheel is rotated, it actuates one lever by reciprocation. The other lever is pushed back and forth by the eccentric shape of the cam wheel's



rim. The cam-actuated lever shown in this case uses a roller on the end of the lever so that smoother and quieter operation will be obtained. Rollers, however, are not always used with cam surfaces.

### Incline-cam drive

A good example of this basic change-cycle drive method is shown in Fig. 612. The change-cycle drive gear is turned by the

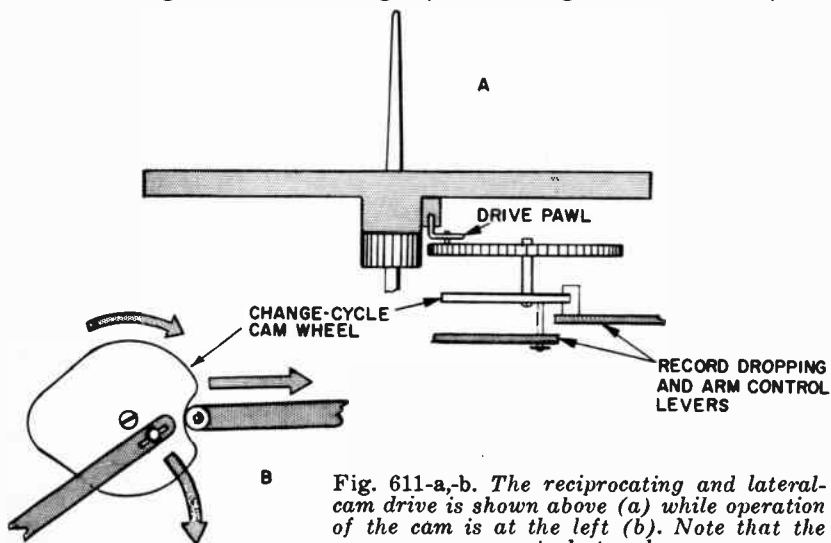


Fig. 611-a,-b. The reciprocating and lateral-cam drive is shown above (a) while operation of the cam is at the left (b). Note that the cam controls two levers.

turntable hub gear by means of two intermediate gears. These are used to keep rumble at a minimum. The change-cycle drive gear always turns, even while a record is being played, and so nonmetallic intermediate gears are used to prevent noise and vibration. The change-cycle cam wheel is driven by the pawl latch. As shown in Fig. 612-b, as the drive rotates, the incline of the cam surface moves the lever up and down. Here, too, the lever utilizes a roller on the cam surface for quieter and smoother operation. As the illustration shows, two such inclines are employed in this unit. In addition, a groove track is used.

### Compound-cam drive

Fig. 613 shows a change-cycle drive gear that employs two lateral cams on its topside and an incline cam at the bottom. The drive gear is rotated by the turntable hub gear and the cycle is started by a drive pawl. As the illustration shows, the levers driven by the cam surfaces in this case have no rollers. However, quiet, smooth operation is secured by using a sufficient amount

of lubrication on the cam surfaces. In addition to the cam surfaces, the lever with the stud shown at the top of the drive gear rides in a groove track.

### Groove-track drive

The operation of a stud in a groove track can be likened to a

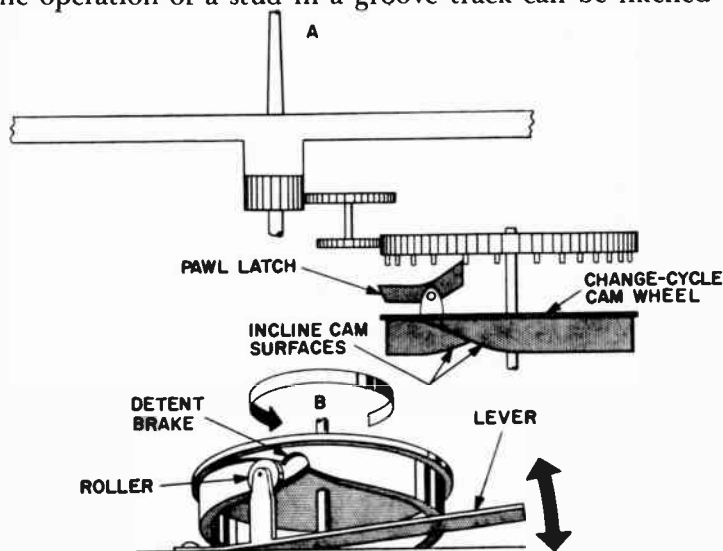


Fig. 612-a,-b. Basic change-cycle drive method using the incline cam drive.

pickup needle riding in the record's groove. Just as the pickup needle carries the pickup arm while following the grooves, so will a stud carry a lever while following a groove track in the

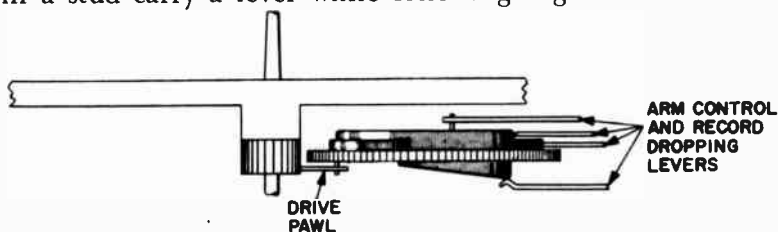


Fig. 613. Compound-cam drive uses two lateral and one incline cam.

change-cycle drive wheel. The groove track can move the lever in two ways. Fig. 614-a shows how the stud riding in the moving groove pushes the lever from side to side. Fig. 614-b shows how the groove track moves the lever back and forth. Besides the groove-following stud, the lever has a slotted slide that limits its motion along one line.

## Slide-cam drive

Slide-cam units are used because one driving device can accomplish most of the work during the change cycle. It permits a more

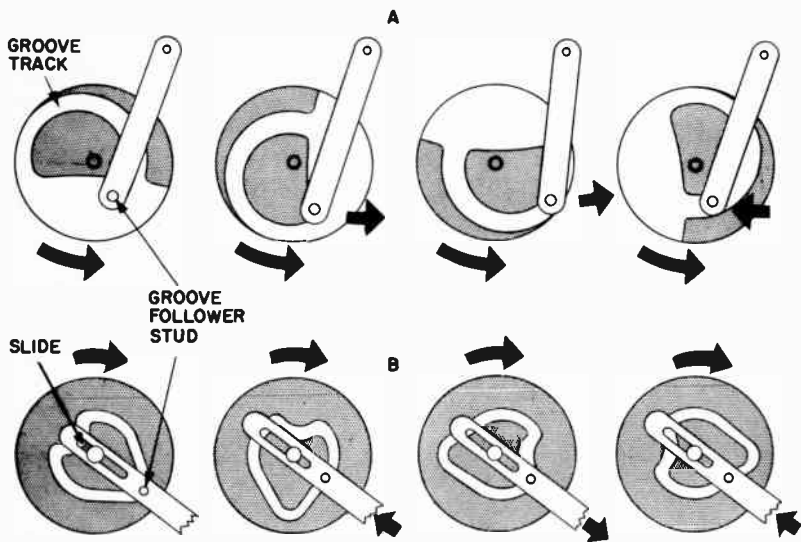


Fig. 614-a, -b. Illustrations show sequence of operation of groove-track drive.

compact and less complicated mechanism. The slide cam is shaped so that various portions of it are used to control the functional assemblies. A slide cam system is shown in Fig. 615-a, -b. The change cycle is started by a pawl latch and flange, and the turntable hub gear drives the change-cycle drive gear during the cycle. A stud is mounted off center on the change-cycle drive gear so that, as the gear turns, the stud will drive the slide cam back and forth. The spring is used for a braking effect so that the slide cam will move through its cycle smoothly. The rear of the cam is sloped to act as an incline.

Another type of slide cam arrangement is illustrated in Fig. 616. This unit uses the rim drive. The trip lever touches the tab on the change-cycle drive wheel so that the wheel is turned slightly. The wheel then contacts the knurled drive wheel which drives it through its cycle. The change-cycle drive wheel is eccentrically shaped and pivoted so that, as it rotates, it is pushed away from the knurled drive wheel. The slide return spring shown in Fig. 616-a maintains tight coupling between the knurled drive wheel and the change-cycle drive wheel. As the wheel is pushed away,

it carries with it the slide cam. This is because the wheel is pivoted to it. After the rotating drive wheel is moved to its limit, the

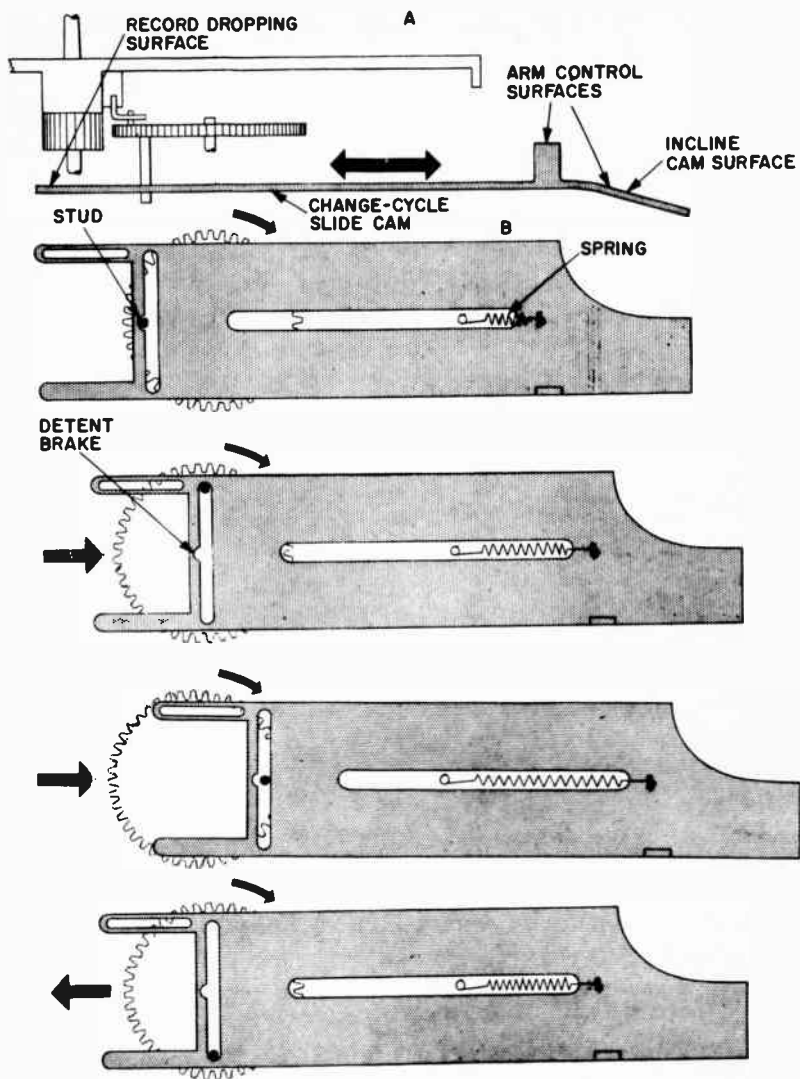


Fig. 615-a,-b. Steps in the operation of the basic slide-cam drive.

slide return spring pulls the assembly back against the action of the change-cycle drive wheel. Should this spring break or fall off, the slide cam would be pushed out but not pulled back. Thus, only a portion of the change cycle would be accomplished. Fig.

616-b shows how the change-cycle drive wheel actuates the slide cam.

### **Change-cycle brake**

Most change-cycle drive mechanisms, especially the gear drives, have a problem resulting from inertia. As shown in Fig. 604, the change-cycle drive gear has a section without teeth, so that when the end of the change-cycle is due, this dead spot of the drive gear faces the main drive gear and the two gears become disengaged. However, because of inertia, the change-cycle drive gear tends to rotate a little more. If this happens, the gear teeth will mesh again and another change cycle will take place. To prevent this, a detent braking arrangement is used. One example of this is shown in Fig. 615. At the end of the cycle, the stud moves into the detent brake, thereby applying a slight extra pressure to the change-cycle drive gear to help it stop.

In most record changers, the detent braking action is made automatic, especially with cam drives. For instance, a roller or lever is pressed firmly against the cam surface during the cycle for actuating purposes; at the end of the cycle, this roller or lever will fall into an indented section of the cam surface. The roller or lever falling into the indentation forms the detent that brakes the change-cycle mechanism. An example of this is shown in Fig. 612.

Some record changers have a separate detent brake. The change-cycle drive gear in the Admiral record changer has a stud underneath that contacts a braking lever at the end of the cycle. The Webcor model 141 record changer has a detent spring and a plunger to stop the change-cycle drive gear.

### **Servicing the change-cycle drive**

The clutch devices, such as the drive pawl, clutch lever, pawl tooth, etc., are actually more closely associated with the trip mechanism and so their troubles will be discussed in Chapter 7. For troubles such as (1) the change cycle starting before the end of the record, (2) the change cycle not starting and (3) the change cycle repeating itself right after the next record has dropped, refer to Chapter 7. However, with the dog-latch drive these troubles can also occur because of an improperly adjusted drive dog.

The stopping of the turntable when the change cycle starts gives the appearance of trouble associated with the change-cycle drive, but this is almost always caused by the motor's drive assembly. Re-

fer to Chapter 3 to check the drive assembly first. The parts used with the change-cycle drive are made relatively rugged and so they very rarely develop defects. Trouble does occur, though, but mainly because of neglect and abuse. The change-cycle drive

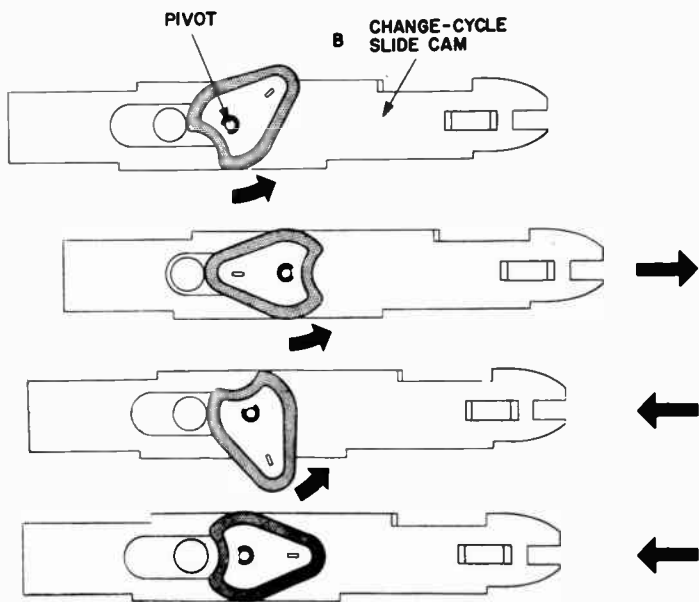
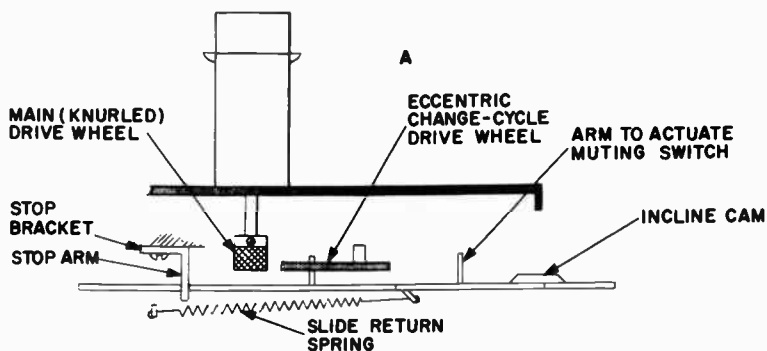


Fig. 616-a,-b. Eccentrically driven slide. The drawings show how the change-cycle drive wheel actuates the slide cam.

should be cleaned and lubricated at every opportunity. While cleaning and lubricating inspect the drive parts. Also, the change-cycle brake can permit the change cycle to repeat so check the braking effect of the mechanism as well.

## **Cleaning the change-cycle drive**

It is impossible for the change-cycle drive to give satisfactory operation after it has accumulated dirt, grime, sticky grease or oil. Therefore, clean all pivot, gear mesh, cam and groove-track surfaces. A vacuum cleaner can be used as a blower or a suction device to remove all excess dust and dirt as a starter. As a blower the vacuum is more effective for loosening stubborn dirt. Use a brush, (such as a toothbrush) to scrub the surfaces. The toothbrush should enable you to get into narrow blocked spaces to do a thorough job. Continually dip the brush in carbon tetrachloride during the cleaning. Clear out as much of the old lubrication as possible. Use a fine-point tool to scrape and loosen stubborn spots. After the unit is cleaned, it will have to be lubricated.

## **Lubricating the change-cycle drive**

As a precautionary measure, here are the parts that should not be lubricated.

1. The drive surfaces of the rim-drive type of change-cycle drive.
2. The dog latch, pawl latch, pawl tooth or clutch lever. These parts must remain dry for most trip mechanisms to function properly. This is explained in Chapter 7. If any lubrication contacts these parts, clean and dry them thoroughly. To lubricate points that are narrow and blocked a brush can be used for grease and an eye dropper for oil. For inaccessible points, the long-nozzled syringe applicator should be used. Lubricate the drive as follows: Apply a sufficient amount of grease to all gear teeth, lateral and incline cam surfaces, groove tracks, slide-slots on levers and the lever rollers. Oil, SAE No. 20, should be applied to the cycle-drive shaft, all pivot studs for levers and slide cams and all cam surfaces on the slide cam. Do not apply too much lubrication because it tends to run or splatter, and may cause erratic operation.

## **Check list**

### **Gears**

Check all gears in the cycle drive for chipped, cracked or broken teeth. With recent changers, if the turntable hub gear is damaged, the turntable will have to be replaced. On some of the older changers, the main drive gear was mounted on the turntable hub with a screw. See if this screw is tight. Check the cycle drive gear mounting. On some changers, it is held in place on a shaft with a retaining ring; on others, a screw is used. Tighten it or replace the retaining ring if required.

### **Rim drives**

See that the knurled wheel is not damaged. Make sure the mounting screw is tight. Replace the rubber-rimmed drive wheel if the rim is smooth enough to cause the wheel to slip. Check the drive-wheel mounting. It is usually held on a shaft with a retaining ring. Make sure the retaining ring is in good order. Inspect the rim surfaces for oil and clean them if necessary.

### **Dog latch**

See that the drive dog is not bent or broken. Straighten if bent and replace it if it is broken. Check the drive dog operation to see if it needs adjustment. It should latch firmly to the flange during a change cycle and should not touch the flange during playing of a record. If it does not latch the flange or makes unreliable contact, the drive dog should be adjusted down. If it contacts the flange during record playing and causes noise or if it starts a change cycle, then the drive dog should be adjusted up. If the setup shown in Fig. 601 is used, the adjustment screw is loosened and the drive dog assembly is moved up or down on the turntable hub. If the arrangement shown in Fig. 602 is used, the adjustment nut is loosened and the drive dog is screwed in or out of the turntable as required. The adjustment may have to be made a few times before the drive dog is set properly.

### **Springs**

See that the springs used with the rim drives and slide cams have not broken or fallen off. Replace the spring if it is weak. In an emergency, a weak spring can be shortened to give it more tension. This is bad practice, however, because the spring will not last long.

### **Cams**

See that the lateral and incline cam surfaces are not chipped or worn. This will cause the lever to fall off and possibly jam the mechanism. If a separate cam wheel is used, make sure it is mounted properly. Retaining rings or screws are usually used to hold them to a shaft. Inspect the detent brake in the cam surface if one is used.

### **Groove track**

Check for the same troubles described under "Cams."

### **Pivots and studs**

Inspect all pivots and studs to see that they are not loose or broken. In most cases they are riveted to other parts. The part that holds them will have to be replaced if defective.

### **Levers**

Check levers to see that they are not bent. Make sure they



contact cam surfaces firmly. If they do not, bend them back to shape so that they function properly. Check the lever pivot or slide mountings. Make sure the retaining rings that hold them in place are not missing. See that the groove-actuated lever is riding firmly in the groove track.

### **Slide cams**

See that the studs that drive the slide cams are neither loose nor broken. Make sure the cam does not bind as it slides. Straighten it if it is bent. Inspect the cam surfaces for wear or breakage. Inspect the detent brake if one is used.

### **Removal of cycle drive parts**

It would do no good to attempt to illustrate and describe all the numerous cycle drives used by the record changer manufacturers for two reasons: there are too many for the reader to remember and they change when new models are introduced. The following basic information, though, will be helpful.

1. The cycle drive is usually mounted on a shaft and is held in place with a retaining ring or screw.

2. The main drive gear is usually part of the turntable hub, although on some older changers it is held to the hub by a screw.

3. The drive dog is held in place as shown in Figs. 601 and 602.

4. The drive pawl (Fig. 603) is part of the change-cycle drive in most cases; the drive must be replaced if the pawl is faulty.

5. The ends of the springs are usually hooked into mounting holes; a slight pull will free them.

6. The pivots and studs are generally riveted to other parts; the parts that hold them must be replaced if the pivots and studs are broken.

7. The levers are usually pivoted or held loosely on studs. Retaining rings are used to keep the levers in place although screws are sometimes used. Rollers on the end of the levers are usually secured by retaining rings.

8. Slide cams, in the great majority of cases, require removal of other parts for the slide cam itself to be removed.

Parts may be in an open area so that they can easily be taken out; on the other hand they may be hidden behind other parts, making their replacement more difficult. When a number of parts must be taken out to get at the faulty part, it would be wise to use the manufacturer's literature. The "exploded" view discussed in Chapter 14 can be used as a guide.

# trip mechanism

**T**HE automatic record changer is, in actuality, a computer device, probably one of the first to become part of everyday life. Although not usually thought of in this way, it is a “thinking” machine, a sort of robot that places a new record in playing position when the previous record is ended. As explained previously the trip mechanism is the “brain” of the automatic record changer. It determines when the record being played is finished and then connects the change-cycle drive. Therefore, if the trip mechanism becomes faulty, the automatic action of the record changer will be disrupted. The trip mechanism works in conjunction with the pickup arm. Because of this, the trip mechanism must be light and sensitive so that it will not present any undue pressure to the arm.

Present-day record changers employ highly sensitive trip devices. As a result, the tripping portion of a changer is easily damaged and misadjusted. Next to the motor drive assembly, the trip mechanism is probably the most troublesome section of the automatic record changer. It is a rapid-acting device and is very difficult to watch in operation. Its action takes place at the end of a record play, and it stops almost immediately. The series of levers, links and pawls that comprise the trip mechanism act almost simultaneously. The use of the trip mechanism varies considerably, partly because of the different types of change-cycle drives employed and partly because of manufacturers’ preference.

Fortunately, though, trip methods employed can be broken down into three basic types. These are:

1. The position or positive trip.
2. The eccentric or oscillating trip.
3. The velocity or acceleration trip.

To offer a clearer presentation, the basic principles of these trips will first be given. To clarify the discussions further, the basic trips will be presented with a gear-driven change-cycle drive that is started by a drive pawl. After these principles have been discussed, a few basic actual trip mechanisms, employed by popular record changers, will be illustrated and described. These trips represent the prime variations used by the industry and understanding them will prepare the reader for any changer that may be encountered.

### **Position trip**

The position or positive trip mechanism was the first method devised for starting the change cycle. The basic position trip mechanism is shown in Fig. 701. A trip finger is rigidly attached to the pickup arm shaft. In most cases, it is locked in place with a screw. Because of this, the trip finger will follow the lateral motion of the pickup arm faithfully. While the pickup arm is riding the modulated grooves of a record, slowly moving toward the spindle, the trip finger moves with it. The trip finger slowly approaches the drive pawl, as shown in Fig. 701-a. The drive pawl is seated in the disengaged position. When the pickup arm rides off the end of the playing grooves, however, the screw at the tip of the trip finger moves the pawl and turns it, as shown in Fig. 701-b. The pawl then couples the main drive gear (mounted on the turntable hub) to start the change cycle. The pawl stop obstructs further rotation so that the pawl is locked in mesh with the main drive gear. The pickup arm is raised and swung out, taking with it the trip finger. As the change-cycle drive gear rotates, the end of the drive pawl strikes a stud, as shown in Fig. 701-c. This causes it to move back to the disengaged position so that the change-cycle drive gear will stop when it reaches the position shown in Fig. 701-a.

The adjustment screw shown at the tip of the trip finger is used to adjust the position at which the tripping action takes place. Turning the screw in will move it closer to the drive pawl to start the tripping action sooner. Turning it out, of course, will cause tripping to take place later.

The position trip mechanism in Fig. 701 is a simple one and shows the trip finger directly contacting the drive pawl. Some record changers were made in just this way. Others employed an extra trip lever or two between the trip finger and the drive pawl. The action, however, is the same; the intermediate lever merely transfers the movement of the trip finger. When intermediate levers are used, the trip-adjustment screw can also be mounted on these parts; the adjustment, though, has the same effect.

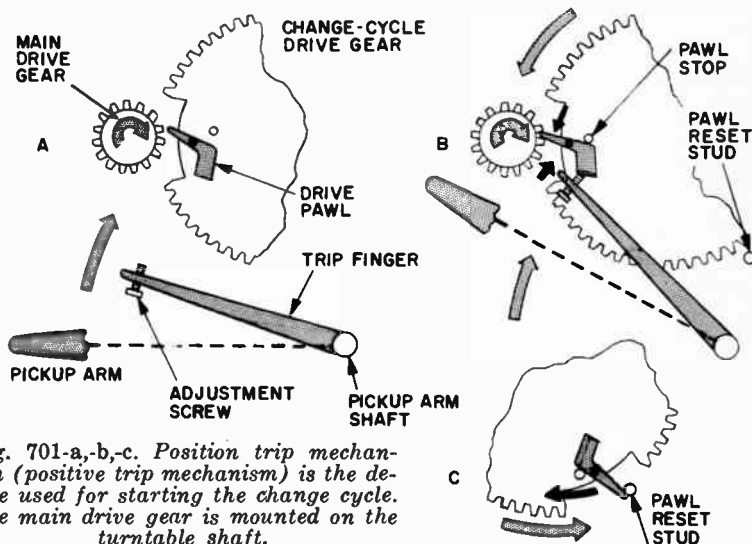


Fig. 701-a,b,c. Position trip mechanism (positive trip mechanism) is the device used for starting the change cycle. The main drive gear is mounted on the turntable shaft.

Another popular method of setting the tripping position is shown in Fig. 702. The trip finger is pivoted on a trip plate secured to the pickup arm shaft. The spring, between the finger and the plate, pulls the rear of the finger against an eccentric stud. This stud sets the position of the trip finger. As the arrows show, turning the stud will reset the position of the trip finger and, therefore, the position of tripping action.

This type of trip device was found unreliable because of the lack of standardization between records. Some records have longer playing time than others and so the modulated grooves run closer to the spindle. If the trip mechanism is adjusted for the record with shorter playing time, it will trip too early with a longer-playing record. On the other hand, if it is adjusted for the longer record, it may not trip at all with the shorter one because the run-off grooves may not carry it over far enough. Because of this, a quest was made for a more reliable device. The result was the eccentric trip mechanism. The position trip is still used, however,

by some changers. The RCA model RP-190 uses it. This changer is for 7-inch records only which provide a very wide runoff groove area. Because of this, the position trip can be reliably adjusted for all records played on this type of changer.

### Eccentric trip

The eccentric (or *oscillating trip* mechanism) was developed so that tripping action would be more reliable. The runoff groove

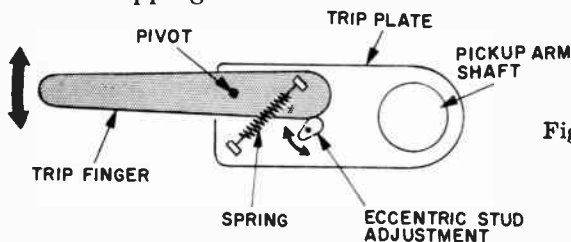


Fig. 702. Trip finger adjustment.

at the end of a record moves in close to the spindle and terminates in a final groove cut eccentrically around the center hole. The pickup needle rides into this groove and, because of the groove's eccentricity, the needle moves the pickup arm back and forth, toward and away from the spindle. If allowed, the pickup arm would keep oscillating in this groove in just this manner. It is the backward motion of the pickup arm that actuates the eccentric trip mechanism.

The basic mechanism is shown in Fig. 703. The trip finger in this device employs, at its fingertip, a series of saw teeth. About half-way through the record playing, the saw, or ratchet teeth, contact a trip pawl pivoted on a trip lever. The lever actuates the drive pawl. As shown in Fig. 703-a, as long as the pickup arm moves toward the spindle, the trip pawl merely turns and rides over the sloping portions of the saw teeth. Thus, no movement is transferred to the trip lever. The purpose of the pawl spring is to keep the tip of the pawl in firm contact with the trip finger.

At the end of the record, the pickup arm rides into the runoff groove and then the final eccentric groove. When the final eccentric groove carries the pickup arm back, away from the spindle, the trip finger moves in the reverse direction, as shown in Fig. 703-b. When this happens, the trip pawl catches in a notch between two saw teeth. The trip pawl cannot turn; instead it transfers the backward motion to the trip lever which, in turn, moves the drive pawl. The drive pawl is turned so that it meshes with the main drive gear to start the change cycle. The pickup arm is raised and swung out, taking with it the trip finger. The

lever reset spring resets the trip lever to its playing position and during the cycle the pawl reset stud moves the drive pawl back to the disengaged position. When the change cycle ends, the condition shown in Fig. 703-a exists again.

The trip adjustment screw is used to adjust the action and sensitivity of the trip mechanism. After the screw is loosened, the trip finger can be moved from side to side and back and forth so that tripping can be accurately set. While Fig. 703 shows the basic eccentric trip mechanism, in practice an extra trip lever or two may be used. Also, the trip pawl and saw teeth can be located on other parts. An example of this is shown in Fig. 704, a portion

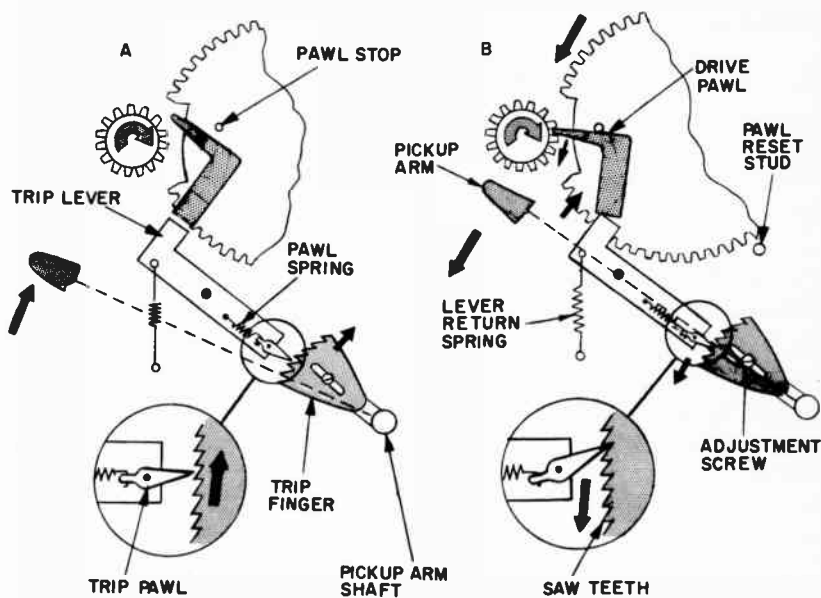


Fig. 703-a, -b. Eccentric trip mechanism. Insets show details of trip pawl and saw teeth on the trip finger.

of the basic RCA RP-177 trip mechanism. The saw teeth and trip pawl are reversed. Operation and adjustment, however, are the same.

The eccentric trip mechanism did bring about more reliable tripping action, but it had the disadvantage of taking too long to start the change cycle. The arm, in this trip, must ride into the final groove and oscillate to start the tripping action. On some records, the final groove has only a small amount of eccentricity and the pickup arm has to oscillate a number of times until enough backward motion is built up to actuate the drive pawl.

Because of this extra time required, there was an undesirable break in continuity between record playings. This was particularly noticeable and annoying when an album was being played that had one continuous musical piece comprised of a few records. A search for a fast, reliable method of tripping the change-cycle mechanism was continued.

### Velocity trip

To provide fast, reliable tripping action, the velocity trip (sometimes called *acceleration trip*) mechanism was developed.

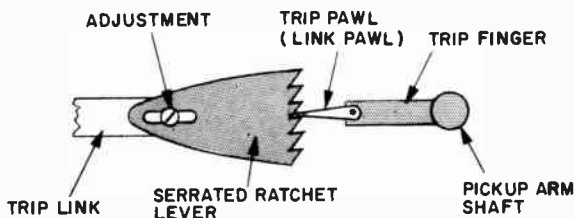


Fig. 704. Sketch of oscillating trip. The positioning of the ratchet lever can be adjusted on the trip link.

While the previously mentioned trip devices depend on the position of the pickup arm and the direction of the arm movement, this mechanism utilizes the pickup arm velocity—the speed at which the arm moves toward the spindle. While the record is being played, the grooves, being closely spaced, will carry the arm inward slowly; at the end of the record playing, though, where the runoff groove starts, it suddenly becomes widely spaced and moves rapidly toward the spindle. This sudden increase in speed, at the start of the runoff groove, actuates the trip mechanism.

The trip mechanism, then, must have some method of determining this increase in speed. To do this, the velocity trip employs a reference common to both slow and fast pickup arm speeds. This reference is one turntable revolution. The playing grooves will carry the arm a very small distance during one turntable revolution, but the runoff groove will carry the arm a greater distance during that time. As an average, if the arm moves  $\frac{3}{8}$  inch or more during one revolution, the velocity trip will be actuated.

In appearance the basic velocity trip is similar to the position type. The big difference, though, is that the trip finger is not rigidly attached to the pickup arm shaft. Instead, it is loosely coupled by means of a friction clutch, as shown in Fig. 705-a. The trip finger will follow and transfer the pickup arm motion as long as it is not opposed by an excessive force. As the pickup arm

rides the playing grooves, the trip finger contacts the drive pawl about half-way through the playing. The drive pawl is then slowly turned by the trip finger. The latching end of the drive pawl is gradually moved toward the flange on the main drive gear but because of its slow movement is placed directly in the path of the flange, as shown in the encircled drawing of Fig. 705-b.

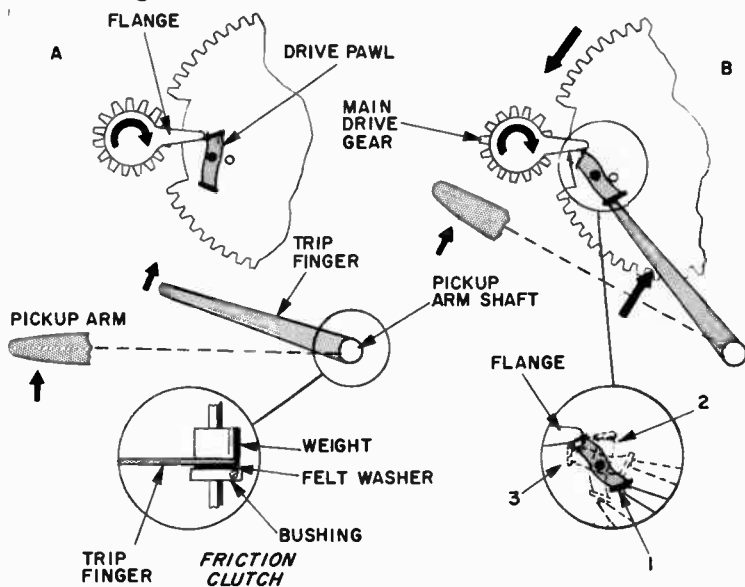


Fig. 705-a,-b. Velocity trip mechanism. It resembles the position type but differs in the use of a friction clutch.

This is position 1. The tip of the flange then strikes the face of the pawl, and resets it back to position 2. In turn, the pawl applies this force to the trip finger which slips in the friction clutch and also moves back. Because of this slippage, the pickup arm is not affected at all. This striking and resetting is repeated intermittently while the trip finger moves the drive pawl slowly. When the pickup arm rides into the runoff groove, on the other hand, the trip-finger velocity increases considerably and the trip finger turns the drive pawl to position 3 before the flange can come around to reset it. Instead, the flange latches it and the change cycle starts. As the pickup arm is raised and swung out, the trip finger is also moved back. The drive pawl is reset by the reset stud and at the end of the cycle the gear is disengaged as shown in Fig. 705-a. While the flange acts as the trip reset device this resetting can be accomplished by either: a separate flange, driven by the turntable; an extension on the change-cycle



drive; or a reciprocating lever. Also, it is not always the drive pawl that is reset; the trip finger can be pushed back or, if an intermediate lever or link is used, it too can be reset. Likewise, the use of the friction clutch varies slightly.

### **Trip friction clutch**

The trip friction clutch shown in Fig. 705 is used in Webcor changers and is fairly representative of the type. The bushing, held to the pickup arm shaft by a screw, holds the assembly up; it also acts as the bottom clutch plate. The other clutch plate is the weight that rests freely on top of the trip finger. (Sometimes two weighted discs are used instead of one.) This weight supplies the proper clutch pressure. The felt washer is used under the trip finger to supply a friction surface. With this setup, the finger will follow the motion of the pickup arm and transfer it to a freely pivoted part, but it will slip if it is obstructed. Although some trip clutches are adjustable, this one is not. Its operation is kept normal, though, if it is maintained clean and dry. Lubrication should never be used on a friction clutch or it will slip and be useless.

The friction clutch need not be at the pickup arm shaft; it can also be at the intermediate levers or even at the drive pawl. Fig. 706-a is a variation of the friction clutch previously described. The only difference is that the trip finger is at the top of the weight and securely attached to it; therefore the weight and trip finger slip together. The other parts perform the same functions. This clutch is not adjustable and must be kept clean and dry. The trip clutch pressure is adjustable in the unit shown in Fig. 706-b. The clutch parts are mounted on a plate securely attached to the pickup arm shaft. The two clutch plates apply the necessary friction for the trip finger to follow the motion of the pickup arm. When the adjustment screw is turned to move the stud up or down, the clutch plates will close up or loosen, causing the friction to increase or decrease.

The adjustable trip clutch shown in Fig. 706-c has the trip finger also resting on a plate securely attached to the pickup arm shaft. A pressure spring, held in place by a tapped washer, supplies the necessary friction to the trip finger. Turning the tapped washer up or down will decrease or increase the pressure so that trip finger slippage can be controlled. Fig. 706-d shows a trip friction clutch used at the drive pawl. The fiber washer between the drive pawl and the trip lever supplies the friction

between these parts. The spring washer on top of the drive pawl develops the pressure that controls the friction. With this clutch, the drive pawl slips when it is reset but the other parts keep following the pickup arm motion. If friction drops off with this clutch, the spring washer must be replaced. No adjustment is required.

It is very important that the proper pressure be maintained

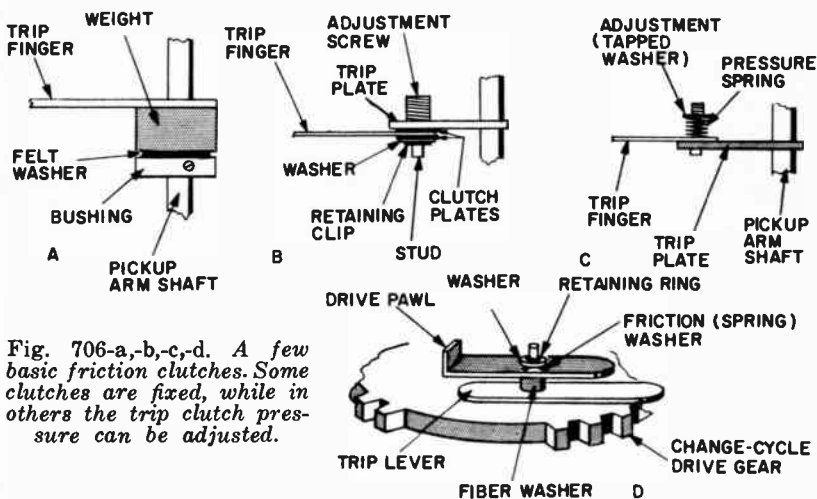


Fig. 706-a,-b,-c,-d. A few basic friction clutches. Some clutches are fixed, while in others the trip clutch pressure can be adjusted.

at the trip friction clutch for the trip mechanism to function properly. If the clutch is too tight, the record changer will trip too soon. If it is much too tight, it might kick the pickup arm back a groove or two whenever it is reset. If the clutch is too loose, the changer may not trip at all.

Trip clutches that have no provision for an adjustment should be kept clean, dry and free of lubrication. This should also be done with adjustable trips. If the trip clutch has an adjustment, it should be handled only as a last resort. Other troubles should be looked for first. If all else is normal, then make the adjustment. The adjustment is a trial-and-error procedure. If tripping occurs too soon, turn the adjustment to loosen the clutch. If tripping does not occur at all or is intermittent, turn the adjustment to tighten the clutch plates. The trip-clutch adjustment is sensitive. Because of this, make slight changes, in successive steps, until normal tripping operation is obtained.

### Reject control

Record changers provide a control, usually part of the selector knob, that permits the operator to reject a record being played

before that record is finished. The reject device is probably the simplest part of the changer mechanism. A fast look at what happens when the reject knob (or button) is operated makes the unit self-explanatory. The reject functions in conjunction with the trip mechanism. When the reject control is used, a lever (or possibly two) moves to actuate the trip mechanism. In the case of the trip mechanism previously discussed, the reject lever can turn the drive pawl, or else it can move the trip finger, or if a rim type change-cycle drive is used, the reject lever can move the drive wheel so that it engages. These are shown later.

### **Manual operation**

A number of record changers are designed so that when the selector knob is turned to "manual," the automatic function is temporarily incapable of operating. Without this added characteristic, the record changer would not operate properly with badly warped records, records without lead-in or runoff grooves, off-standard records and home recordings. If a record changer has a manual position, it makes certain service checks easier to accomplish, such as checking for rumble or magnetic cartridge hum pickup. With the selector knob placed in the manual position, the service check can be made without the bothersome worry about the change cycle starting suddenly. When a record changer is set for manual operation, all that is done, in effect, is that the trip mechanism is disabled.

When an automatic record changer is set for manual operation, an obstructing lever (in most cases), is moved against one of the trip mechanism parts to prevent it from acting as it normally would. This is shown in Fig. 707. The selector knob is shown in the automatic position. In this position, the knob holds the obstructing lever out of the way so that the trip finger can contact the drive pawl. When the knob is turned for manual operation, the obstructing lever moves directly into the path of the trip finger. Because of this, the trip finger will move in only until it meets the obstructing lever; then it will slip in the friction clutch and as a result the tripping action cannot take place.

The basic example shown in Fig. 707 is only one way of blocking the trip. Obstructions can also be placed at points A and B. If extra trip levers are used, they can also be obstructed. It is important to note, though, that the obstruction is always located between the friction clutch and the change-cycle drive so that the motion of the pickup arm is not hindered in any way. For instance, if the clutch were located at the drive pawl, the

trip finger would be securely fixed to the pickup arm shaft; therefore, if an obstruction were placed at the trip finger, the pickup arm would be held back.

### Servicing the trip mechanism

Before servicing the trip mechanism, remember that the condition of the record being played and the pickup needle are determining factors on how it functions. To start, it is common knowledge that the older records having no runoff grooves cannot possibly work with record changers, except in the manual position. Second, the center hole of the record should not be excessively worn. If it is, the record will seat off center and turn ec-

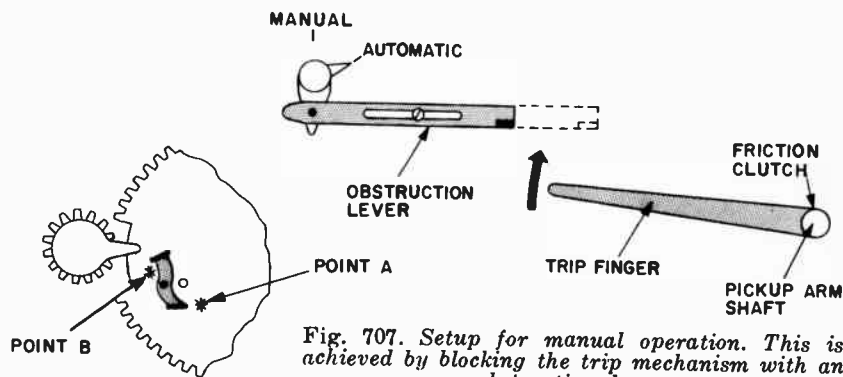


Fig. 707. Setup for manual operation. This is achieved by blocking the trip mechanism with an obstructing lever.

centrically. This will cause the arm to oscillate as it rides the playing grooves, and it may possibly actuate the trip too early. Third, since some trip mechanisms do apply a small amount of pressure to the pickup arm, the pickup needle being used should not be worn. If it is, the trip mechanism will cause the needle to jump back on the grooves.

In general, the trip mechanism produces three kinds of troubles: (1) the change cycle does not start, (2) the change cycle starts too early and (3) the change cycle keeps repeating. Their causes are basically similar in most automatic record changers. But, since each changer employs a somewhat different trip and drive combination, individual changers may sometimes present peculiarities common only to themselves. Therefore, it is more informative to give service information for some basic trip devices used by popular record changers. The following paragraphs discuss specific trip mechanisms, together with problems that may be encountered. These trips represent the basic methods employed by the industry. It will be noted that no eccentric trip is shown. (For the

last few years the eccentric trip has been discarded. It was discussed earlier for reference purposes.) The position trip is still occasionally used, but the velocity trip is by far the most popular and shows signs of taking over the tripping function completely.

The most important part of servicing a trip mechanism is that of cleaning. Dryness and cleanliness are essential for proper operation. If dirt or foreign matter accumulate at the trip parts, they will bind. This can prevent the tripping action from taking place or else the parts may bind in the tripped position and cause

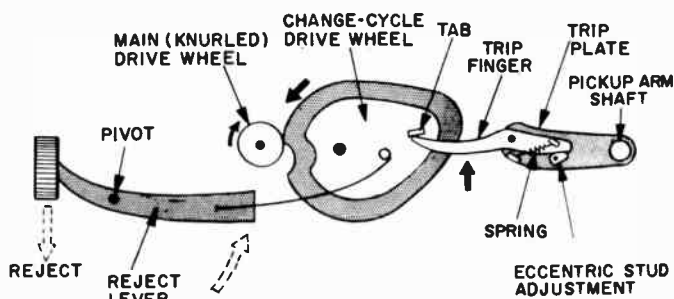


Fig. 708. Simple type of position trip mechanism used in automatic record changers.

the change cycle to repeat. If only a slight binding occurs, the reset action may be affected and the changer will trip too early. Lubrication, especially with the velocity trip, can render the mechanism useless. Oil or grease can accidentally contact a trip part while some other part is being lubricated. It is wise, therefore, to check each trip part after some other adjacent component has been lubricated. Then clean the trip parts until they are dry, if necessary. Do a thorough cleaning job with carbon tetrachloride. Pay particular attention to the pivot points and the friction clutch. Use an eye dropper for inaccessible points, and a brush (toothbrush) for more available areas.

Note in the following paragraphs that the troubles discussed are specifically concerned with tripping operation. Troubles such as the reject not operating, or the manual position not functioning are not dealt with because they are so simple. A short inspection determines these causes in short order. If the reject is faulty, just turn the reject knob and watch the reject lever to see that it actuates the trip. If manual operation is faulty, turn the knob to manual and trace the manual lever to see if it obstructs the trip. Most repairs on these parts involve no more than bending a lever or tightening a loose screw.

It was mentioned near the end of Chapter 6 that the change-cycle brake can cause the change cycle to repeat. This is an infrequent trouble, however, and so the trip mechanism should be checked first. If the trip mechanism functions properly, then check the change-cycle brake.

### **RCA position trip**

In Fig. 708 is shown the basic RCA RP-190 trip mechanism. It is probably one of the simplest used in automatic changers. The trip finger is mounted on a trip plate securely attached to the pickup arm shaft. The spring pulls the trip finger against the eccentric stud which is used to adjust the finger position and therefore the tripping action. During record playing, the trip finger does not contact the tab on the change-cycle drive wheel at all. At the end of the record, the finger strikes the tab and turns the change-cycle drive wheel; the wheel turns slightly and couples the drive wheel to start the change cycle. Note that in this changer the drive wheel is knurled, not geared. The reject lever can be used at any time during record playing to start the change cycle. When the reject button is moved, the lever turns and its extension spring moves the change-cycle drive wheel so that it couples the knurled drive wheel.

Following are the troubles that can cause improper tripping operation and the suggested remedies.

#### **Change cycle starts too early**

1. Eccentric stud improperly adjusted. Turn the stud to move the trip finger away from the change-cycle drive wheel so that the trip finger makes contact when the pickup arm enters the runoff grooves.

#### **Change cycle does not start**

1. Eccentric stud improperly adjusted. Turn the stud to move the trip finger toward the change-cycle drive wheel so that the trip finger makes contact when the pickup arm enters the runoff grooves.

2. Tab on change-cycle drive wheel is bent. Straighten it.

3. Change-cycle drive wheel binding on shaft. Clean shaft thoroughly and straighten if bent.

4. Trip-finger spring weak or missing, causing finger to be loose. Replace spring.

5. Knurled main drive wheel loose on turntable shaft. Tighten screws holding wheel in place.

6. Rim of change-cycle drive wheel worn so that it slips. Replace wheel.

7. Change-cycle drive wheel located too far from knurled drive wheel so that they cannot couple. Cycle wheel is mounted on a slide cam that pulls the wheel toward the main drive. (This was shown in Fig. 616.) It is held at bay by a stop bracket. Loosen stop-bracket mounting screws and reposition the bracket to allow the slide cam to bring the change-cycle drive wheel closer to knurled drive wheel; if this does not help, bend stop arm on stop bracket.

#### **Change cycle keeps repeating**

1. Reject lever jammed in reject position. Clean its pivot or bend lever to prevent binding.

2. Change-cycle drive wheel located too close to knurled drive wheel. Adjust slide-cam stop bracket to relocate drive wheel. (See Fig. 616).

#### **Motorola position and velocity trip**

This basic trip, illustrated in Fig. 709, is used for the dogclatch drive discussed in Chapter 6. Discounting the dotted lines, we have a position trip. The trip plate holds up the weighted end of the drive clutch lever so that the flanged end cannot couple the turntable drive dog. The trip plate is part of the trip arm which is mounted as a slide. The trip spring tends to pull the trip arm back but the trip flag prevents this. At the end of the record playing, the trip finger moves the trip flag, as shown in the encircled drawing. This permits the trip spring to pull back the trip arm and the trip plate. The drive clutch lever then tilts so that its flange couples the drive dog on the turntable to start the change cycle. At the end of the cycle, the trip arm and plate are moved back into position to level off the drive clutch lever; this stops the change cycle. The trip flag falls back in position to hold the trip arm. This mechanism is the Motorola RC-36. A later type, the RC-36A, has the added parts shown by the dotted lines to make it a velocity trip.

As a velocity trip, the trip finger is mounted in a clutch and contacts the trip flag while the pickup arm is on the playing grooves. As the trip finger moves with the pickup arm, it has a tendency to push out the trip flag. With every revolution of the turntable, however, a reset wiper, mounted to the turntable underside, hits the trip rod (reset lever). The trip rod then resets the trip flag. But, at the runoff grooves, the trip finger

pushes out the flag before the wiper can come around to reset it. The following conditions can cause improper tripping operation. Also, the drive-dog adjustment, discussed in Chapter 6, can produce these troubles.

**Change cycle starts too early**  
**With the position trip**

1. Trip finger adjusted too close to trip flag. Adjust eccentric stud to move trip finger away from trip flag so that finger makes

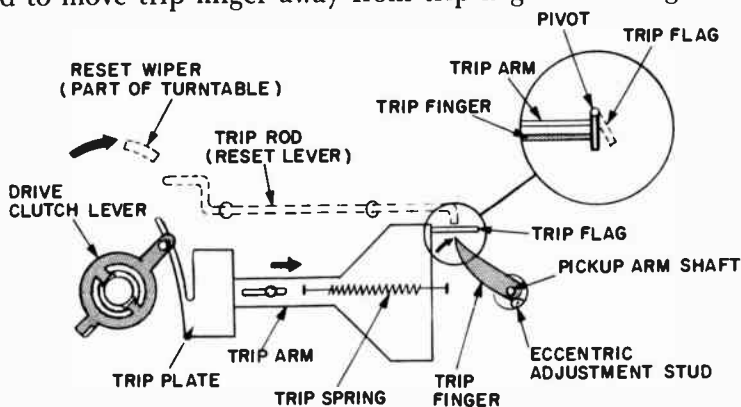


Fig. 709. Position and velocity trip mechanism. Inset shows details of trip flag and finger.

contact when pickup arm enters runoff grooves.

2. Trip flag bent so that it barely holds back trip arm. Straighten flag.

**With the velocity trip**

1. Reset wiper does not contact trip rod enough to reset trip flag. Bend wiper down to make better contact.
2. Trip rod bent so that it binds or makes poor contact. Straighten trip rod.
3. Trip flag bent so that it barely holds back trip arm. Straighten flag.
4. Trip finger clutch binding. Clean it thoroughly.

**Change cycle does not start**

**With the position trip**

1. Trip flag binding. Clean it thoroughly and bend it if necessary.
2. Trip arm binding—cannot slide back. Clean slide surfaces thoroughly.
3. Trip spring weak or missing. Replace spring.
4. Trip finger adjusted so that it does not hit trip flag. Adjust



eccentric stud to move trip finger closer to trip flag so that contact is made when pickup arm enters runoff grooves.

5. Lever on trip plate bent outward so that it does not release drive clutch lever. Straighten lever on trip plate.

### With the velocity trip

1. Reset wiper makes too much contact with trip rod so that trip flag is reset too far. Bend wiper up to make less contact.

2. Same as for position trip.

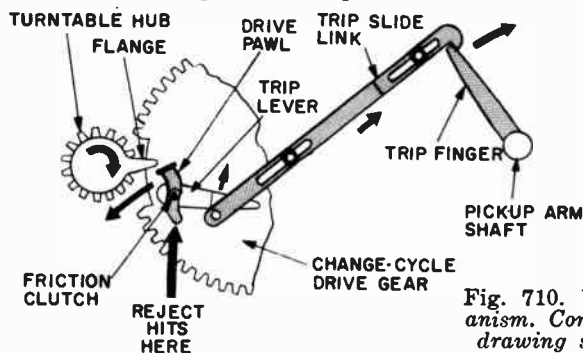


Fig. 710. Velocity trip mechanism. Compare this with the drawing shown in Fig. 705.

### Change cycle keeps repeating

#### With the position and velocity trips

1. Trip flag bent or binding so that it does not hold back trip arm. Straighten flag and clean it thoroughly.

2. Lever on trip plate bent so that it does not disengage drive clutch lever at end of cycle. Straighten lever.

3. Drive clutch lever mounted on main drive gear 180° out of phase. Turn clutch lever around.

### Admiral velocity trip

The trip finger (see Fig. 710) is firmly attached to the pickup arm shaft. At about the center of the playing grooves it contacts and moves the trip slide link; at the other end of the trip slide link, the trip lever turns. The trip lever is mounted on the same shaft as the drive pawl and couples to it by a friction clutch. The drive pawl turns with the trip lever. But, during the record playing, with each revolution of the turntable, the end of the flange on the turntable hub strikes the face of the drive pawl. This resets the drive pawl. Due to the friction clutch, the other parts are not affected. At the end of the record, the drive pawl is moved too fast to be reset, so it moves in and latches with the flange to start the change cycle. During the cycle, the drive pawl is reset to the disengaged position and the trip slide link is

pushed back to the starting position. When the reject knob is rotated, it causes a lever to push the other end of the drive pawl so that the drive pawl turns and latches with the flange.

The following are causes and cures of improper tripping operation.

### Change cycle starts too early

1. Binding friction clutch. Clean it thoroughly.
2. Latching end of drive pawl bent so that flange latches it instead of resetting it. Bend latching end straight.

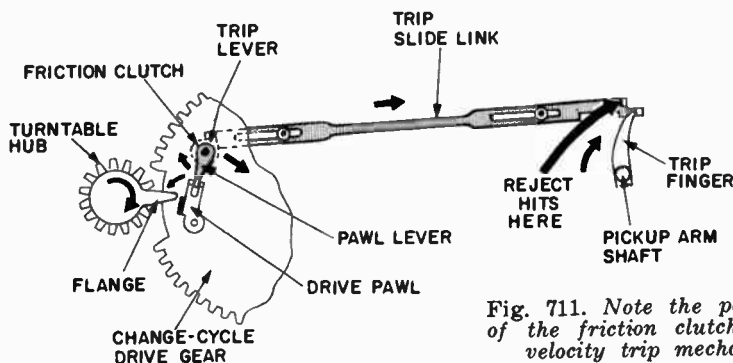


Fig. 711. Note the positioning of the friction clutch in this velocity trip mechanism.

### Change cycle does not start

1. Trip slide link bent so that it does not turn trip lever. Straighten the link.
2. Trip lever bent so that it is not turned by trip slide link. Straighten the lever.
3. Friction clutch spring weak. Replace spring.
4. Drive pawl binding. Clean drive pawl thoroughly and straighten, if bent.
5. Latching end of drive pawl bent so that it cannot latch flange. Straighten.

### Change cycle keeps repeating

1. Trip slide link not returned to start position. A thin spring on the arm control assembly is used to push the trip slide back. This spring may be bent. Straighten it.
2. Trip slide link binds so that it is not pushed back to start position. Clean slide points and straighten if bent.
3. Reject parts binding. Clean thoroughly and straighten if bent.

## V-M velocity trip

Shown in Fig. 711, this basic trip is similar in many respects to the previous one; the main difference is the position of the friction clutch. The trip finger is secured to the pickup arm shaft. About halfway through the record playing, the trip finger contacts the trip slide link and moves it back. This, in turn, rotates the trip lever at the bottom of the change-cycle drive gear. The trip lever is coupled to the pawl lever at the other side of the cycle drive by means of a friction clutch. The pawl lever turns and moves the drive pawl toward the flange on the turntable hub. During the record playing, the flange strikes the face of the drive pawl and resets it. The drive pawl also moves the pawl lever back, but due to the friction clutch, the other parts are not affected. As the pickup arm enters the runoff grooves, the drive pawl is moved too fast to be reset and so it latches with the turntable hub flange to start the change cycle. The reject knob, when turned, moves a lever that pushes the trip slide link to start the change cycle before the end of a record. Causes and cures of improper tripping operations are:

### **Change cycle starts too early**

1. Binding friction clutch. Clean it thoroughly.
2. Latching end of drive pawl bent so that flange latches it instead of resetting it. Bend latching end straight.

### **Change cycle does not start**

1. Trip slide link bent so that it does not turn trip lever. Straighten link.
2. Trip lever bent so that it is not turned by trip slide link. Straighten lever.
3. Friction clutch spring weak. Replace spring.
4. Pawl lever or drive pawl binding. Clean thoroughly and straighten bent part.
5. Latching end of drive pawl bent so that it cannot latch flange. Straighten.

### **Change cycle keeps repeating**

1. Trip slide link not returned to start position. A locating lever on the arm control assembly is used to push back the slide link. The lever or the trip slide may be bent. Straighten bent part.
2. Binding of trip lever, pawl lever or drive pawl. Clean parts thoroughly or straighten bent parts.

## Webcor velocity trip

The basic trip of the Webcor Model 1121, shown in Fig. 712, is the velocity trip employed with the pawl-latch drive discussed in Chapter 6. The trip finger is attached to the pickup arm shaft by a friction clutch. About half-way through the record playing, the trip finger contacts the trip lever, tending to turn it so that it will release the drive pawl. However, while the pickup is riding the playing grooves, reset projections on the circumference of the change-cycle drive gear strike the reset bumper on the end of the trip lever. This resets the trip lever so that it does not release the drive pawl. The trip finger slips back in the friction clutch when the trip lever is reset. When the pickup arm

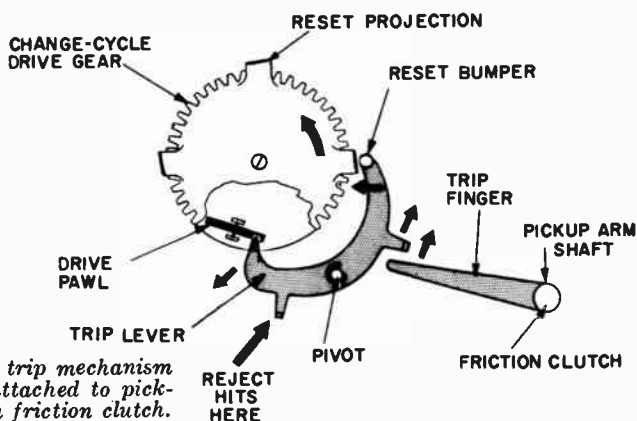


Fig. 712. Velocity trip mechanism with trip finger attached to pickup arm shaft by a friction clutch.

enters the runoff grooves, the trip finger moves the trip lever too fast for it to be reset. The trip lever then releases the drive pawl so that the pawl turns to latch the bosses (metal extensions) at the underside of the change-cycle drive gear; this starts the change cycle. During the cycle, the trip lever is reset by the reset projections on the change-cycle drive gear; it is put directly in the path of the drive pawl so that it will uncouple the pawl at the end of the cycle.

The reject knob, when operated, moves the reject lever which turns the trip lever to start the cycle while a record is being played. (The later Webcor model 141 record changer uses a change-cycle drive similar to that shown in Fig. 705, but the trip mechanism is essentially the same as that discussed here). The following can cause improper tripping operation:

### **Change cycle starts too early**

1. Trip lever bent so that it does not engage and hold drive pawl properly. Straighten lever.
2. Trip lever bent so that reset bumper does not contact reset projections on change-cycle drive gear. Straighten it.
3. Trip finger binding in friction clutch. Clean friction clutch thoroughly.

### **Change cycle does not start**

1. Friction clutch loose or greasy. Tighten clutch-plate mounting screw if it is loose and clean clutch thoroughly.
2. Friction clutch felt washer worn smooth. Replace.
3. Trip finger bent so that it does not contact trip lever. Straighten finger.
4. Trip lever binding so that it is not moved by trip finger. Straighten it or clean its pivot thoroughly.
5. Drive pawl binding so that it does not turn when released. Clean pivot points thoroughly.

### **Change cycle keeps repeating**

1. Trip lever bent so that it is not reset. Straighten lever.
2. Trip lever bent so that it does not disengage drive pawl. Straighten.
3. Reject lever binding in reject position. Straighten reject lever and clean thoroughly so that it moves freely.

### **Zenith electrical velocity trip**

All of the trip mechanisms discussed up to now were purely mechanical devices. The basic Zenith S-14057 velocity type utilizes an electromagnet as the trip release. The drive pawl, a gear tooth (see Fig. 713-a), is held off by a trip lever. The trip magnet, when energized, will attract one end of the trip lever and cause it to turn and release the drive pawl. One lead of the trip magnet winding is connected to 6.3 volts a.c. The other lead is connected to a trip contact. If this trip contact is connected to ground (through the changer chassis), the trip magnet-winding circuit will be completed, and the magnet will become energized. The trip finger, being at ground potential, will complete the circuit when it strikes the trip contact.

During the record-playing, the trip finger slowly approaches the trip contact and at about the middle of the playing grooves the finger tends to make contact. However, an oscillating reset

stud, projecting through an opening in the chassis, moves back and forth, resetting the trip finger before it makes contact. The trip finger is mounted to the pickup arm shaft by a friction clutch and slips back whenever it is reset. The reset stud is made to oscillate by an eccentrically pivoted gear, as shown in Fig. 713-b. The illustrations show how the eccentric (or oscillating)

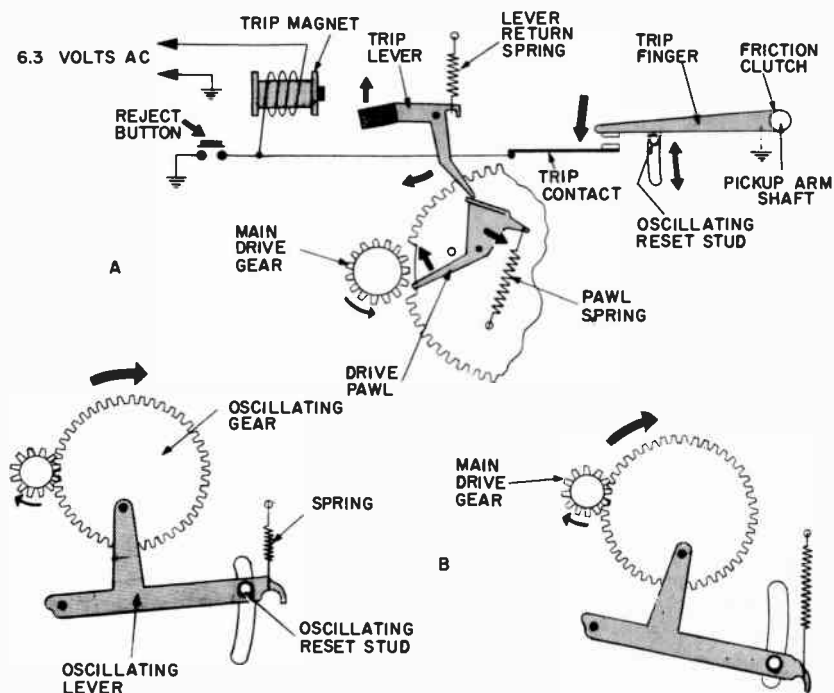


Fig. 713-a, b. Illustrations above show action of basic Zenith S-14057 velocity trip mechanism.

gear, driven by the main drive gear on the turntable hub, moves the oscillating lever back and forth. The reset stud is attached to the end of the lever so that it oscillates too.

When the pickup arm enters the runoff grooves, the trip finger moves too rapidly for the reset stud to reset it. The trip finger moves in and touches the trip contact, completing the trip magnet circuit. The trip magnet becomes energized and attracts the trip lever. The trip lever turns and permits the drive pawl spring to turn the pawl into mesh position with the main drive gear; this starts the change cycle. As the pickup arm is lifted and pulled back, the trip finger is also moved back, so that the trip magnet is de-energized. The lever return spring pulls the trip lever back

into position directly in the path of the drive pawl. At the end of the cycle, the trip lever contacts the drive pawl and causes it to turn out of mesh so that the change cycle stops.

The reject method in this device is quite simple. When the reject button on top of the changer chassis is depressed it completes the electrical circuit of the trip magnet so that the cycle is started. (With radio-phono combinations, this reject button is sometimes located on the front panel.) Following are causes of improper tripping operation.

#### **Change cycle starts too early**

1. Friction clutch dirty. Clean thoroughly.
2. Trip finger bent so that contact is made before it can be reset. Straighten trip finger.
3. Trip contact bent so that contact is made before finger can be reset. Straighten.
4. Reset mechanism not working. Gear may be stripped, lever may be bent causing binding or spring may be loose or missing. Repair or replace necessary part.

#### **Change cycle does not start**

1. Friction-clutch felt washer worn smooth, causing finger to slip back. Replace washer.
2. Trip finger bent so that it cannot meet trip contact. Straighten finger.
3. Trip contact bent so that it does not meet trip finger. Straighten contact.
4. Reset mechanism not oscillating and stopped in position to block trip finger. Replace faulty part.
5. Trip magnet open-circuited. Repair wiring or replace trip magnet.
6. Necessary 6.3 volts not being supplied to trip magnet. Sometimes a separate transformer supplies this voltage or it may be obtained from the filament supply of the receiver if the changer is part of a combination. In later Zenith changers, the record changer motor acts as a transformer to supply this voltage. Trace circuit and replace faulty part.
7. Drive pawl binding. Clean it thoroughly.
8. Drive pawl spring weak or missing. Replace spring.

#### **Change cycle keeps repeating**

1. Lever return spring weak or missing. Replace spring.
2. Trip lever binding or damaged. Clean thoroughly or replace.

3. Reject button stuck in reject position. Repair or replace.
4. Trip contact or wiring grounded. Repair circuit.
5. Trip finger positioned on wrong side of oscillating reset stud. Reposition it.

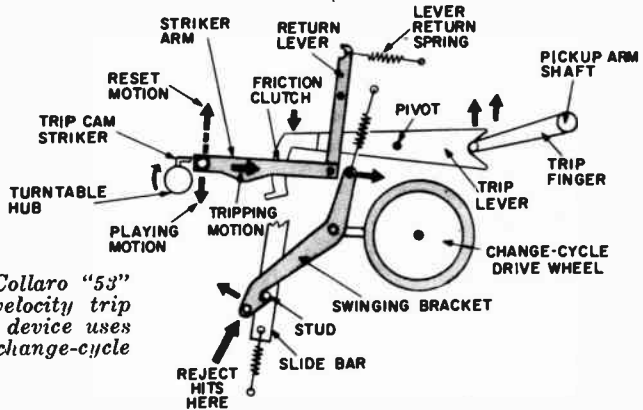


Fig. 714. Basic Collaro "53" Series striking velocity trip mechanism. This device uses a rim type of change-cycle drive.

### Collaro striking velocity trip

This trip mechanism is shown in Fig. 714. At a glance, it appears to be much more complex than the previous ones. It is a little more difficult to understand because it operates in a slightly different manner, but it is not as bad as it looks. The trip device shown represents the basic Collaro 53 type. This employs a rim type of change-cycle drive. For the mechanism to be tripped, the change-cycle drive wheel must be released so that it can move toward the rim of the turntable. The change-cycle drive wheel is held away by the swinging bracket whose lip is latched to the stud on the slide bar. The swinging bracket lip must be moved in the direction shown by the arrow for it to be released by the stud. To pivot the swinging bracket in just this manner, the striker arm is driven in the direction of the tripping-motion arrow to strike the other end of the swinging bracket. What must be done, then, is to get the striker arm to act in this way.

The trip finger, firmly secured to the pickup arm shaft, follows the travel of the arm. It moves the V portion of the trip lever so that the curved section of the trip lever carries the striker arm toward the turntable hub. The striker arm is carried only by its own weight as it rests on the curved portion of the trip lever. This comprises the friction clutch. While the pickup arm is on the playing grooves, the striker arm approaches the turntable hub slowly until the trip cam striker contacts it slightly and moves it back; it is reset in the direction of the dotted arrow.



When the pickup arm rides into the runoff grooves, though, the striker arm moves in faster so that it is not reset. Instead it moves directly in the path of the trip cam striker and makes solid contact. This drives the striker arm in the direction of the tripping arrow, so that it hits the swinging bracket. This pivots the bracket so that it is released (moves off the stud) and the change cycle starts. After the mechanism has been tripped, the return spring pulls the return lever so that the striker arm is moved back.

To start the tripping action while a record is being played, the reject device is used to push the stud to release the swinging bracket. Improper tripping can be caused by:

#### **Change cycle starts too early**

1. Friction clutch surfaces dirty. Clean thoroughly.
2. Curved end of trip lever bent so that striker arm slides in. Straighten lever.

#### **Change cycle does not start**

1. Swinging bracket spring weak or missing. Replace.
2. Curved end of trip lever bent so that striker arm slides away. Straighten.
3. Return lever binding. Clean thoroughly and straighten if necessary.
4. Striker arm bent or broken. Repair or replace.

#### **Change cycle keeps repeating**

1. Swinging bracket bent so that it does not latch in disengaged position. Straighten bracket.
2. Lip on swinging bracket worn or stud that latches it is broken. Replace defective part.
3. Striker-arm return spring weak or missing. Replace spring.
4. Curved end of trip lever so bent that it does not carry striker arm back to playing position. Straighten trip lever.

# raising the pickup arm

**T**HE first action of the change-cycle drive is to raise the pickup arm above the finished record so that it can safely be swung out clear of the stack of records on the spindle. Most automatic record changers are designed so that the pickup arm can be lifted high enough to permit twelve 10-inch or ten 12-inch records to be played in sequence. Some record changer manufacturers rate this as a 1-inch stack. They strive to make this arm-raising operation as smooth as possible and to prevent the arm from bouncing when it reaches the limit of its travel. With most record changers, the action is smooth, but with some it is not because of the methods employed. Arm raising is accomplished around the pickup arm hinge. Because most pickup arms are now made of plastic, an erratic motion can cause wear at the hinge points. The arm would tilt while riding the grooves, causing poor tracking.

## Basic raising methods

The various arm-raising devices do not differ too much. There are a few modifications but actually these can be broken down to two basic actions: (1) we can push up the pickup arm in front of the hinge or (2) we can pull down the pickup arm in back of the hinge. The differences come about in the method of pushing or pulling. The most popular device is a rod that pushes the arm in front of the hinge. Three examples are shown in Fig. 801. The push-rod device is popular because it facilitates adjustment and can be actuated smoothly. As shown, pickup-arm hinging can be accomplished in a number of ways: the arm can be hinged directly

or it can be attached to a plate which is hinged; a simple hinge pin may be used or cone-point screws may be the pivots.

The push rod rests freely inside the hollow pickup-arm shaft. With the simple arrangement shown in Fig. 801-a, the push rod rises to meet the screw and then pushes up the pickup arm. The screw can be adjusted so that, if it is turned down, the arm will be pushed up higher, and vice versa. The spring is used with the

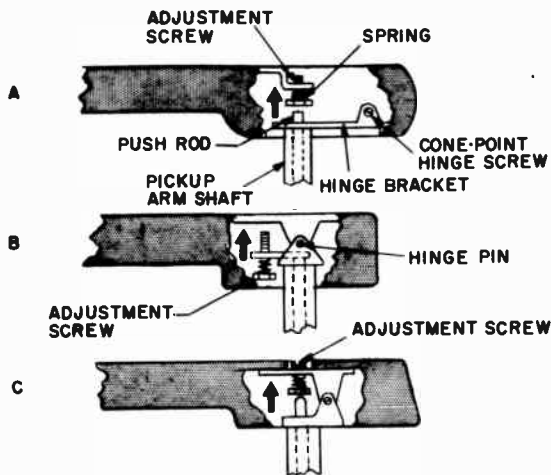


Fig. 801-a,-b,-c. Basic push rod arm-raising devices.

adjustment screw to keep the screw tight so that it will not turn and become misadjusted when it is driven by the push rod.

The arrangement of Fig. 801-b does the same thing, except the adjustment screw is mounted on a push-rod assembly. Turning down this screw will decrease the pickup-arm height. The setup shown in Fig. 801-c is similar to that shown in Fig. 801-a except that it has the added feature that the screw can be turned from the top of the arm. To adjust the others, the arm must be lifted to gain access to the screw.

Three methods of pulling the rear of the arm down to raise the arm are shown in Fig. 802. These methods are each quite different. In Fig. 802-a we have a pull cord attached to the rear of the hinge plate. When the change-cycle mechanism tugs at the pull cord, the pickup arm is turned so that it is raised. The arm-raising setup in Fig. 802-b is actuated in a manner similar to the push-rod device. Here, though, the pickup-arm shaft itself is moved up. As the assembly rises, the rear of the hinge is obstructed by a plate and so the arm turns around its hinge and is raised. In the

assembly of Fig. 802-c, a raising pin extends from the hinge assembly down below the record changer chassis. When the change cycle starts, a lever engages the raising pin and pushes it. This turns the arm around its hinge to raise it. The raising pin is attached to a bracket that is positioned by an adjustment screw. Turning the screw in or out will reposition the pin and cause it to be pushed earlier or later to change the pickup arm height. The raising assemblies of Fig. 802-a,-b have no convenient adjustment screw. In these the height is varied by bending a lever.

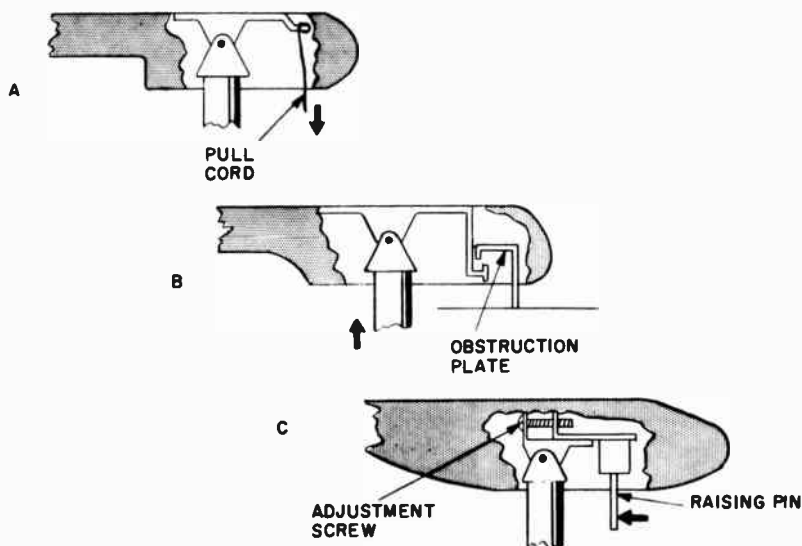


Fig. 802-a,-b,-c. Behind-the-hinge pickup arm raising methods.

The previous paragraphs discussed basic devices employed to raise the arm. These must be actuated by the change-cycle drive so that they act in the proper manner. Since it is an upward movement that is being dealt with, the incline cam surface is used quite extensively. The incline cam can be on the change-cycle drive or it can be on a separate plate.

Fig. 803 shows the simple arrangement that is possible with the use of a change-cycle slide cam. While a record is being played, the change-cycle slide cam is in the neutral position shown by the dashed lines and is separated from the push rod. When the change cycle starts, the slide cam is driven so that the push rod rides up the incline surface and raises the pickup arm. At the end of the cycle, the slide cam moves back and the return spring moves the push rod down so that the arm is lowered. In this record changer,

the incline surface is the bent end of the slide cam. The incline surface, though, need not be a bend. The RCA slide cam, for instance, is straight but has on its surface a raised portion that moves the push rod up.

Fig. 804 shows the use of an arm control plate with a depressed area acting as the incline surface. This assembly is actuated by a change-cycle cam wheel. While the record is being played, the roller at the end of the drive link seats in the indented portion of the cam wheel. In this position, the recessed section of the arm control plate, which is the incline surface, is directly below

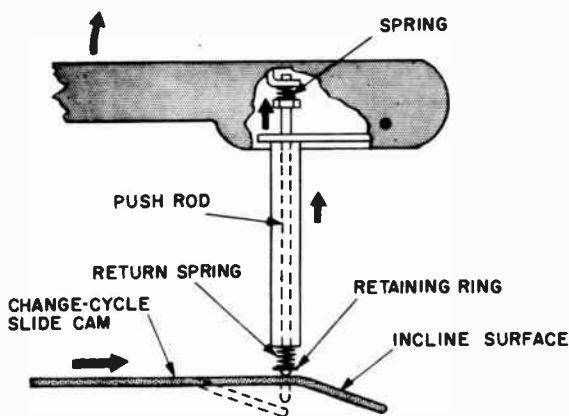


Fig. 803. Slide-cam push-rod technique.

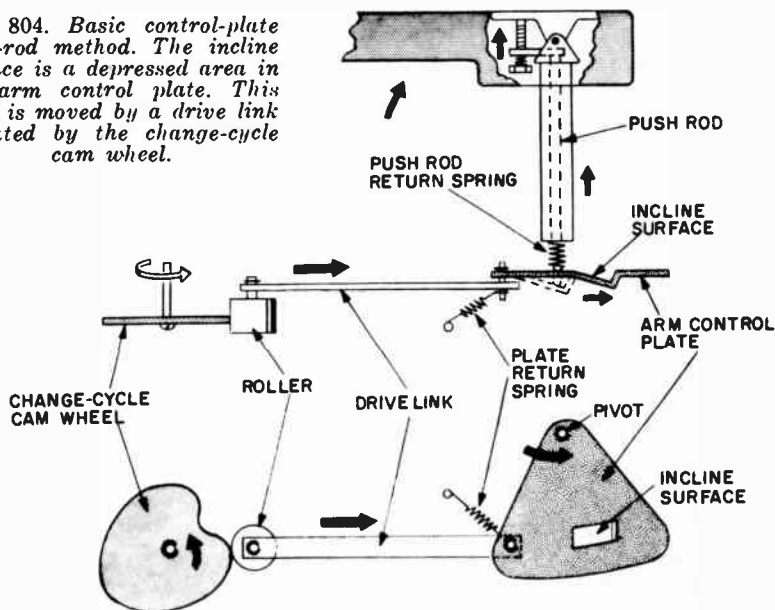
the push rod, so that the push rod is not actuated. When the change cycle starts, the change-cycle cam wheel is turned. The rim of the cam wheel pushes the roller and drive link so that the arm control plate is turned. When the plate turns, the push rod rides up the incline surface and raises the arm. The plate return spring pulls the arm control plate back into playing position when the roller moves into the indented portion of the cam wheel at the end of the cycle. The incline surface then moves under the push rod to release it, so that the arm is lowered.

In Fig. 805 the pickup arm shaft is lifted. An incline cam surface at the underside of the change-cycle cam wheel (shown by dashed lines) pushes down on the raising lever as the cam wheel turns. The lever pivots and pushes up the pickup-arm shaft. As the assembly moves up, the rear of the hinge bracket is obstructed by a plate so that the front of the pickup arm is raised. The return spring pulls the lever to lower the arm when the incline surface on the change-cycle cam wheel tapers off at the end of the

cycle. The height adjustment in this unit is made by bending the raising lever up or down.

Fig. 806 illustrates the pull-cord method of raising the pickup arm. The dashed lines show the position of the parts while a record is being played. The pull cord has enough slack in it so that it will not interfere with the pickup-arm motion as it rides across the record. When the change cycle starts, the incline sur-

Fig. 804. *Basic control-plate push-rod method. The incline surface is a depressed area in the arm control plate. This plate is moved by a drive link actuated by the change-cycle cam wheel.*



face at the bottom of the change-cycle drive moves and permits the raising spring to pull the raising lever; the lever pivots and tightens the cord. The cord pulls down the rear of the hinge plate and the pickup arm moves up. When the change-cycle drive comes around at the end of the cycle, the incline surface pushes the raising lever back so that the pickup arm is released and lowered. The height adjustment in this unit is made by bending the hinge-plate lip up or down; the raising lever can also be bent.

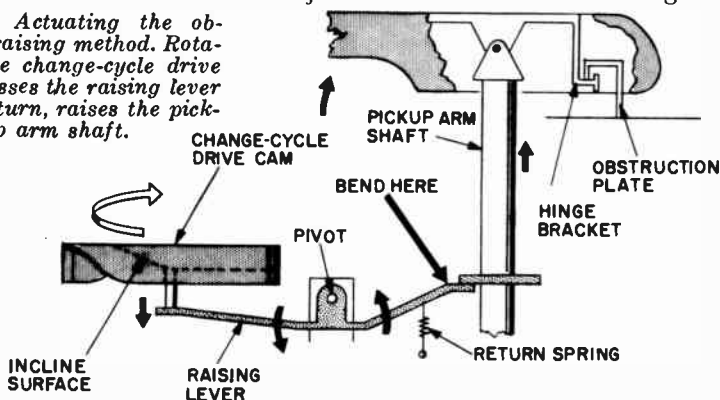
In Fig. 807 we have an arm-raising setup that does not use an incline surface at all. The arm is lifted when the raising lever pushes the raising pin. (See the side view in Fig. 807.) While the record is being played, the holdoff stud on the change-cycle drive gear keeps the raising lever in the position of the dashed lines. When the change cycle starts, the cycle drive turns and moves the holdoff stud away from the raising lever. The raising spring then pulls the raising lever in to pivot it so that its other end engages

the raising pin; this raises the arm. At the end of the change cycle, the cycle drive comes around and the holdoff stud pushes the raising lever back to the playing position, so that the pickup arm is released and lowered.

### Adjusting pickup-arm height

Adjustment of the pickup-arm height is probably the simplest procedure associated with automatic record changers, since, in most cases, it is not a critical adjustment. Most record changers

Fig. 805. Actuating the obstruction-raising method. Rotation of the change-cycle drive cam depresses the raising lever which, in turn, raises the pickup arm shaft.



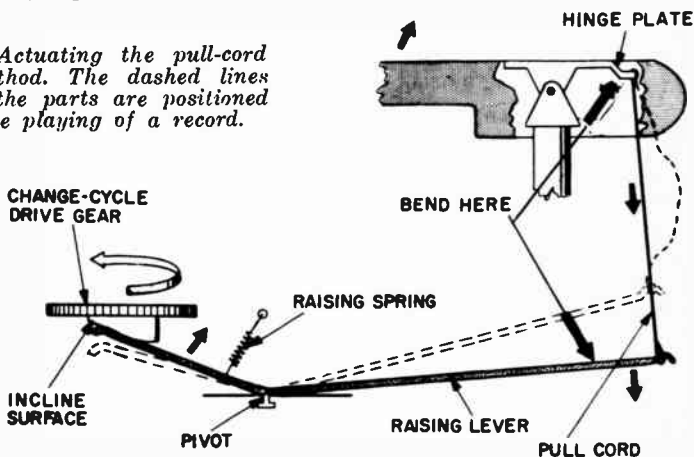
will work well over a wide range of heights. However, some service technicians think all that is necessary is to turn the screw or bend the lever so that the arm will be moved up as close to the next record as possible. With some changers, this procedure is satisfactory; with others it will not work. Most changers that employ the push-rod raising method utilize the neutral position of the rod as a needle saver. This means that if the pickup arm is inadvertently dropped, the push rod will stop the arm before the needle strikes the record changer chassis. Because of this design, if the pickup arm height adjustment is made too great, the push rod will seat too high and interfere with the pickup arm, preventing it from resting properly on the first one or two records. With these record changers the arm is adjusted while the changer is out of cycle, as shown in Fig. 808-a. Make the adjustment so that the needle rests  $\frac{1}{4}$  inch above the record changer chassis.

In other changers, the arm is adjusted during the cycle, with a full stack of records on the turntable, as shown in Fig. 808-b. Set the arm height with the power off and rotate the turntable by hand until the arm is raised to its limit. There should be at least  $\frac{1}{4}$ -inch clearance between the needle tip and the top record. Some manufacturers recommend only  $\frac{1}{16}$  inch clearance, but this will not be sufficient if a record is slightly warped.

## Servicing the pickup-arm-raising assembly

The most common trouble that occurs, of course, is the height adjustment going off and normally this is easily rectified. Other troubles do occur but very rarely. Among them are: (1) pickup-arm height cannot be adjusted, (2) pickup-arm height adjustment changes, (3) pickup-arm raising is erratic, (4) pickup-arm is not raised and (5) pickup-arm does not lower or comes down too slowly.

Fig. 806. Actuating the pull-cord raising method. The dashed lines show how the parts are positioned during the playing of a record.



### Pickup-arm height cannot be adjusted

This trouble pertains to the adjustment screw. First make sure the adjustment screw threads are not stripped; this will prevent it from moving up or down when it is turned. If the screw or the part that holds it has stripped threads, it will have to be replaced. If the adjustment screw seems to act normally, one of the parts that actuates the assembly is probably bent. In this case, the height adjustment screw should be set at its midpoint and the turntable rotated by hand until the pickup arm is raised to its limit. Then the slide cam, or lever, whichever the case may be, should be bent so that it moves the pickup arm close to the proper height. The screw can then be used to complete the adjustment. It would do well to note that the RCA model RP-190 changer provides a thumbscrew adjustment at the slide cam which moves the slide cam up or down to change the pickup-arm height.

### Pickup-arm height adjustment changes

If the pickup-arm height has been adjusted so that the arm operates normally, and then operation becomes abnormal, it is a sign of a loose part changing position while it is operating. The first part to check is the spring that holds the adjustment



screw tight. If it is weak or broken, replace it. Next, see that the threads on the adjustment screw or the assembly that holds it are not worn or stripped. If they are, the screw will be loose and it will turn of its own accord when it is contacted. The defective part must be replaced.

The actuating part under the changer chassis, such as the raising lever, should not be excessively loose on its pivot. If it is it will slant intermittently when actuated; this will change the effective distance it moves the arm-raising parts. These are most often held in place by a retaining ring, but screws or rivets are also used.

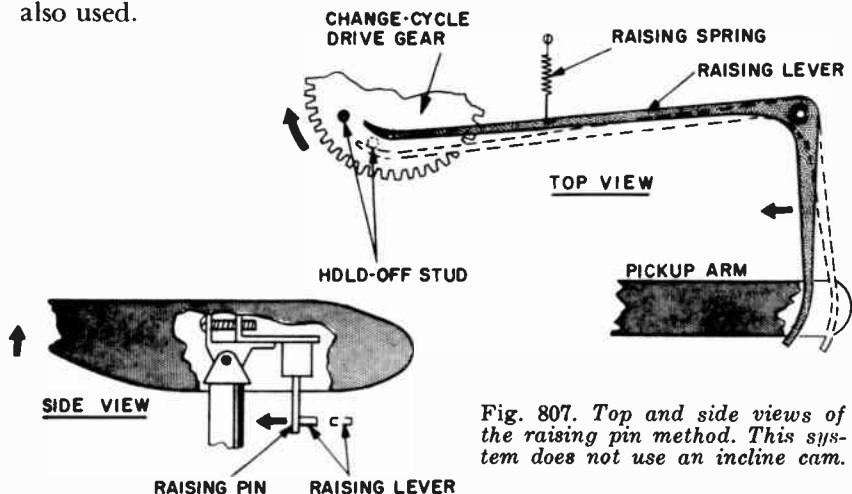


Fig. 807. Top and side views of the raising pin method. This system does not use an incline cam.

Washers are often used with retaining rings to prevent excessive endplay and therefore tilting of the lever. See that the washer (or washers) has not been mistakenly left out after a previous repair. Put in a new washer to reduce the endplay. Be careful not to retard the free motion of the lever; a small amount of endplay is necessary. If a screw is used, make sure it is tight. Washers are also used with screws, so see that the washers are in place.

If the lever is pivoted on a rivet, the rivet may be loose, permitting the lever to tilt. Use a rivet tool to tighten the rivet. If the rivet is too far gone, drill it out and hammer a new one in its place. If a rivet tool is not on hand, a nut and screw can sometimes be used. However, when substituting a nut and screw in place of a rivet, use lockwashers so that they will not loosen with use. Also, do not make the nut and screw too tight; allow the part to pivot freely. If, however, it is not desirable to make a detailed repair, the entire riveted assembly can be replaced.

### Pickup-arm raising is erratic

If pickup-arm raising is erratic—that is, it jumps, bounces or takes place in jerky motions—it can be due to loose parts, dirt, or lack of lubrication. In looking for loose parts, use the information given in the previous paragraphs. If there is an accumulation of dirt or foreign matter on the incline cam surface, the lever pivot, or the push rods, erratic operation will result. Clean and lubricate these points thoroughly. Apply carbon tetrachloride freely to the pivot points and cam surfaces. Rub them with a clean cloth or

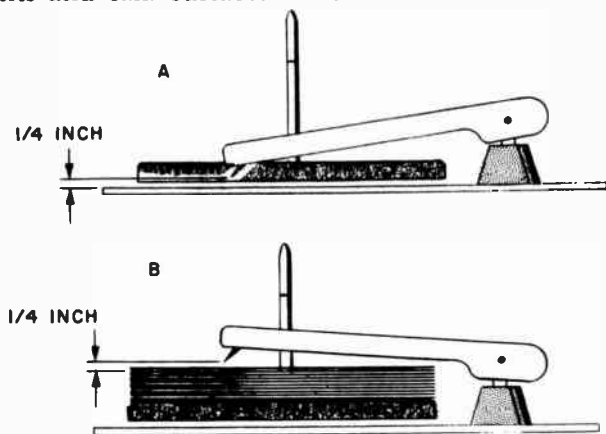


Fig. 808. *Adjusting the pickup arm height.*

scrub with a toothbrush, whichever is more convenient. Move the lever manually while cleaning its pivot. Move the push rod up and down while applying the solvent. On some record changers, the push rod can be easily lifted out after the arm is raised. If this can be done, do it so that you can do a more thorough cleaning job. Check for burrs on the push rod and cam surfaces; polish them with emery cloth. Pay particular attention to the cleaning and polishing of the incline cam surfaces.

If the existing lubrication is worthless, remove it thoroughly before re-lubricating. Apply a thin film of grease to the incline cam surface. Use a small amount of grease at the end of the raising lever, where it actuates the raising parts. Put some SAE No. 20 oil on the raising lever pivot while manually turning the lever back and forth to work the oil in. If the push rod can be slipped out, rub its surface with a clean cloth dipped in SAE No. 20 oil. If it cannot be taken out, apply a couple of drops to its surface. Use oil sparingly, especially if it can possibly contact the trip friction clutch.

### **Pickup-arm is not raised**

This trouble occurs very rarely and is associated mostly with the methods that utilize a raising spring. It is the spring tension on the lever that actually does the lifting. If the spring gets weak or falls off, the arm will not be raised; the spring must be replaced. See that the parts (levers, plates, etc.) driven by the cycle drive are in place. They may have become loose because of missing retaining rings or pivot screws. Make sure the height adjustment is not so far off that the pickup arm is not lifted. Readjust it. See that the adjustment screw has not fallen out. Inspect the raising lever to see that it is not bent out of coupling; if necessary bend it back to shape.

### **Pickup-arm does not lower or lowers too slowly**

These, too, are uncommon troubles and are mostly associated with raising methods that employ a return spring to hasten the lowering of the pickup arm at the end of the change cycle. The return spring is used to move the parts back to the playing position. If this spring is weak or missing, the arm will lower slowly or not at all; the spring must be replaced. Accumulation of dirt at the pivots and especially at the push rod will retard the action of the arm lowering. Therefore, these parts should be cleaned thoroughly and then re-lubricated.

The pickup arm hinge, too, can cause this trouble. If cone-point pivot screws are used at the hinge, they may be too tight. Loosen them but do not make them too loose or the arm will tilt and affect needle tracking. Accumulation of dirt at the hinge will also cause the arm to stick, so clean these points thoroughly. If the pickup arm is made of plastic, do not use carbon tetrachloride; carbon tetrachloride attacks plastic. Dry-brush clean the hinge points instead.

Some RCA "45" changers utilize a piston-and-cylinder arrangement to control the speed at which the arm lowers to the record. These parts are located under the turntable. The piston is linked to the pickup arm, and the arm can lower only as fast as the piston can move in the cylinder. An air-escape hole in the cylinder determines the speed. The air hole should not be clogged, and the piston and cylinder must be clean and undamaged.

# swinging the arm out

**A**FTER the pickup arm has been raised, the change-cycle mechanism must swing it out to make the way clear for the next record to be dropped into playing position. This operation, like raising the arm, should be as smooth as possible, so that it will not undergo any unnecessary stress. Most automatic record changers swing the arm out to the edge of the changer chassis, directly over the rest post—the device that supports the pickup arm while the changer is not being used.

Since the pickup arm shaft offers easy lateral motion, all record changers accomplish the swinging action by applying a torque to it. The method of doing this varies from one record changer to the next. In all automatic record changers, however, the direct application of the turning force is accomplished by driving either a lever or plate rigidly attached to the pickup arm shaft. The driving force can be obtained with a groove track, drive lever or link, or a slide cam.

## Basic slide-cam drive

The actions that take place with a slide-cam drive are considerably easier to understand than some other methods. This swing-out drive is shown in Fig. 901; the pickup arm is laterally fixed to the pickup arm shaft at the top and the arm control lever is fastened to the bottom. Both parts, then, will move in unison along a horizontal plane. Because the arm control lever is representative of the position of the pickup arm, one side of the lever,

in this case, is used as the trip finger. When the change cycle starts, the parts are in the position shown in Fig. 901-a. During the change cycle, the slide cam is driven toward the pickup arm shaft. The driving edge on the slide cam contacts the arm control lever and pushes it back, causing the shaft to turn and swing out the pickup arm, as in Fig. 901-b. The entire process is very simple.

Another problem does exist, however. What would happen if someone grabbed the arm while it was being carried out? With-

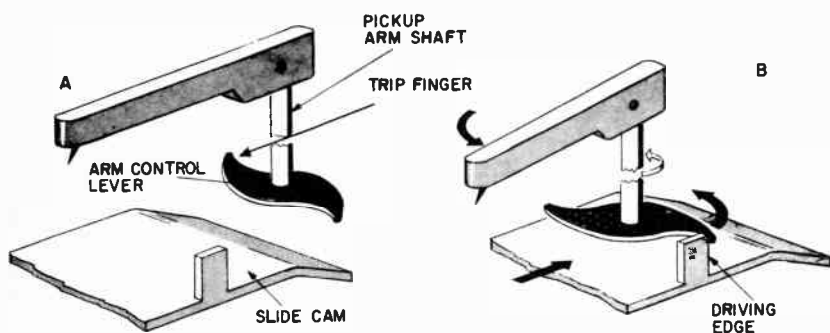


Fig. 901-a,-b. Slide-cam swing-out drive. Illustration at left shows parts at start of change cycle. Action during change cycle appears in drawing at the right.

out a safety precaution, the arm could break, the arm control lever could break or pull loose, the slide cam could be bent out of shape or the change-cycle drive itself could become damaged. The entire record changer mechanism might jam, causing expensive trouble. Therefore, it is wise to use some form of safety drive to prevent such mishaps.

### Safety drive

It would simplify matters if no one would touch the arm while it is being driven. But unfortunately people, especially children, get an irresistible urge to hold it back just to see what will happen. Too many people have had to do it at least once, completely ignoring manufacturers' warnings. The resultant expensive repair always cures the adult, but children become fascinated by the strange noise and sudden stillness that follow. Realizing that the arm-holding obsession was a serious problem, the great majority of manufacturers turned to safety drives; this is why some manufacturers claim their automatic record changer has an anti-jamming mechanism. Not only is this safety drive of value in swinging the arm out, but it is equally necessary in swinging it in again. Not all record changers employ safety drives—it is still

foolish to grab the arm during the change cycle.

A safety drive can be accomplished in different ways. Spring release is most common and the friction clutch is next. The physical position of the safety drive is unimportant; it may be at the hinge bracket, the pickup arm shaft, the arm control plate, the drive link or the swing-out method itself may comprise an automatic safety drive.

Fig. 902 shows the hinge-bracket safety drive. The nut attaches the safety plate to the pickup arm shaft so that the plate

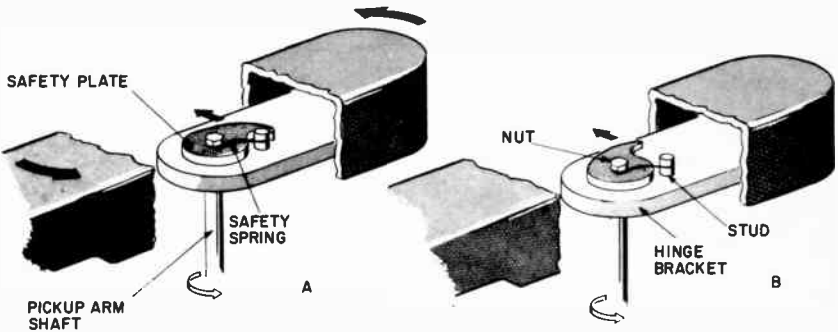


Fig. 902-a,-b. Basic hinge-bracket safety drive. The safety plate turns with the pickup arm shaft.

turns with the shaft. Discounting the safety spring, the hinge bracket is loosely seated on the pickup arm shaft. If it were not for the spring, the arm would swing freely, uncontrolled by the shaft. However, the safety-spring tension holds the hinge-bracket stud snugly against the safety plate so that under safe conditions the hinge bracket will swing out with the safety plate. Therefore, when the pickup arm shaft is turned, the hinge bracket will swing the pickup arm out, as shown in Fig. 902-a. On the other hand, if the pickup arm is obstructed, it will hold back the hinge bracket and the tension of the safety spring will be overcome. The elasticity of the safety spring allows the safety plate and the pickup arm shaft to continue on their way, as shown in Fig. 902-b, so that the entire mechanism can go through the cycle as it normally would. If the pickup arm is retarded only momentarily, it will be snapped sharply back into position by the safety spring when released. This rapid action can also harm the pickup arm so, if it is mistakenly retarded, it should be eased into position, not just released.

## Basic groove-track drive

The groove-track drive employs the lateral swing of a groove track to shift a lever which, in turn, is used to rotate the pickup arm shaft. Fig. 903-a shows the position of the components when

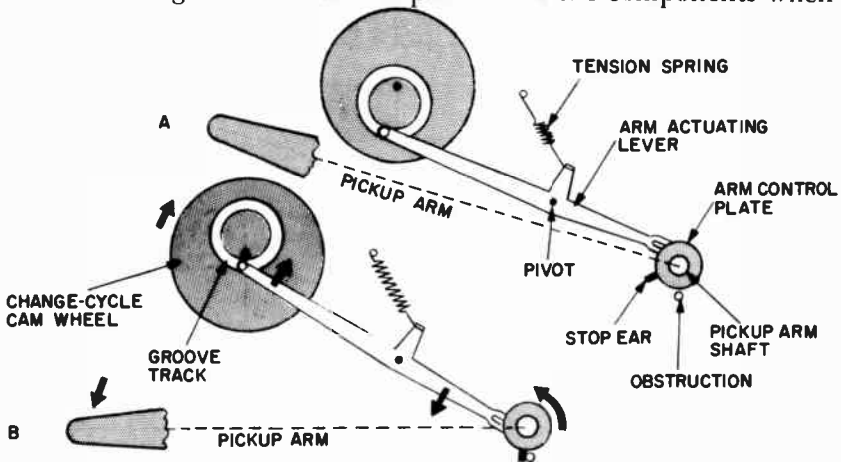


Fig. 903-a, -b. Groove-track swing-out drive. Top illustration shows beginning of change cycle. Lower drawing shows action during change cycle.

the change cycle starts, with the pickup arm close to the spindle. As the cycle continues, the groove track on the change-cycle cam wheel moves one end of the arm actuating lever. The other end of the lever pivots, turning the pickup arm shaft so that the arm is swung out. See Fig. 903-b. The tension spring keeps the action

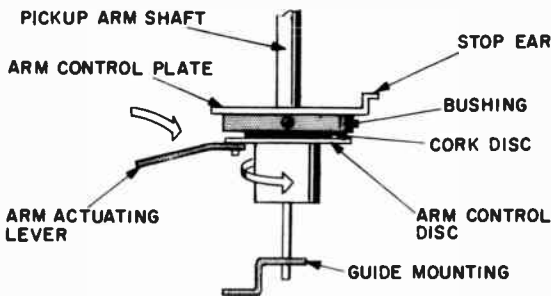


Fig. 904. Basic friction-clutch safety drive.

smooth. The arm swings to the position where the stop ear on the arm control plate hits the obstruction; then it stops, although the groove track and arm actuating lever keep driving it. This is possible because of the safety drive.

The safety drive in this unit is a friction clutch on the pickup arm shaft, as shown in Fig. 904. The arm control plate and bushing are held tight to the pickup arm shaft. The arm control disc

is a separate assembly that is pushed against the bushing when the arm is raised. The cork disc on top of the control disc supplies the clutch friction under the weight of the pickup arm assembly. When the actuating lever turns the control disc, clutch friction causes the pickup arm shaft to turn with it. However, when the arm is prevented from being turned, the assembly will slip on the cork disc while the control disc keeps turning. Thus the change-cycle mechanism can continue in motion while the pickup arm is held still. With this safety drive, the pickup arm will set down

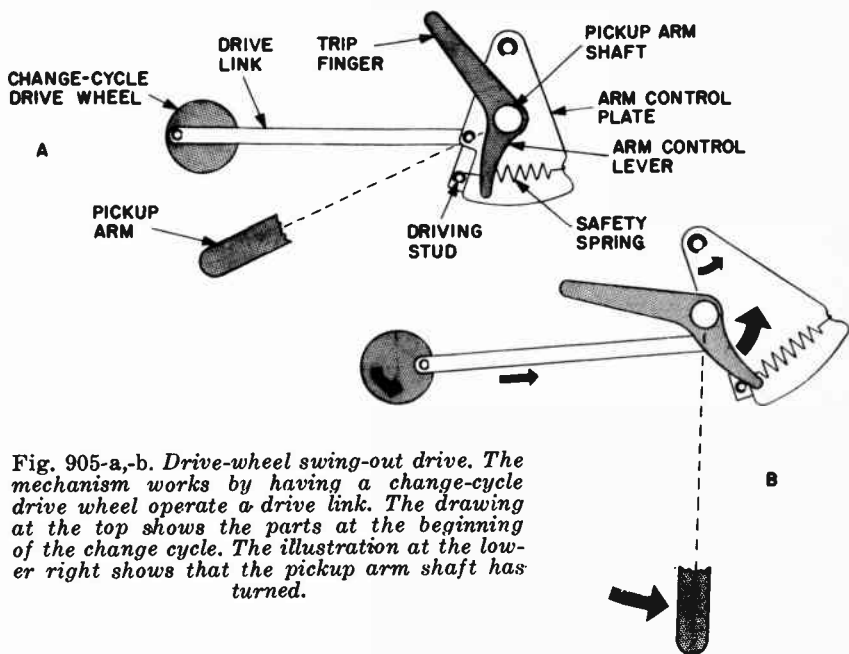


Fig. 905-a,-b. Drive-wheel swing-out drive. The mechanism works by having a change-cycle drive wheel operate a drive link. The drawing at the top shows the parts at the beginning of the change cycle. The illustration at the lower right shows that the pickup arm shaft has turned.

improperly on the record after it is released. It will, however, slip into proper position during the next change cycle.

### Basic drive-wheel drive

This type of mechanism utilizes a drive wheel that reciprocates a link for actuating purposes. The link can be used to push a lever or a plate to swing out the arm. At the start of the change cycle, all parts are in the position shown in Fig. 905-a. The arm control lever is securely attached to the pickup arm shaft so that they move together. During the cycle the drive wheel pushes the drive link so that the arm control plate is turned as in Fig. 905-b. The driving stud on the arm control plate contacts and turns the



arm control lever; consequently, the pickup arm shaft is turned and the arm is swung out.

For safety the driving stud is on an arm that is pivoted on the

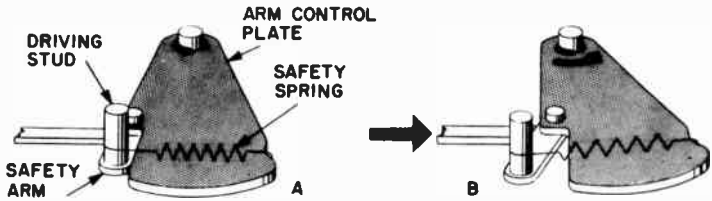


Fig. 906-a,-b. Arm control plate safety drive.

arm control plate. The safety arm is held firmly in position by the safety spring, as shown in Fig. 906-a. If the pickup arm can move freely, the stud will turn it. On the other hand, if the pickup arm

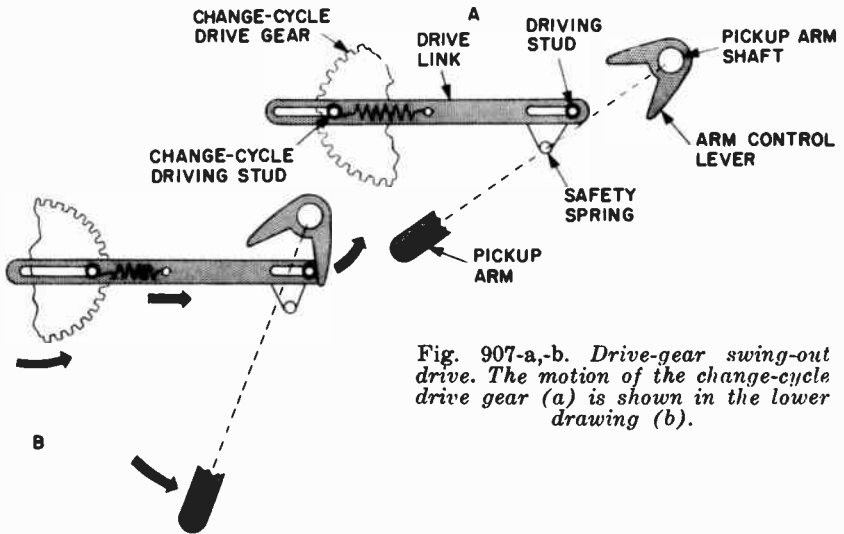


Fig. 907-a,-b. Drive-gear swing-out drive. The motion of the change-cycle drive gear (a) is shown in the lower drawing (b).

is held back, the driving stud will also be held back, as shown in Fig. 906-b. The safety arm will then pivot and the safety spring will stretch, permitting the rest of the change-cycle mechanism to go through the change cycle unhindered. But, if the pickup arm is then freed, the safety spring will pull in the safety arm, driving the pickup arm to its normal position.

Another example of the basic drive-wheel actuating device is shown in Fig. 907. This is quite similar to the previous one, the main differences being that the driving stud is on the drive link and no arm control plate is used. Fig. 907-a indicates the position of all parts when the change cycle first starts. The arm control

lever is rigidly attached to the pickup arm shaft so that they move together. The change-cycle drive wheel, actually a gear, pushes the drive link toward the arm control lever. The driving stud at



Fig. 908-a, b. Drive-link safety drive. A spring holds the driving stud in position.

the end of the drive link turns the arm control lever and pickup arm shaft, causing the pickup arm to swing out. This is illustrated in Fig. 907-b.

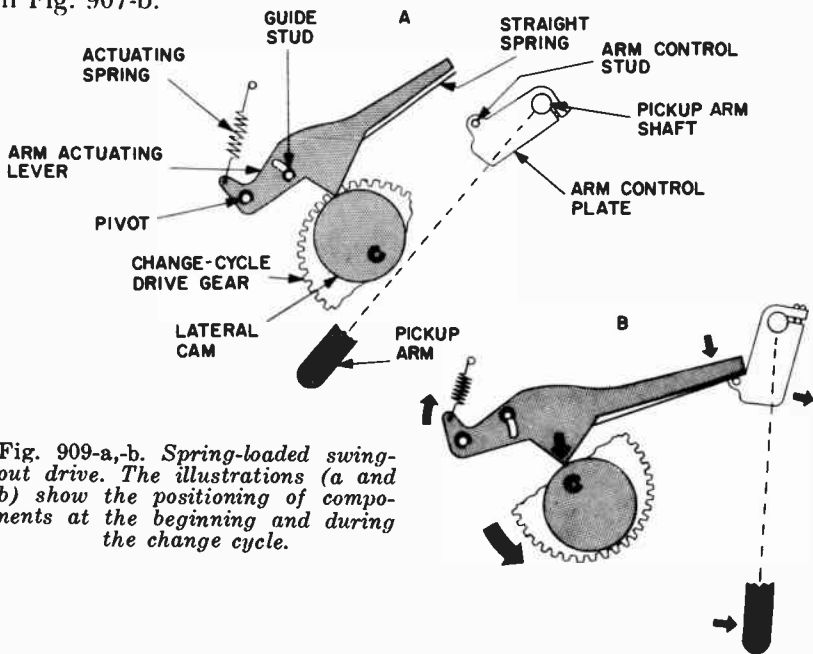


Fig. 909-a, b. Spring-loaded swing-out drive. The illustrations (a and b) show the positioning of components at the beginning and during the change cycle.

The safety device in this unit is on the driving end of the link. The driving stud is kept in place by a spring and, as long as the pickup arm is not held back, the stud will stay in place as shown in Fig. 908-a. If the pickup arm is held back, though, the driving stud will also be held back, as in Fig. 908-b. The safety spring is compressed, allowing the other parts to go through the cycle as they normally would. If the pickup arm is then released, the spring will snap the driving stud, and therefore the pickup arm, back to playing position.

## Basic lateral-cam drive

Lateral cams can be used with the swing-out mechanism in two ways: (1) the cam surface can be used to permit a spring-loaded actuating lever to *follow* its eccentric surface inward and (2) the force of the turning cam surface can be used to *push* an actuating lever. The advantage of the first method is that the assembly is also an automatic safety drive. Fig. 909-a shows the components at the start of the change cycle. The actuating spring tends to turn the arm actuating lever, but the change-cycle cam surface holds the lever back. During the cycle, the lateral cam is turned so that

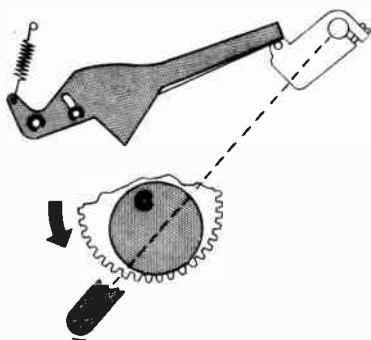


Fig. 910. Automatic (spring-loaded) safety drive. With this type of mechanism the motion of the pickup arm can be impeded, but the change cycle will continue.

its surface moves inward. This permits the actuating spring to turn the lever, causing the lever to ride in, as shown in Fig. 909-b. The end of the lever pushes the arm control stud, forcing the arm control plate to turn. Since the plate is bolted to the pickup arm shaft, the shaft turns and swings out the pickup arm.

The safety drive in this device is automatic. When the pickup arm (Fig. 910) meets interference, the actuating lever is simply kept from following the cam surface. The rest of the change-cycle parts continue unhampered. When the pickup arm is released, the spring acts and drives the pickup arm to its normal position. All spring-loaded drives of this sort are automatic safety drives.

Fig. 911-a shows the second type of lateral-cam drive with the position of the parts at the start of the change cycle; the return spring holds the arm actuating lever away from the arm control lever. But when the change-cycle drive gear turns, the eccentric drive cam (lateral cam) pushes the actuating lever, overcoming the return spring tension. The lever then pivots, as in Fig. 911-b. The driving stud pushes the arm control lever around, swinging out the pickup arm. *No swingout safety drive exists in this unit.* The swingout parts are rigidly coupled. If the pickup arm is blocked, damage will result.

## Servicing the pickup arm swingout assembly

Troubles developing with the assembly that swings out the pickup arm can be put in two categories: (1) the pickup arm does not swing out and (2) the pickup arm swings out erratically. The erratic action includes jerky motion and not swinging out far enough at times.

### Pickup arm does not swing out

In general, this trouble is associated mostly with devices that employ an actuating spring to originate the driving force, such

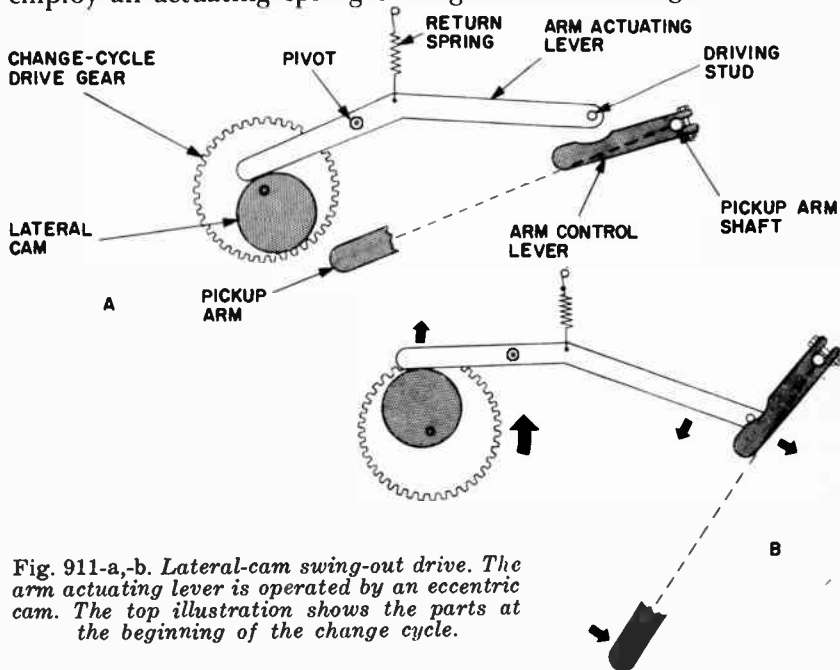


Fig. 911-a,-b. Lateral-cam swing-out drive. The arm actuating lever is operated by an eccentric cam. The top illustration shows the parts at the beginning of the change cycle.

as that shown in Fig. 909. If the spring breaks or falls off, the cam actuating lever will not move and so no swingout motion develops. The first part to check then, and replace if necessary, is this spring. The next most probable source of this trouble is the safety drive. The safety springs hold the driving members, such as the studs, arms or plates (Figs. 902, 906, 908) in driving position. If these springs break or fall off, the driving member will have no effect; it will merely slip away on contact.

The least likely occurrence, but a possible source of trouble nevertheless, is the other parts coming loose or bending. Inspect the arm control lever or plate attached to the pickup arm shaft. It

may be held in place by a nut, a bolt or setscrews. See if the lever or plate is loosely mounted; tighten it. See if either is bent, preventing it from being driven; straighten the bent part. Next, check the mountings of the actuating plates, arms, links or levers. These are usually held on their pivots by retaining rings, although screws are also used. See that a screw has not loosened or that the retaining ring has not come off. Make sure none of the parts are bent. Check the parts moved by the change-cycle drive. If the part is driven by a groove track, make sure it is snugly seated. If it is pushed by a cam, see that it firmly couples the cam surface. If a slide cam is used, check the slide-cam driving edge.

#### **Pickup arm swings out erratically**

Normally this trouble is not noticed unless it causes the pickup arm to be in the way when the next record is dropped. However, it should be corrected before it interferes with operation, so that additional damage will be prevented. Actually, the same defects that were discussed for the previous trouble also apply here, but they occur to a lesser degree. For instance, the safety or actuating spring may only be weak or the arm control lever or plate may be loose, yet not enough to lose all driving power. Bent parts may couple poorly but still enough to produce some swingout motion. Therefore, the information given earlier also applies here. The most common causes of erratic motion are dirt and lack of lubrication.

#### **Cleaning and lubricating swingout parts**

The cleaning procedure for the parts that swing out the pickup arm is about the same as for other assemblies. Use a brush where possible and an eye dropper where necessary. If practicable, to help the cleaning action, move the parts being cleaned. Use carbon tetrachloride at the pivots of the actuating and control levers, links and plates. Clean the surface moved by the cam or groove track. Pay particular attention to the friction clutch if a friction-clutch safety drive is used. Clean out old, worthless lubrication. Re-lubricate. Lubricating these parts is fairly standard. The most important thing to remember is not to lubricate the clutch plates of the friction-clutch safety drive. These must remain absolutely dry to function properly. Apply a light grease to the surfaces actuated by a cam or groove track. Apply the grease to all driving surfaces. Apply SAE No. 20 oil to all pivot points. Move the parts while oiling to work the oil in.

# dropping the next record

**A**FTER the pickup arm has been swung clear of the record stack, the next record at the bottom of the stack must be selected, separated, and dropped to the turntable. This operation is very important since the records are acted upon directly. The mechanism should handle the records with care to prevent their being chipped, scratched, cracked or worn prematurely. And, since these are fastmoving times, the listener wants the sequence to be rapid with a minimum of "dead" time between playings. In general, a good record changer will have the record drop fast, smooth and flat. The record falling flat is an important requirement. The record builds up a force in its fall; if it drops on one side, the entire force is carried by the point that lands first. This will put a strain on the record and it will probably crack after a while. If the record falls flat, the force is distributed over its entire surface and so no strain will be encountered by any one point. A flat-falling record may make a louder sound, but it is safer.

The record-dropping mechanism is called by several names. Some manufacturers say the *record-selector* chooses the next record, while others say the *separator* removes the bottom record from the stack. Another calls it the *pushoff*, while still another has a *record-release* device. These terms, however, are only partially descriptive. The end result is the same in each case.

The device can be either an ejector or slicer mechanism. The ejector has a pushing motion and the slicer a knifelike action. The main record-dropping device can be at the record shelf or it can

be at the spindle. Generally, the method used is determined by the manner in which the stack of records is held above the turntable.

### Holding the stack of records

On all record changers, the spindle acts as a guide for the records, so they will always be centered on the turntable. On present-day changers, the spindle also holds up the record stack. The spindle is offset shaped, with a ledge for the records to sit on. With this arrangement alone, though, the records would tilt over and fall off. So, as additional help in holding the records, either a

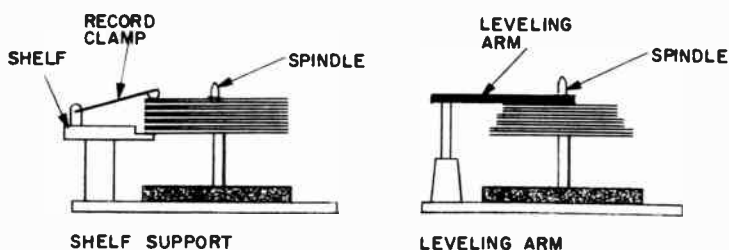


Fig. 1001. Either a shelf or a leveling arm can be used to help support the records.

shelf or leveling arm is used; both are shown in Fig. 1001. The leveling arm rests on top of the stack and the force of its weight keeps the records in a level position. The shelf, on the other hand, sits under the stack, at the outer edge, to help the spindle support the records. When a shelf is used, the records need not be kept level. A record clamp is used with the shelf to keep the records in place.

There is a slow trend away from the use of the shelf although it is still very popular. With a shelf only records of a single size can be played in a stack whereas, with the leveling arm, record sizes can be intermixed. (This does not necessarily mean that all changers employing leveling arms can intermix records.) The shelf is somewhat of an eyesore and has to be repositioned for different-size records. Fig. 1002-a shows the way the shelf works. It has three usable sides, a record clamp, and is rotated by hand. In the 10-inch position, the edge of the shelf is the proper distance from the spindle to accommodate a 10-inch record. When the shelf is turned around to the 12-inch position, the shortest section faces the spindle, so that the distance is increased to accommodate 12-inch records. To play 7-inch records, the shelf is turned so that the extended edge faces the spindle. The record clamp ro-

tates within the shelf so that it can be used in any position. Fig. 1002-b indicates another shelf positioning method. The shelf is moved forward and back. When it is pushed forward (toward the spindle), it is the proper distance for a 10-inch record. Pushed back, it will hold a 12-inch record. To play 7-inch records, the

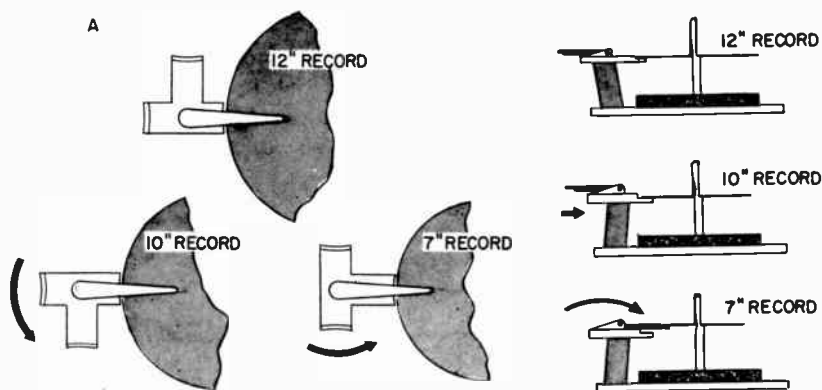


Fig. 1002-a,b. The shelf can be adjusted to accommodate records of different sizes.

shelf is kept in the 10-inch position and an extension plate is turned over.

### Basic shelf mechanisms

There are five ways the shelf is used to cause the next record to drop to the turntable: (1) shelf slicer, (2) shelf ejector cam, (3) shelf ejector plate, (4) nodding shelf and (5) nodding spindle. (The matter of the nodding spindle being considered a shelf ejector is a controversial one. The stand taken here is that the nodding spindle is a shelf ejector. Although the spindle does the moving, the shelf does the pushing).

#### Shelf slicer

This method is not seen on newer changers, but was quite popular earlier. It was given up because it was slow, unsightly, used more parts and damaged records. As shown in Fig. 1003-a, two shelves are required, with two slicer blades at each shelf. While the record plays, the releasing blades hold up the stack and the holding blades are kept out of the way. During the change cycle, both shelves start turning, and as they do, the holding blades slice their way between the two bottom records. The releasing blades are then out of the way so that the bottom record drops to the turntable. The rest of the stack, however, is held by the holding blades. Then both shelves start turning back, so that the releasing



blades move in and the holding blades move out. The stack of records drops off the holding blades onto the releasing blades, ready for the next cycle.

The biggest problem is that the holding blade does not always slice its way between records. At times it drives against the edge of the record, damaging it. If both holding blades jam at once, the

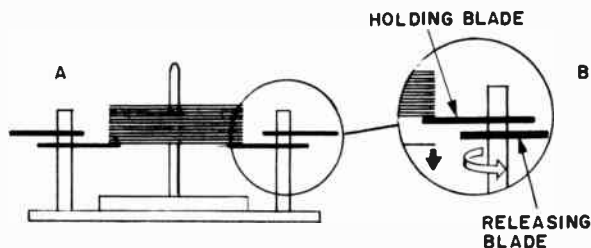


Fig. 1003-a, b. This is an early type of shelf mechanism. It requires two shelves.

record could break in half. With this device, the spindle functions only as a guide and so it is not offset. It is a straight round rod, although it may sometimes appear with a taper.

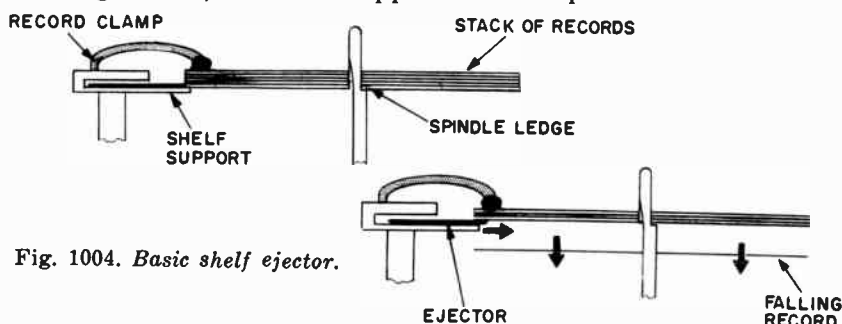


Fig. 1004. Basic shelf ejector.

### Cam and plate shelf ejector

To make the mechanism simpler, faster and more reliable, shelf ejectors were developed. (See Fig. 1004.) The spindle has a ledge that holds up the center of the stack while the shelf and its clamp support the edge. With this setup, the record is dropped to the turntable when the ejector on the shelf moves out and pushes the bottom record off the spindle ledge and the shelf. The record should leave the spindle ledge and the shelf simultaneously so that it will fall flat.

The ejector can be a cam or a plate. The ejector cam (Fig. 1005-a) is secured to a shaft that goes down through the shelf to the underside of the record changer chassis. The change-cycle mechanism rotates the ejector shaft so that the ejector cam turns

and pushes off the record. The ejector plate (Fig. 1005-b), actuated by a cam similar to the previous one, moves forward and back to complete the action. The actuating cam turns and pushes the plate out so that the record drops. When the cam turns back, the return spring forces the ejector plate back to the playing position. The ejector plate shown in Fig. 1005-c operates in another manner. An actuating lever passes up through the shelf into a hole in the ejector plate. When this lever is pivoted back and forth, it also moves the plate.

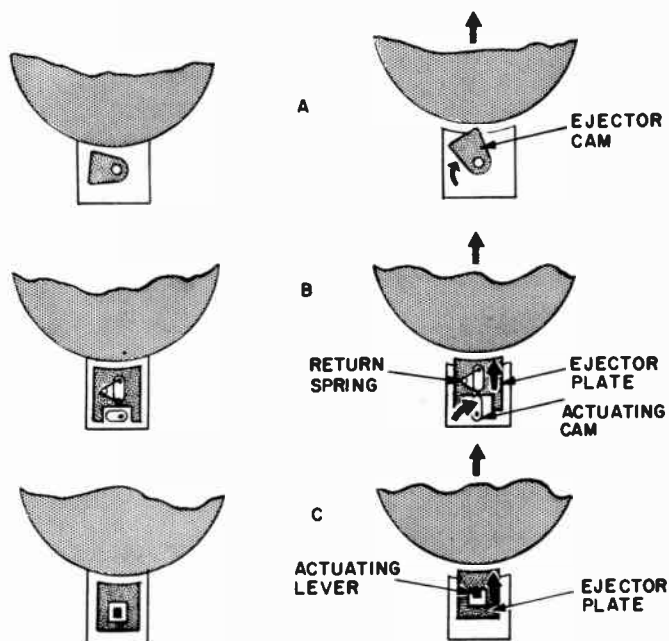


Fig. 1005-a,-b,-c. *Types of cam and plate shelf ejectors.*

Referring once again to Fig. 1004, the shelf ejector pushes only the bottom record and passes under the succeeding one. However, there is a tendency for the next record to follow the bottom record because of friction. This is prevented by the record guide, illustrated in Fig. 1006. The guide is at the top of the spindle on the side opposite the ledge. When the record stack is first put on the spindle, the guide lets the records down so that they seat firmly on the spindle ledge. The guide extends downward, but not as far as the spindle ledge. It allows enough space for the bottom record to be pushed off the ledge but blocks the others, permitting only one record to drop at a time. The record guide is in a slot and is

free to move up and down. It moves up when records are brought up the spindle, so that it will not obstruct their removal.

The basic Admiral model RC550 shelf cam ejector uses a

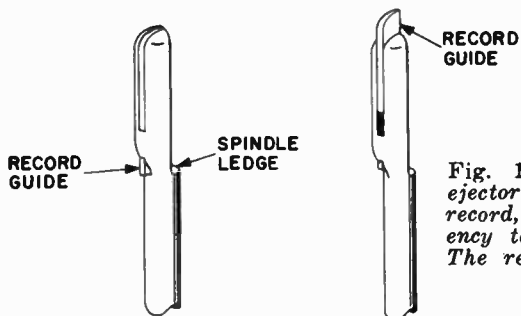


Fig. 1006. Although the shelf ejector pushes only the bottom record, other records have a tendency to drop down the spindle. The record guide prevents this.

change-cycle cam wheel and a lever to do the initial driving. Fig. 1007-a shows the parts before they are set in motion. During the cycle the turning change-cycle cam wheel pivots the ejector drive

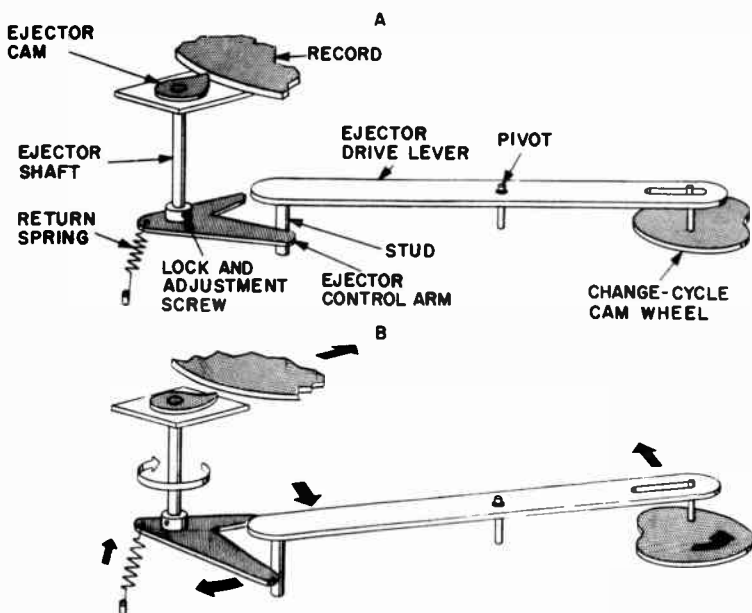


Fig. 1007-a,-b. Mechanism of a shelf cam ejector.

lever, as in Fig. 1007-b. The stud at the end of the lever moves into the V-section of the ejector control arm making it rotate the ejector shaft. The shaft turns the ejector cam and the record is pushed off the shelf. After the record drops, the ejector drive lever stud

is backed away from the ejector control arm. This permits the return spring to pull the control arm, and therefore the ejector cam, back to the neutral position. The lock-and-adjustment screw is used to set the position of the ejector cam so that it will push the record off at the proper time. When the screw is loosened, the cam can be repositioned; then, when the screw is tightened, the cam will be held securely in the new position.

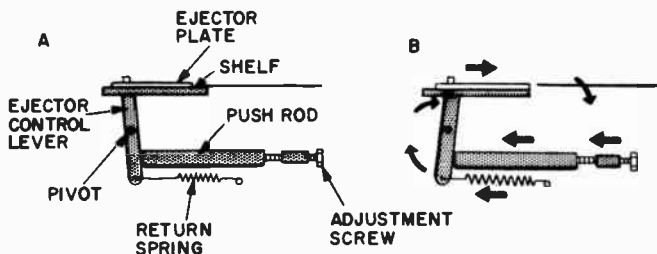


Fig. 1008-a, -b. These illustrations show the operation of a shelf plate ejector.

The shelf plate ejector shown in Fig. 1008 is the one that was used in the RCA model 960282. Ejection, in this case, takes place when the ejector plate is moved forward. Fig. 1008-a shows the components when the unit is not actuated. When the record is to be dropped, the part holding the adjustment screw is pushed by

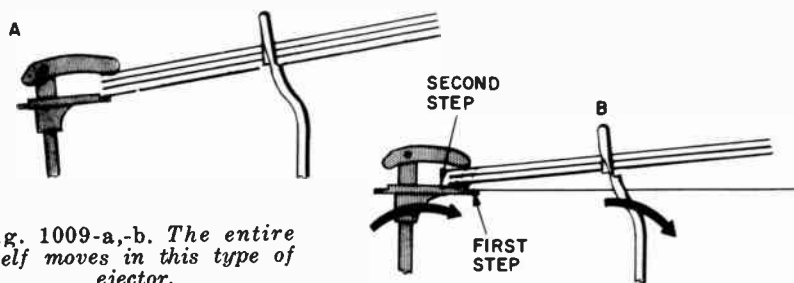


Fig. 1009-a, -b. The entire shelf moves in this type of ejector.

a lateral cam. As a result of this, the screw moves the push rod against the ejector control lever, causing the lever to pivot. The top of the control lever is in a slot in the ejector plate and so the plate is moved to the edge of the shelf, causing it to push off the bottom record. After the record drops, the part holding the adjustment screw is moved back, allowing the return spring to pull back the ejector control lever and push rod. The ejector plate is pushed back to its neutral position, ready for the next change cycle.

In its neutral position, the adjustment screw presses against the

push rod and so its position determines the neutral position of the ejector plate. If the screw is adjusted inward, the ejector plate will be moved closer to the edge of the shelf; consequently it will push the record off the shelf sooner. If the screw is turned out, the opposite effect will result.

### Nodding shelf ejector

In the ejector device shown in Fig. 1009, the entire shelf moves. The shelf has two steps. During the playing, the stack of records seats on the bottom or first step. During the cycle, the entire shelf is moved forward. The rise of the second step pushes out the bottom record but, since the rise is small, it does not push the other

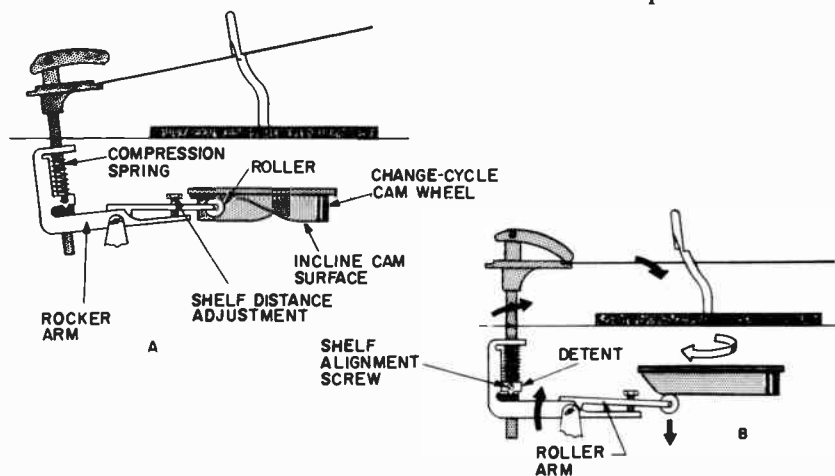


Fig. 1010-a,-b. This nodding shelf mechanism uses an incline cam and lever arrangement.

records; instead they slide on top of the second step. In this position, although the bottom record has been pushed off the spindle ledge, it is still on the shelf step. Because of this, the records are started in an off-level position. As the ejected record approaches a level position, the outward slope of the spindle at that point pulls the record off the shelf so that the record drops flat. As the shelf moves back to its rest position, the records slide off the second step onto the first step, ready for the next change cycle. The record guide on the spindle acts in a conventional manner.

The Webcor model 1127 nodding-shelf mechanism is shown in Fig. 1010. This record changer utilizes an incline cam and lever arrangement to nod the shelf. Fig. 1010-a indicates the position of the parts before the change cycle starts. During the change cycle, the cam wheel turns and the incline cam surface pushes down on

the roller on the end of the roller arm. This pivots the rocker arm, causing the shelf to move toward the spindle and eject the bottom record. After the record drops, the incline cam surface releases the assembly and the compression spring pushes the parts back. This returns the shelf to its original position.

The shelf-distance adjustment screw is used to pivot the rocker arm in relation to the roller arm and so controls the distance between the shelf and spindle. Turning the screw in will move the shelf closer to the spindle, and vice versa. The shelf-alignment

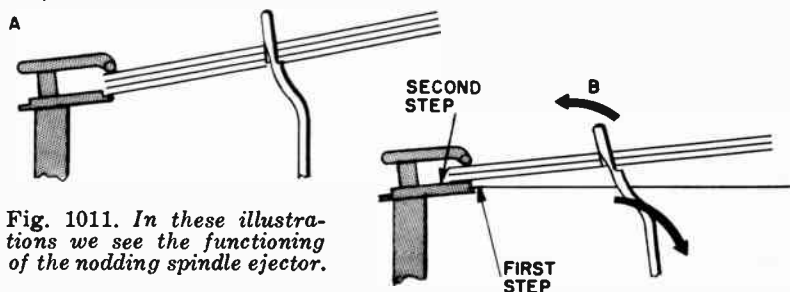


Fig. 1011. In these illustrations we see the functioning of the nodding spindle ejector.

screw is used to set the edge of the shelf concentric with the edge of the record. In the 7-, 10- and 12-inch positions, a detent arrangement holds the shelf steady. By loosening the screw while the shelf is set for the proper record size, the shelf can be repositioned for concentricity; when the screw is tightened, the shelf should be concentric for all three record sizes.

### **Nodding spindle ejector**

In effect, the nodding spindle ejector does the same thing that the nodding shelf ejector does. The important action of both ejectors is to close the distance between the spindle and the shelf. See Fig. 1011-a, b. While a record is being played, the stack of records seats on the spindle ledge and the first step of the shelf. During the cycle, the spindle is moved toward the shelf. The spindle tends to push the entire stack of records as well. However, the rise of the second step on the shelf holds back the bottom record and in doing so pushes it off the spindle ledge as the spindle moves closer. As the record drops off the ledge, the slope of the spindle pulls the record off the shelf step. During this time, the other records slide over the top of the second step. The spindle then moves back and pulls the remaining records back with it. The records drop off the second shelf step onto the first step, ready for the next change cycle. The shelf is stationary for the entire cycle, yet it accomplishes the ejection because of the spindle motion.

The ejector used in the Philco model M-24 is actuated in a somewhat unconventional manner. As shown in Fig. 1012, the initial driving force is obtained by means of a groove track. Fig. 1012-a shows the parts with the spindle in the neutral position. The vertical position of the spindle is determined by the ejector lever. The actuating spring tends to pull in the ejector lever but the lever is held back by the adjustable ear on the actuating lever.

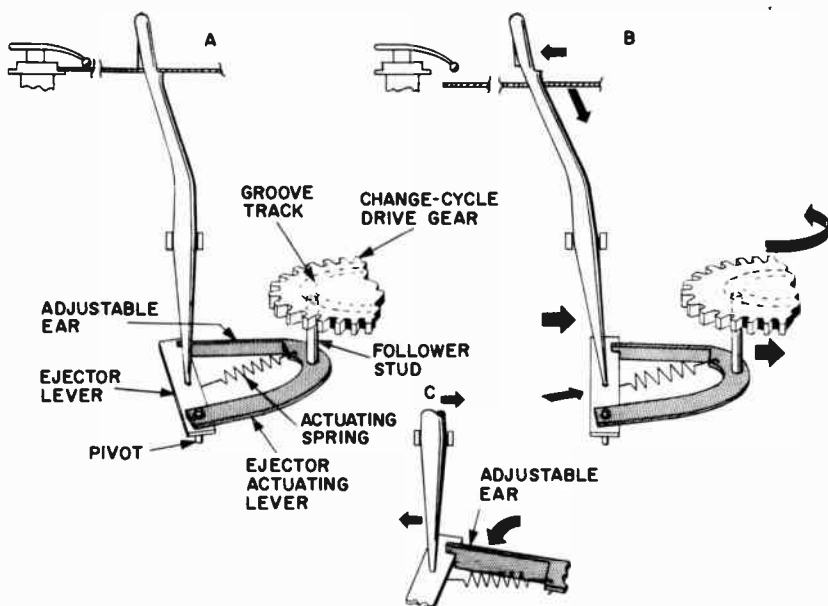


Fig. 1012-a,b. Unconventional ejector used in the Philco model M-24.

During the change-cycle, the stud on the actuating lever follows the groove track on the change-cycle drive gear, as shown in Fig. 1012-b. Hence the actuating lever turns, permitting the actuating spring to pull the ejector lever. This motion pivots the spindle, causing it to nod so that a record is dropped. After the record has been ejected, the change-cycle drive gear returns the parts to the neutral position.

The adjustable ear on the actuating lever is used to reposition the ejector lever. Since the bottom of the spindle is attached to the ejector lever, bending the adjustable ear (Fig. 1012-c) will pivot the spindle to a new position, and the distance between the spindle and the shelf will change accordingly.

### Basic spindle ejector

The spindle ejector accomplishes the record-dropping opera-

tion by using a device to push inside the center hole of the bottom record, so that the record is moved off the spindle ledge. The spindle ejector can be either a cam or lever. The spindle is hollow and the ejector actuator runs through the center of the spindle. The basic spindle ejector varies only slightly in most record changers. Fig. 1013 shows the four actions used by the great majority of automatic record changers.

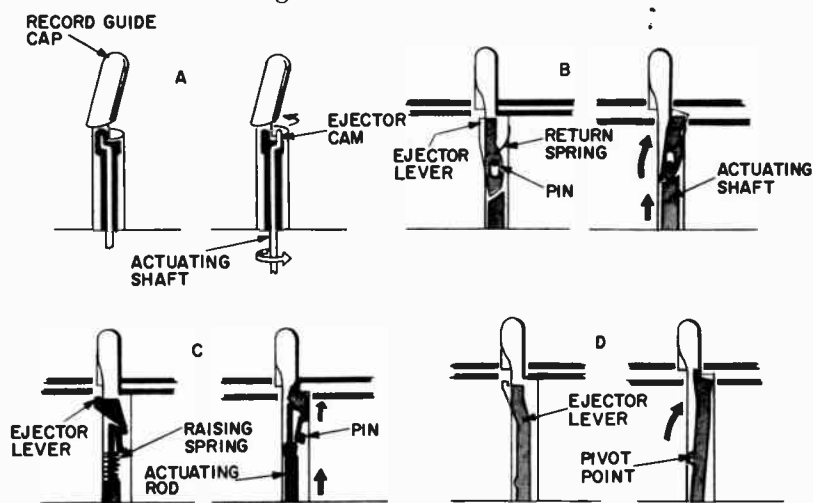


Fig. 1013-a,b,c,d. Most record changers use one of these types of basic spindle ejectors.

During playing operation (Fig. 1013-a) the ejector cam is in the recessed portion of the spindle, inside the center hole of the bottom record. The ejector cam is part of the actuating shaft which extends down through the center of the spindle to the change-cycle mechanism. During the change cycle, the mechanism turns the actuating shaft. This causes the ejector cam to move out of the spindle recess against the edge of the record center hole. The cam moves out and around, toward the edge of the spindle ledge, until it pushes the bottom record off the ledge. The ejector cam is only high enough to act on the bottom record. The rest of the record stack is held in place by the spindle guide cap which acts in exactly the same manner as the record guide described earlier. After the bottom record drops down the spindle, the ejector cam moves back into the recess, permitting the other records to drop onto the ledge, ready for the next change cycle.

The spindle ejector shown in Fig. 1013-b uses an ejector lever. Before the change cycle starts, the ejector lever is kept below the ledge, away from the bottom record. During the change cycle, the



actuating shaft is pushed up against the ejector lever. The lever is held by means of a slotted hole around a pin, which passes through the spindle. Hence the ejector lever will first move up into the center hole of the bottom record and then it will pivot to the edge of the ledge, pushing off the bottom record. After the record is dropped and the actuating shaft is moved down, the return spring pushes the lever back and the lever lowers as a result of its own weight. The spindle has slotted openings that permit the protrusion of the ejector lever. The record guide is of the conventional type.

The spindle in Fig. 1013-c uses an ejector lever and an actuating rod. In its quiescent state, the raising spring tends to push up the ejector lever but the hooked end of the actuating rod holds the lever down. During the change cycle, the actuating rod is moved up and so it allows the raising spring to push the ejector lever up into the center hole of the bottom record. The ejector lever moves up until it is held back by the pin. Then the actuating rod turns the ejector lever toward the edge of the ledge, causing the bottom record to be pushed off the ledge. After the record drops, the actuating rod moves down and the ejector lever returns to its rest position. A conventional record guide is used on this spindle.

In Fig. 1013-d the ejector lever is one part, extending down through the spindle. When not in use, the lever is kept low, out of the way of the record stack. During the change cycle, the ejector lever is pushed up into the center hole of the bottom record. Then the change-cycle mechanism pivots the lever, causing the top of the lever to move out and push the bottom record off the spindle ledge. After the record drops, the ejector lever moves back to its original position. With this spindle also, a conventional record guide is used.

### **Actuating the spindle-ejector mechanism**

In general, the parts of the change-cycle mechanism used to actuate spindle ejectors are simpler and more compact than those used with the shelf ejectors. With the former, the actuating parts are usually grouped close together at the bottom of the spindle. With shelf ejectors, they cover a wider area. Like most other record changer functions, the actuating mechanisms vary considerably and no one method is considered better than the next. However, some devices supply adjustments so that the mechanism can be kept operating properly.

### **Spindle cam ejector**

The spindle cam ejector, used in the Zenith model S14036

changer, is shown in Fig. 1014. Before the change cycle starts, as shown in Fig. 1014-a, the ejector actuating lever holds the actuating shaft in a position that keeps the ejector cam in the recessed portion of the spindle. During the change cycle, as in Fig. 1014-b, a stud on the change-cycle drive gear pulls the ejector actuating link around. The link, being pivoted to the actuating lever, causes the actuating lever to rotate. Consequently the actuating shaft turns out the ejector cam to push off the bottom record. As the change-cycle drive gear continues rotating, it moves back the actuating link; the rest of the parts are returned to their neutral positions.

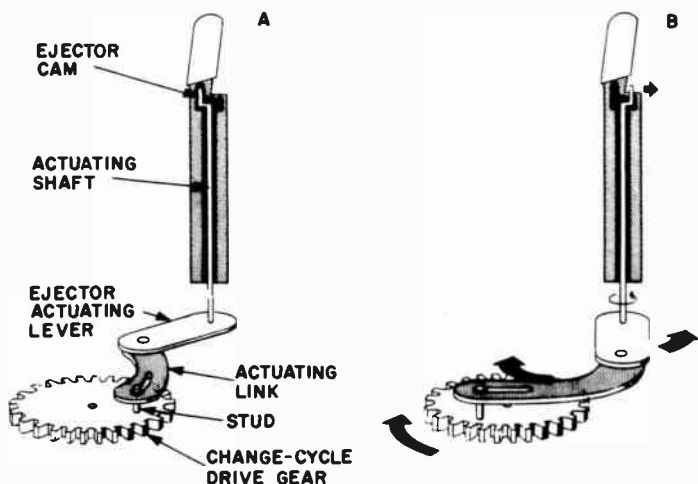


Fig. 1014-a,-b. Steps in the operation of a spindle cam ejector.

## Spindle lever ejector

The basic actuating motion of the spindle lever ejector is an upward force which can be obtained in four popular ways: (1) lateral-cam-lever drive, (2) slide-cam-lever drive, (3) incline-cam-lever drive, and (4) sliding-incline-cam drive.

### Lateral-cam-lever drive

Before the change cycle starts, the actuating shaft is kept low, as shown in Fig. 1015-a, so that the ejector lever is below the ledge of the spindle. The return spring keeps the actuating shaft down until the main drive lever is set in motion. During the change-cycle (Fig. 1015-b) the roller on the change-cycle cam wheel moves against the intermediate drive lever, making the lever turn. Since the main drive lever is linked to the intermediate drive lever, it

also turns, pushes up the actuating shaft and causes the ejector lever to eject the bottom record. After the record drops, the roller on the change-cycle cam wheel moves away from the intermediate drive lever. The return spring is then free to push down the actuating shaft so that the other parts are returned to their neutral positions.

The adjustment nut changes the effective length of the actuating shaft and so it controls the time at which the ejector lever will push off the bottom record. If the nut is moved down, ejection will take place sooner, and vice versa.

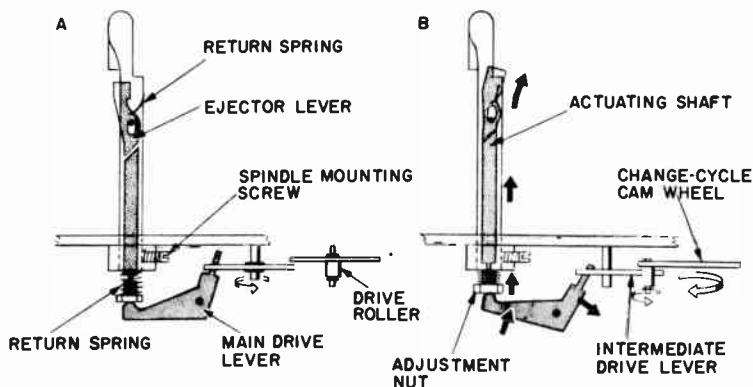


Fig. 1015-a, b. *Lateral-cam-lever drive.*

### Slide-cam-lever drive

As shown in Fig. 1016-a, the drive lever is kept clear of the ejector actuating rod before the change cycle starts. The drive lever fits into a slot in the slide cam. During the change cycle (Fig. 1016-b) the slide cam moves and turns the drive lever. The other end of the drive lever pushes up the actuating rod and the ejector lever moves the bottom record off the spindle ledge. After the record drops, the slide cam moves back to release the drive lever, allowing the tension of the raising spring to move the parts back. No ejector adjustment is available in this device.

### Incline-cam-lever drive

This arrangement is very similar to the nodding-shelf mechanism discussed previously. As Fig. 1017-a shows, before the change cycle starts, the incline cam surface permits the drive lever to keep the actuating rod down. During the change cycle, however (Fig. 1017-b) the change-cycle cam wheel turns and pressure of the incline cam surface against the roller causes the drive lever to pivot.

The drive lever forces the actuating rod up and the ejector lever pushes off the record. The ejector adjustment here is the same as the one described under "Lateral-cam-lever drive."

### Sliding-incline-cam drive

As shown in Fig. 1018-a, the ejector lever is kept in the low position before the change cycle starts due to the position of the incline cam and the action of the tension spring. The ejector lever passes through a slot in the incline cam but the ejector guide rests on its surface. During the change cycle, as shown in Fig. 1018-b, the drive link pushes the actuator plate. The incline cam then raises the ejector lever up into the center hole of the bottom record. When the actuator plate nears the limit of its travel, it pushes

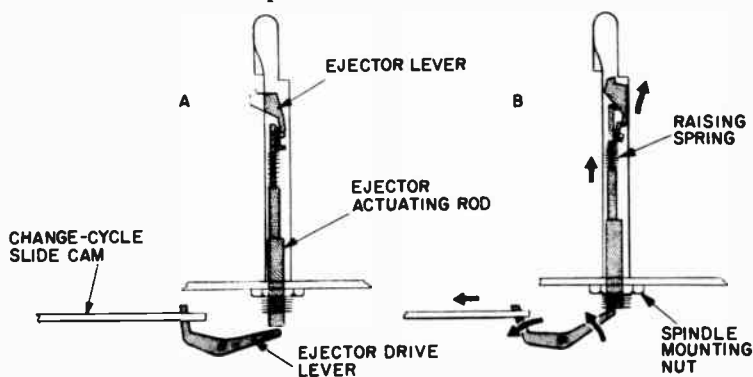


Fig. 1016-a,-b. Slide-cam-lever drive.

against the bottom of the ejector lever and, because of its shape, the lever pivots and ejects the bottom record. After the record drops, the actuator plate is moved back and the tension spring pulls the ejector lever back to its starting position.

The adjustment screw is used to stop the pivoting motion of the ejector lever so that the lever will push the bottom record enough but not too much. The adjustment screw is turned to a new position after the locking nut is loosened. When the nut is tightened, the screw will be held in that position.

### Spindle slicer

This device, at present, is only for large-center-hole, 7-inch, 45-r.p.m. records. The RCA model RP-190 record changer, which plays only large-hole records, utilizes the stubby spindle shown in Fig. 1019. The spindle in this changer is part of the turntable (that is, for operating purposes) and is attached to the turntable

with screws so that both rotate together. The primary parts of the record-dropping mechanism are two releasing shelves and two holding blades, located in the upper part of the spindle. Before the change cycle starts, the shelves are in an extended position so that they hold up the stack of records. The blades are held inside the spindle.

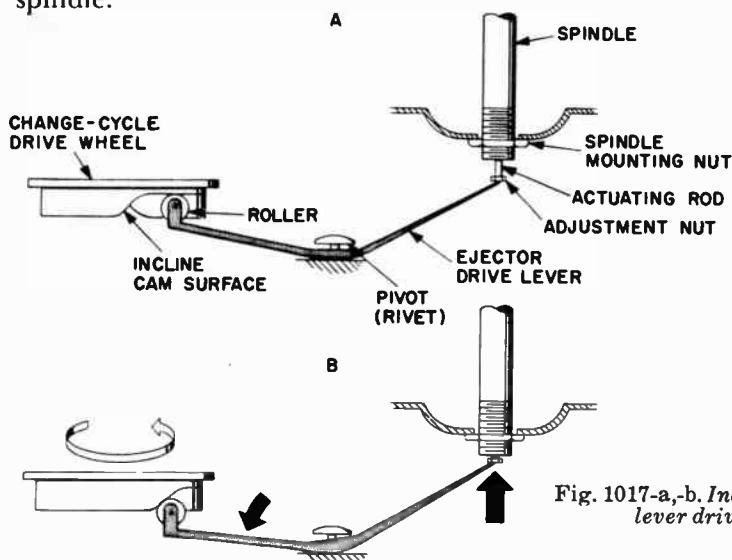


Fig. 1017-a,-b. *Incline-cam-lever drive.*

During the change cycle, both slicer blades are pushed out. While moving out, the blades slice their way between the two bottom records. The blade on the right is attached to the shelf on the left so that, when that blade is pushed out, it pulls in the shelf. In the same way, the left blade pulls in the right shelf. When both shelves are in, the bottom record drops. The two slicer blades, however, hold up the rest of the records. After the record has dropped, the spring tension between the shelves causes the shelves to move out again; the shelves pull in the blades and the stack of records drops onto the shelves, ready for the next change cycle.

The previous spindle is used only with large-hole records and so presents no problem. Other automatic record changers, however, are designed primarily for the small-center-hole records; since large-center-hole records are being used, these changers must be adapted to handle them as well.

The simplest way to do this is to use the center-hole adapter, an example of which is shown in Fig. 1020. The adapter is press-snapped into the large hole of the record and the small hole in the adapter is then used so that the record will fit properly on a

standard spindle. The disadvantage of this is that after a while the center hole of the record or the rim of the adapter wears and a loose fit results. Consequently the record has a tendency to fall off the adapter while in the stack or while it is dropping.

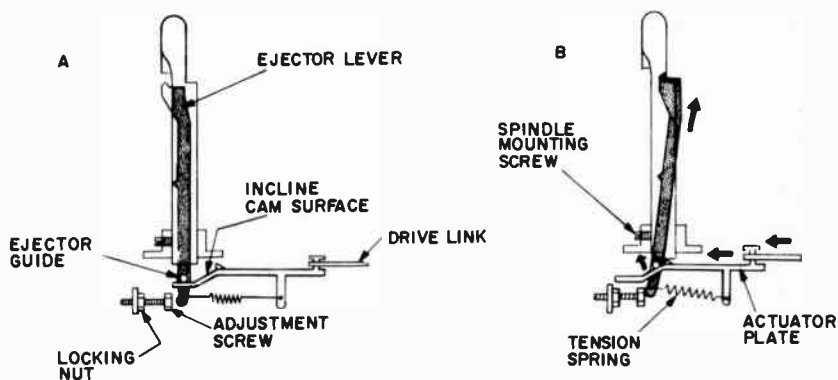


Fig. 1018-a,b. Sliding-incline-cam drive.

To make the operation more reliable, some record changers are supplied with a large-spindle attachment. This can be used in two ways. For some changers the large spindle is merely slipped over the standard spindle; for others, the standard spindle is slipped out of the turntable and the large spindle is set in its place. The unit shown in Fig. 1021-a utilizes the nodding-spindle record-dropping mechanism. The large-spindle attachment is just a fat

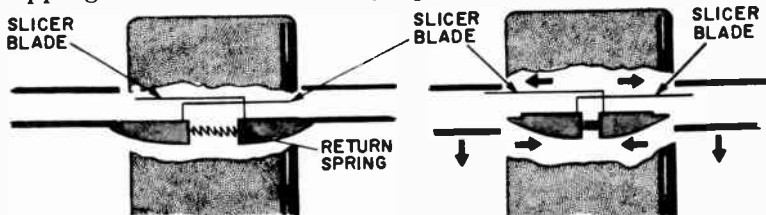


Fig. 1019. Spindle slicer is used on the RCA model RP-190.

duplicate of the standard spindle it is slipped over. This spindle will follow the nod of the standard spindle and so it contains no ejector mechanism of its own. (The record guide, however, has an adjustment that permits only one record to drop at a time.) Similar adapters are used with other record changers that employ shelf ejectors.

The attachment shown in Fig. 1021-b is used with a record changer that employs a spindle ejector. If it is the type that slips over the standard spindle, the ejector lever in the standard spindle

actuates the parts in the stubby attachment spindle. If the attachment is used in place of the standard spindle, the mechanism inside the attachment is similar to that of the standard spindle. The holding and releasing actions of the shelves and slicers in the large-spindle attachment are similar to those described for the spindle used in the RCA model RP-190.

Most large spindle *attachments* are actuated either by small spindles or in the same way as small spindles. But the large spindle that rotates with the turntable, as in the RCA model RP-190, is actuated in a completely different manner. Standard spindles are stationary and so the attachments, too, are stationary. With the

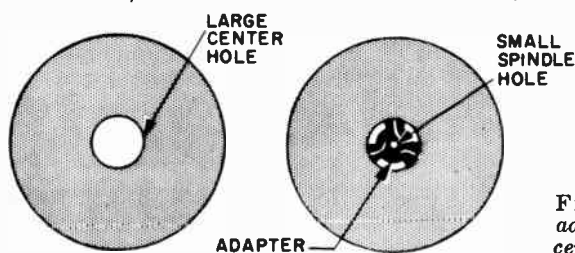


Fig. 1020. *Center hole adapter is snapped into the center hole of the record.*

spindle that rotates with the turntable, the primary parts of the record-dropping mechanism turn also and so most of the actuating parts must revolve with them for the proper relationship to be maintained. With this setup, then, the mechanism is actuated when the parts are held stationary.

This slicer mechanism (change cycle inoperative) is shown in Fig. 1022-a. The turntable and spindle are rotating. The friction collar is attached to the turntable shaft so that it also rotates. The friction collar and ratchet wheel form a friction clutch and so the ratchet wheel will follow the turning motion of the collar as long as the wheel is not held back. Because of the clutch spring, the actuating rod will also turn. The top of the actuating rod is rectangular-shaped. It is positioned between the two slicer blades in a manner that permits the blades to stay inside the spindle. As long as all the parts turn together, this condition continues.

During the change cycle, however, the slide cam moves in and the stop dog (Fig. 1022-b) latches the ratchet wheel. This stops the ratchet wheel from rotating and as a result the actuating rod also stops. Since the spindle is rotating and the actuating rod is now stationary, the rectangular-shaped top of the rod forces the slicer blades apart. The blades pull the shelves in and the bottom record drops.

As the spindle returns to its original position, the actuating rod

permits the slicer blades to return to neutral. At the same time, the slide cam starts moving back so that the stop dog releases the ratchet wheel. Now all parts are moving in unison again and the record-dropping sequence is completed. The stop dog adjustment moves the dog closer to or farther from the ratchet wheel. This causes the record-dropping sequence to start earlier or later and so the mechanism can be precisely timed. The entire record-dropping action takes place in a half-revolution of the turntable. This is the fastest record-dropping mechanism used.

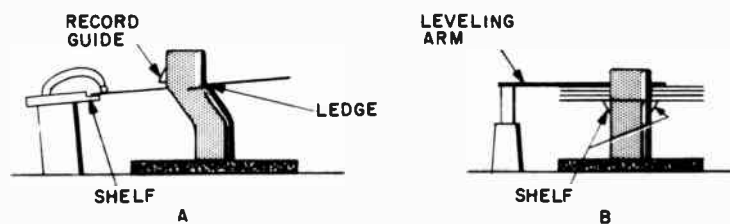


Fig. 1021-a,-b. Examples of large spindle attachments.

### Adjusting the record-dropping mechanism

The record-dropping mechanism must be adjusted properly not only to give good timing results, but to insure the safe handling of records. There are three kinds of adjustments: (1) concentricity, (2) ejection or timing, and (3) guide adjustment.

#### Concentricity adjustment

The concentricity adjustment is the aligning of the edge of the shelf with the edge of the record. If these are not concentric, the record, when ejected, will move off one portion of the shelf first and so will tilt as it drops down the spindle. When a record is on the shelf, it will be plainly evident if the shelf is out of alignment. The shelf is mounted on a shaft which is normally locked to a detent arrangement, as shown in Fig. 1010. By loosening the shelf-alignment screw, the shaft is free to turn and so the shelf can be positioned laterally for concentricity. Tighten the screw and set the shelf for the different record sizes, checking concentricity for each. Normally, if one size is concentric, the other sizes will be also.

#### Ejector or timing adjustment

This adjustment determines the time during the cycle that the record is dropped. If the record drops too early or too late, it may strike the arm while it is swinging out or in. On the other hand, this adjustment can be off in a manner that will prevent the record from being ejected.



Most manufacturers specify definite distances between certain parts for good operation, but service technicians find it too difficult and clumsy to measure distances between irregularly-shaped parts in restricted areas. Therefore, a trial-and-error method is more often used. With cam or plate shelf ejectors, the ejection adjustment is made by varying the distance between the driving edge of the ejector and the edge of the shelf. If the ejector is closer to the edge of the shelf, the record will be pushed off sooner; if the distance is increased, the record will drop later. There are a couple of precautions to remember: If the ejector is too close to the shelf edge, it will be in the way of the stack and so will not allow the records to lower to the shelf. Conversely, if it is too far back, it may not travel far enough to push off the record.

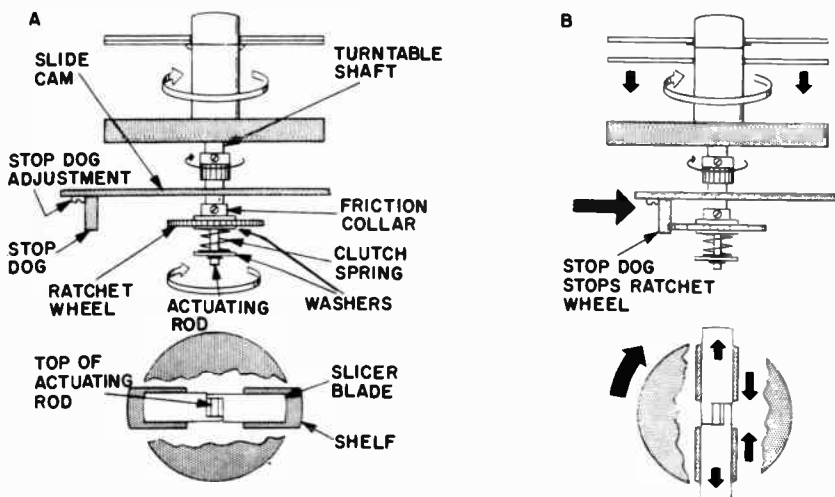


Fig. 1022-a,-b. Adjustments must be made so that the record drops at the proper time.

With the unit shown in Fig. 1007, the lock-and-adjustment screw is loosened, and the ejector cam is positioned by hand. When the screw is tightened, the cam will be held in the new position. With the method shown in Fig. 1008, the screw is turned in or out to reposition the ejector plate.

When adjusting a nodding shelf or nodding spindle mechanism, the distance between the rise of the second step on the shelf and the spindle is the important factor in timing. For convenience, the distance between the rise of the step and the edge of a record on the shelf can be used. If this distance is increased, the record will drop later. The precautions given for the previous shelf adjustment also apply here.

With the mechanism shown in Fig. 1010, turning the adjustment screw in will move the rise of the second step closer to the record; turning the screw out, of course, will move the shelf farther back. With the nodding spindle (Fig. 1012), the adjustable ear is bent toward the lever pivot to move the edge of the record away from the rise of the second step. Bending the ear away from the pivot will move the rise of the step closer.

With spindle ejector mechanisms, the adjustment must be made more carefully. If the ejector in the spindle is caused to move out too far, the mechanism will jam in most automatic record changers. The ejector can move only as far out as the spindle and the record will permit. Even if the mechanism does not quite jam, the excessive ejector force will damage the center hole of the record. The adjustments (Figs. 1015, 1017 and 1018) should be made so that, when the record drops, the ejector extends out just beyond the spindle ledge.

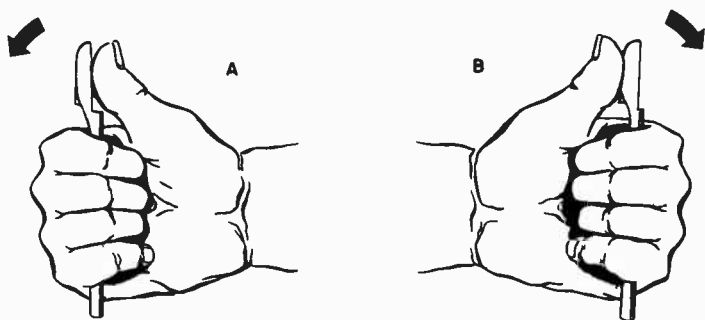


Fig. 1023-a, b. *Technique for adjusting the record guide.*

The adjustment for the spindle slicer is purely a matter of timing. The stop dog (Fig. 1022) is moved back and forth by the adjustment screw. This will cause the dog to engage the ratchet wheel earlier or later, thereby controlling the amount of time it holds the wheel stationary. If the wheel is not held stationary long enough, the record may not drop. If the ratchet is held too long, then more than one record may drop. Poor timing can also cause the record to hit the pickup arm. The screw should be adjusted so that the stop dog holds the ratchet wheel for approximately a half-revolution of the turntable and the record drops when the pickup arm is clear.

### **Guide adjustment**

With either the shelf or spindle ejector, the record guide at the top of the spindle must be in the proper position for the dropping

action to take place correctly. If the guide extends down into the center hole of the bottom record, the record will not drop. If it just barely reaches into the center hole, the slight obstruction of the guide will wear the center hole. On the other hand, if the record guide does not extend far enough down into the center hole of the second record from the bottom, two records will drop at once.

Discounting the possibility of the guide sticking in a high position, adjustment of the guide becomes necessary because the spindle bends out of shape. (Some manufacturers call this being out of perpendicularity.) This causes the position of the record guide to change in relation to the spindle ledge. The correction adjustment for this is a matter of bending the spindle back to shape.

Fig. 1023-a shows the adjustment to prevent two records dropping at once. The guide must be moved down to stop the second record and so the top of the spindle is moved away from the ledge. This lowers the guide. If the bottom record is being obstructed by the guide, bend the top of the spindle toward the ledge, as shown in Fig. 1023-b. This will raise the record guide. The amount of bending usually required is so small that it sometimes cannot be noticed. Therefore, make the bends ever so slight, in successive steps if necessary, until normal operation is returned.

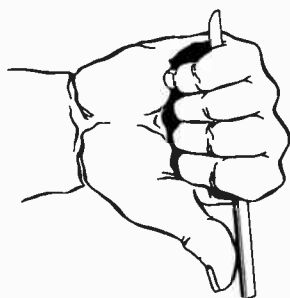
### **Servicing, cleaning and lubricating the record-dropping mechanism**

When the record-dropping mechanism does not seem to be functioning properly, first check the records being used. Exceptionally thin records and ones with worn center holes will cause erratic operation. The record-dropping mechanism should be inspected for service periodically as a preventive measure and to detect trouble when it first starts to develop. This will minimize the probability of the changer damaging records. The two most frequent problems that develop in this mechanism are the ones causing more than one record to drop at a time or no records to drop at all. Other troubles may cause the records not to drop flat or to drop only intermittently.

When a record does not drop flat with a shelf ejector mechanism, the shelf needs to be adjusted for concentricity, as discussed earlier. But, when this trouble develops with the spindle ejector mechanism, it means that either the leveling arm or the spindle is bent. In most cases, it is the leveling arm that is bent, preventing it from holding the records in a level position on the spindle. If this is the case, bend the arm so that it holds the stack of records

on the spindle level. A bent spindle producing this trouble is usually caused by abuse. The bent spindle talked about previously was bent above the ledge. Here, however, the spindle is bent below the ledge so that the record guide still functions properly but the records are held off level. Straighten the spindle as shown in Fig 1024, bending it in the proper direction until the stack of records is held parallel to the turntable.

Fig. 1024. *How to straighten the spindle.*



If the records are dropped erratically or intermittently, the causes are usually weak springs, a loose spindle mounting, dirt or lack of lubrication. Dirt and grime in the actuating mechanism can be treated in the same manner as in any other mechanism. Pay particular attention to the ejection parts and especially to the record guide. The guide must rise and fall freely in the spindle slot to function properly. Inject carbon tetrachloride into the slot and work the guide up and down vigorously to loosen and remove the dirt inside. Use a brush to scrub the cam and plate shelf ejectors. To clean the spindle ejector parts thoroughly, the spindle should be removed from the changer and immersed in the solvent. Minor cleaning, though, can be accomplished by injecting the solvent into the spindle while it is in place on the changer.

Apply motor cup grease to all actuating parts in the change-cycle mechanism. Using an eye dropper, put a couple of drops of oil (SAE No. 20) into the spindle to lubricate the spindle ejector parts. Do not allow the oil to contact the part of the record ejector that pushes the record off the spindle ledge. Do not oil the cam or plate shelf ejectors; these need only to be kept clean to function properly. Apply oil to a soft clean cloth and polish the spindle body. This will provide the dropping record with a smooth, low-friction path.

## **Records do not drop**

The immediate checks to make when this trouble is encountered are the record-dropping and guide adjustments, explained earlier. If the records still do not drop, observe the ejector or slicer mechanism to see that it is being actuated. Rotate the turntable by hand with the power off and watch each of the record-dropping parts to see that they operate normally. See that the mounting screws, nuts or retaining rings holding the levers, links, plates or arms are not loose or missing. Make sure the parts are not bent or broken. Check the springs to make sure that they are not weak. With the spindle ejectors, if the actuating mechanism seems to be operating properly, then the parts in the spindle are probably at fault. If this is the case, the entire spindle must be replaced.

## **More than one record drops**

The spindle record guide is the biggest offender with this type of trouble. Clean the guide to make sure that it stays low enough. Adjust the position of the record guide to try and correct the condition. If neither of the previous helps, inspect the lower end of the record guide to make sure that it is not worn. If it is, replace the spindle. The guide cap shown in Fig. 1013-a can be replaced separately. A pull will lift it off the spindle.

## **Removing the spindle**

Some spindles are held in place only by their own weight and can be removed by merely lifting the spindle. Most are held in place by nuts or setscrews. Unscrewing the nuts or loosening the setscrews will free the spindle. Typical spindle mountings are shown in Figs. 1012, 1017 and 1018. The spindle shown in Fig. 1012 passes through the ejector lever and is held by the actuating spring.

## swinging the arm in

**T**HE pickup arm has now been swung out over the rest post and the record has been dropped to the turntable. The change-cycle mechanism must swing in the arm and set it down on the beginning of the record. Basically there are only two methods of doing this: (1) direct swing-in drive and (2) spring-loaded swing-in drive. Regardless of how the action is accomplished, all present-day record changers employ a safety drive in the swing-in mechanism. This prevents damage if the pickup arm is obstructed, as explained in Chapter 9. However, the swing-in safety drive also has another function; it plays an important part in the determination of the setdown position of the pickup arm. This position is actually determined by a part obstructing the travel of the pickup arm, directly over the point where setdown should occur. This part, known as the *index stop*, holds the pickup arm at this point while the safety drive permits the rest of the change-cycle mechanism to continue to the end of the cycle. At the end of the cycle, the change-cycle mechanism lowers the pickup arm to the beginning of the record. The index stop can obstruct the pickup arm swing-in motion at three different positions so that the arm will be able to set down on the starting grooves of 7-, 10-, and 12-inch records. Indexing is explained in Chapter 12.

### Setting the pickup arm down

This action is the reverse of the arm-raising motion discussed in Chapter 8. At the end of the change cycle, when the mechanism approaches a neutral position, the part that caused the raising of the pickup arm moves away, releasing the arm so that it lowers.

For instance, if an incline cam surface moves in to actuate the arm-raising push rod at the beginning of the cycle, it moves away at the end of the cycle so that the arm-raising push rod drops down. Studying the arm-raising methods discussed in Chapter 8 will make the lowering action obvious.

### Direct swing-in drive

The change-cycle parts that swing the pickup arm in by direct actuation are those that swing it out. After half the change cycle is completed, the parts return to their original position and in doing so carry the arm in again.

An example of the direct swing-in drive is shown in Fig. 1101. These parts are also shown in their swing-out motion in Fig. 907,

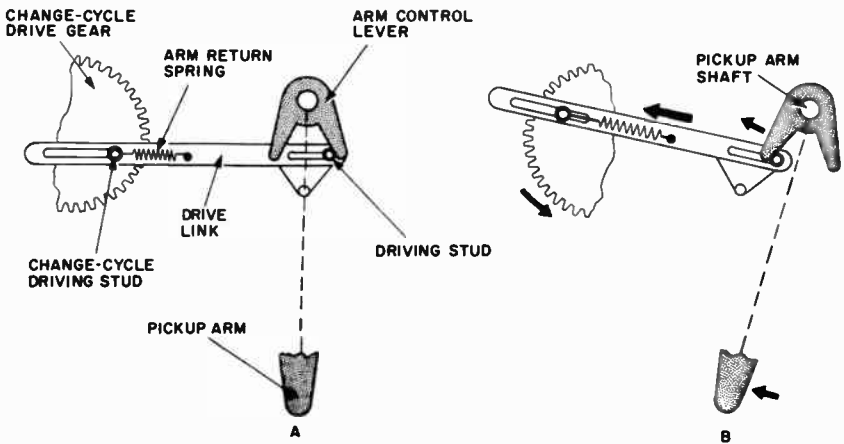


Fig. 1101-a,-b. *Basic direct swing-in drive.*

Chapter 9. There is very little difference between the two actions. In swinging the arm out, the driving stud on the change-cycle drive gear pushes the drive link, causing the stud at the other end of the drive link to move against one finger on the arm control lever. Fig. 1101-a illustrates the position of the parts in the middle of the change cycle, with the pickup arm swung all the way out. As the cycle continues, the change-cycle drive gear carries the driving stud back. The arm return spring pulls the drive link back also, so that the driving stud at the end of the drive link moves against the other finger on the arm-control lever. This is shown in Fig. 1101-b. The arm-control lever is then turned so that it swings in the pickup arm. This action continues until the set-down index stops the drive link as soon as the pickup arm is

directly over the beginning of the record. The arm return spring stretches, permitting the rest of the change-cycle mechanism to continue to the end of the cycle. The indexing action will be explained more fully in Chapter 12.

Another example of a direct swing-in mechanism that uses the same parts for the swing-in and swing-out motions is shown in Fig. 903, Chapter 9.

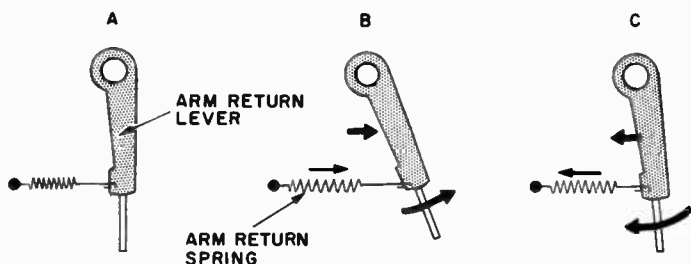


Fig. 1102-a,b,c. *The spring-loaded arm return lever.*

### Spring-loaded swing-in drive

This action is an indirect method of returning the pickup arm. The basic principle of the drive is that, during the pickup arm

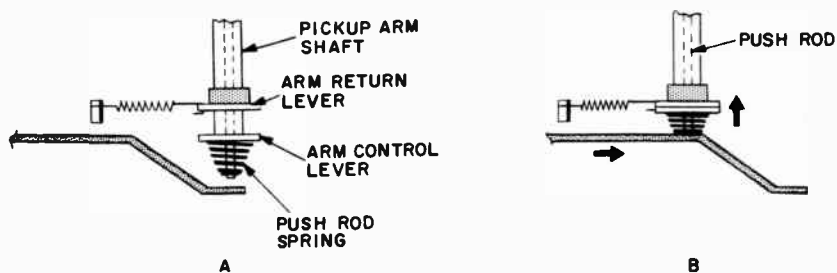


Fig. 1103-a,b. *The spring-loaded drive clutch.*

swing-out motion, the change-cycle mechanism also pushes out an arm-return lever (or plate), as shown in Fig. 1102. As the lever is pushed out, the arm-return spring stretches and builds up tension. When the time comes for the pickup arm to be swung in, the change-cycle mechanism starts moving away from the arm-return lever, as shown in Fig. 1102-c. This permits the arm-return spring to pull in the arm-return lever so that the lever follows the mechanism back. The arm-return lever is coupled to the arm-control lever and so this swing-in motion carries in the pickup



arm. The safety drive here is automatic because the swing-in motion is effectively independent of the change-cycle mechanism.

The arm-return lever can be coupled to the arm-control lever in the various ways. The most popular method is to have the return lever mounted around the pickup-arm shaft and have it couple the control lever by clutch action, as shown in Fig. 1103.

Fig. 1103-a shows the parts while a record is being played. The arm-control lever is kept separated from the arm-return lever because the pickup arm must have complete lateral freedom while it rides the grooves of the record. However, when the change cycle starts and the push rod is moved up to raise the pickup arm,

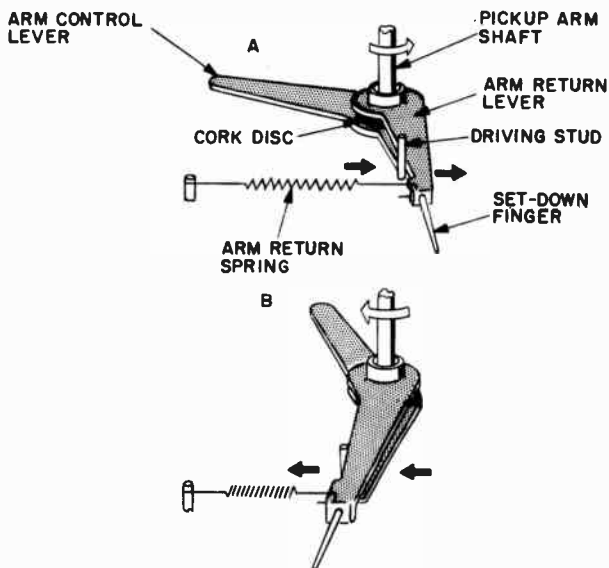


Fig. 1104-a,-b. *Basic Admiral RC600 spring-loaded swing-in drive.*

the push-rod spring is compressed so that it pushes the arm-control lever against the arm-return lever, as shown in Fig. 1103-b. The levers will remain coupled that way during the cycle so that they move in unison until the pickup arm is lowered. At that time, the push-rod spring releases the arm control lever so that the lever moves down, as in Fig. 1103-a. While the two levers remain pressed together, they couple by means of friction or a detent.

Fig. 1104-a, -b shows a type of spring-loaded swing-in drive that is used. During the cycle, when the pickup arm is raised, the arm-control lever is pushed against the arm-return lever. The driving stud moves the arm-control lever around to swing the pickup arm out. The arm-return lever is also pushed around, causing the arm-

return spring to stretch. After the next record has dropped, the driving stud starts moving back and so releases the arm control and return levers. The arm-return spring tension then starts pulling the arm-return lever back so that the lever follows the stud inward. Since the arm-control lever is pressed tightly against the arm-return lever, it swings in also, carrying the pickup arm with it. The cork disc between the two levers supplies the clutch friction.

The arm-return spring continues to cause the pickup arm to swing in until it is directly over the beginning of the record. At

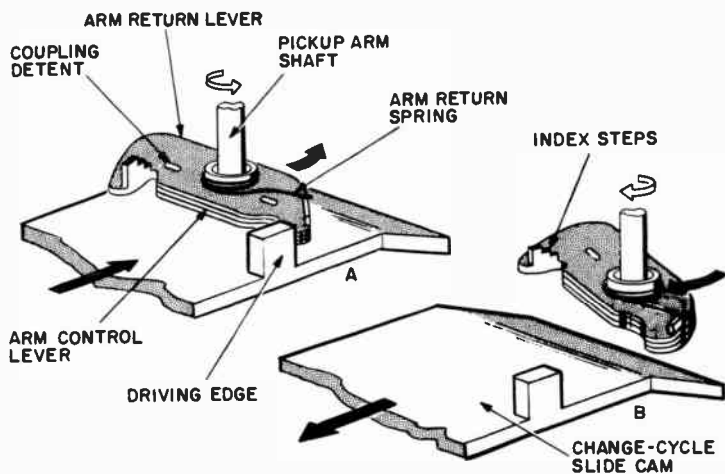


Fig. 1105-a,b. Basic V-M 950 spring-loaded swing-in drive.

this time, the index stop moves against the setdown finger of the arm-return lever. This overpowers the arm-return spring, stops the arm-return lever, and so the arm-control lever and pickup arm are also stopped. The pickup arm hovers over the starting grooves of the record and the rest of the change-cycle mechanism continues to the end of the cycle, at which time the pickup arm is lowered to the record. As the pickup arm is lowered to the record, the arm-control lever is moved down, away from the arm-return lever. The pickup arm now has the lateral freedom necessary to ride the grooves of the record.

A similar spring-loaded swing-in drive is shown in Fig. 1105. When the pickup arm is raised, the arm-control lever is pressed against the arm-return lever in the same manner as discussed previously. These two levers are coupled, however, by detent action rather than friction. Two small protrusions on the arm-control lever move into two mating holes on the arm-return lever,

causing the two levers to lock while they are moved back by the driving edge of the slide cam; this takes place while the pickup arm is being swung out, as shown in Fig. 1105-a. As the arm-return lever turns, the spiral-arm return spring is compressed so that it builds up pressure.

After the next record is dropped, the change-cycle mechanism starts pulling the slide cam back, as in Fig. 1105-b. This permits the arm-return spring to push the arm-return lever and, therefore, the arm-control lever back also, causing the two levers to follow the slide cam inward. Consequently, the arm-control lever swings in the pickup arm. The arm will continue to swing in until the setdown index blocks the path of the arm-return lever, preventing the arm-return spring from pushing it farther. The arm-control lever also stops, causing the pickup arm to hover over the starting grooves of the record. The change-cycle mechanism continues to pull in the slide cam until the end of the cycle; the pickup arm is then lowered and the arm-control lever is moved down, away from the arm-return lever.

The index steps on the arm-return lever are the points at which the setdown index blocks the inward travel of the lever. The set-down position of the pickup arm is determined by which step is contacted by the index.

Fig. 1106 shows another type of spring-loaded swing-in drive. The arm-return lever here swings in the pickup arm by a direct application of a force rather than by means of a clutch.

Near the beginning of the cycle, a change-cycle slide cam turns the arm-control plate to swing out the pickup arm. As the plate moves out, the arm-control stud moves against the arm-return lever, so that the return lever is also pushed around, as shown in Fig. 1106-a. Unlike the previous arm-return levers, this lever is mounted on a separate pivot, independent of the pickup-arm shaft. While the return lever is pushed back, the arm-return spring stretches and builds up tension. At this point, the record drops and the slide cam starts to move back, away from the arm-control plate. The arm-return spring, then, is permitted to pull in the arm-return lever. As shown in Fig. 1106-b, the arm-return lever drives against the arm-control stud. This causes the arm-control plate to move in with the slide cam. The arm-control plate swings in the pickup arm. This swing-in motion continues until the arm-control stud moves into the hooked portion of the arm-return lever, at which time the lever is stopped. In this position, the pickup arm is over the beginning of the record. At the

end of the cycle, when the pickup arm is lowered, the arm-return lever is moved from the arm-control stud. The arm-control plate and pickup arm now have the lateral freedom necessary for the playing of a record.

The arm-control stud is eccentrically pivoted on the arm-control plate so that it can be turned to adjust the setdown position of the pickup arm. There is no indexing problem with this swing-in drive because the record changer in which this setup is used plays only 7-inch 45 r.p.m. records. Therefore, pickup arm setdown always occurs at the same place (when the arm control stud moves into the hooked portion of the arm return lever).

### Servicing and cleaning the swing-in drive

The pickup arm swing-in drive is a very simple assembly to service, discounting, of course, indexing or setdown troubles. In

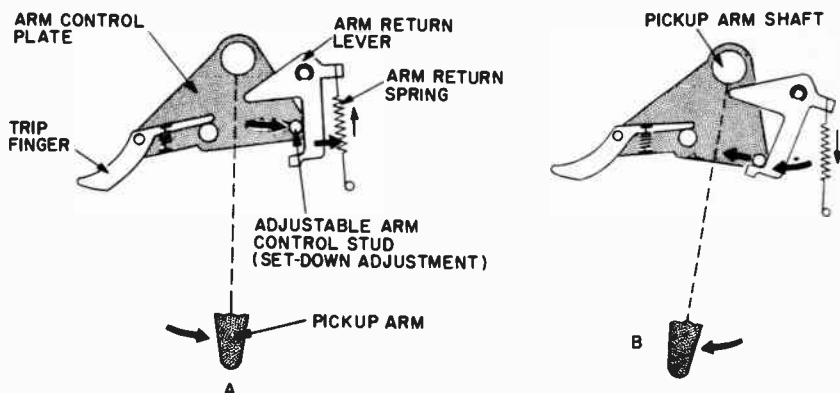


Fig. 1106-a,b. Basic spring-loaded direct swing-in drive.

the great majority of cases, difficulties that develop with the swing-in drive will also be common to the swing-out drive and will most likely be evident first during the swing-out motion. The servicing information given in Chapter 9 also applies, in most part, to the swing-in drive.

### Arm does not swing in or swings in erratically

Because of its construction, the spring-loaded swing-in drive is most susceptible to these troubles.

As shown in Figs. 1104, 1105 and 1106, the entire swing-in action is dependent on the operation of the arm-return spring. If this is broken or missing, the arm-return lever will not be pulled in; consequently the pickup arm will remain near the edge of the changer chassis. If the spring is weak, it will lack the tension required to pull the parts in fast and smoothly. This will cause the

pickup arm to swing erratically, and perhaps not swing in far enough at times. The arm-return spring, then, should be the first part checked.

With the setup shown in Fig. 1104, trouble can be caused by the cork disc between the arm-control and arm-return levers. This disc supplies the friction required for the arm-control lever to follow the arm-return lever in. If the disc is worn smooth, the arm-control lever will have a tendency to slip, causing the pickup arm to swing in improperly. The disc in this case is part of the arm-return lever and so the lever will have to be replaced.

As shown in Fig. 1103, the push-rod spring plays an important part in the clutch type spring-loaded drive. When the push rod raises the pickup arm, the push-rod spring moves the arm-control lever tightly against the arm-return lever. If this spring is weak, broken or missing, the levers will couple loosely or not at all. It is quite possible for the spring to affect the swing-in but not the raising motion of the pickup arm.

Dirt and foreign matter can cause the arm-return lever to bind on its pivot or couple the arm-control lever poorly. If the arm-return lever does not pivot freely, it will oppose the action of the arm-return spring, causing poor swing-in motion. Likewise, if dirt or foreign matter settles between the arm-control and arm-return levers, it will prevent them from coupling firmly. Apply a liberal amount of carbon tet to the pivot points and coupling surfaces. Use a brush dipped in carbon tet to dislodge stubborn dirt. Make sure no lubrication is on the coupling surfaces of the swing-in drive clutch.

# setdown indexing

THE swing-in safety drive permits the indexing device to stop the inward travel of the pickup arm without hindering the action of the rest of the change-cycle mechanism. Like other assemblies, the setdown index is known by other names;—*pickup-arm return locator*, *record-size index* and *determinator* and *discriminator*. These names describe fairly well the function of the setdown

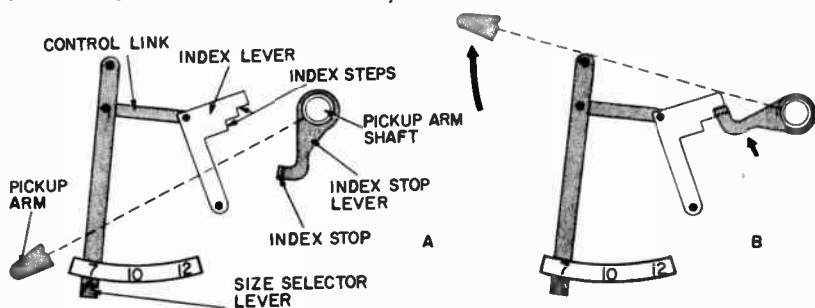


Fig. 1201-a,-b. Selector lever manual indexing (7-inch position).

index: it determines the size of the record to be played and locates the proper setdown position for the pickup arm. With changers that accommodate all three record sizes (7, 10, and 12 inches), the setdown index must be able to point out accurately the setdown position for each record size. It accomplishes this by obstructing the inward travel of the pickup arm at three different positions which can be determined manually or automatically. When a record changer employs manual indexing, the operator changes a control setting, such as a selector lever, whenever a

different size record is to be played. These changers cannot intermix such records. Manual indexing can also be set by changing the position of the shelf.

### Selector-lever indexing

Fig. 1201 shows the basic principle of setdown indexing. This index is used with the swing-in drive method shown in Fig. 1101. The driving stud which causes the swing-in motion (Fig. 1101) is actually attached to the index stop lever shown in Fig. 1201. As a consequence, the lever will move in unison with the driving stud, following the inward swing of the pickup arm. On the other

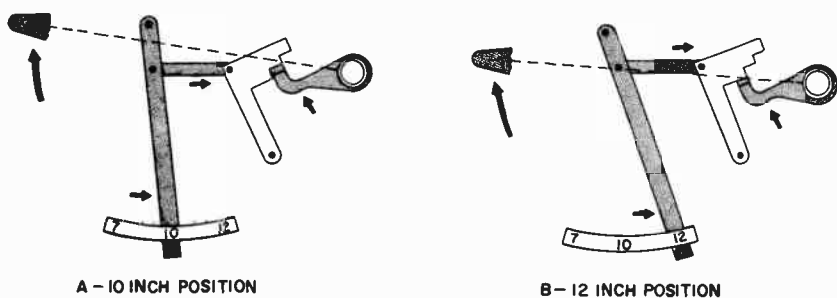


Fig. 1202-a, -b. Selector-lever manual indexing (10- and 12-inch positions).

hand, if the index stop lever is stopped in position, the driving stud will also stop so that it can no longer swing in the pickup arm.

Fig. 1201-a shows the position of the parts right after the pickup arm has been swung out. Since 7-inch records are being played, the size-selector lever has been placed as shown. As a result of this setting, the index lever is positioned for 7-inch operation by means of the control link. In this position, the bottom index step is used. As the pickup arm is swung in (Fig. 1201-b) the index stop lever turns until it is blocked by the index step. The index stop lever is held stationary at this point; the pickup arm swing-in motion stops with the pickup arm above the starting grooves of the 7-inch record.

Fig. 1202-a, -b, shows this setdown index in the 10- and 12-inch positions. When the size-selector lever is placed in the 10-inch position, the index lever is shifted so that its second (10-inch) step is in the path of the index stop lever. This blocks the swing-in action when the pickup arm is directly over the beginning of a 10-inch record. Similarly, when the size-selector lever is in the 12-inch position, the index lever is shifted so that its third (12-

inch) step is in the path of the index stop lever. The pickup arm will now swing in until it is over the starting grooves of a 12-inch record.

### Shelf-position indexing

In Chapter 10 we saw how the shelf had to be repositioned whenever a record of a different size was to be played. Since this must always be done with record changers that employ shelves, some changers make use of the shelf position to control the set-down index.

A good example of this is shown in Fig. 1203. A control link is pivoted to a bushing that turns with the record shelf. When the shelf position is changed, the control link will follow it, turn-

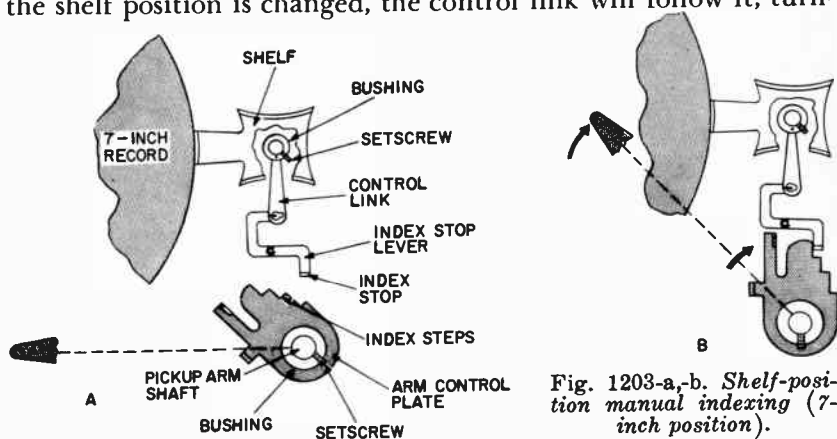


Fig. 1203-a,-b. Shelf-position manual indexing (7-inch position).

ing the index-stop lever so that the stop will be put in the path of the proper index step. Unlike the previous setup, this index stop lever is stationary during the cycle and the index steps swing in with the pickup arm. The overall action, however, is the same.

Fig. 1203-a shows the parts with the pickup arm swung out. The record shelf has been positioned to accommodate a stack of 7-inch records. The index-stop lever is so placed that the index stop is in the path of the first (7-inch) step on the arm-control plate. The arm-control plate and bushing are one unit. Since the bushing is screwed to the pickup-arm shaft, the arm-control plate swings in with the pickup arm, as shown in Fig. 1203-b. The swing-in motion continues until the index stop contacts the 7-inch index step. This blocks the arm-control plate, causing the pickup arm to stop over the beginning of a 7-inch record.

### Automatic indexing

When different speeds were introduced with popular records,



the record changer had to have another control. Controls then included speed selection, size selection, manual operation, rejection and turning on power. In addition to this, the controls on the associated audio amplifier have to be manipulated. For the layman, the record changer was beginning to get annoyingly complicated. To alleviate this condition, automatic setdown indexing was developed to obviate the need for a size-selector control. The first type to be discussed works properly only when the record stack is comprised of one record size at a time; that is, when the record sizes are not intermixed. The automatic index that allows intermixing is discussed later.

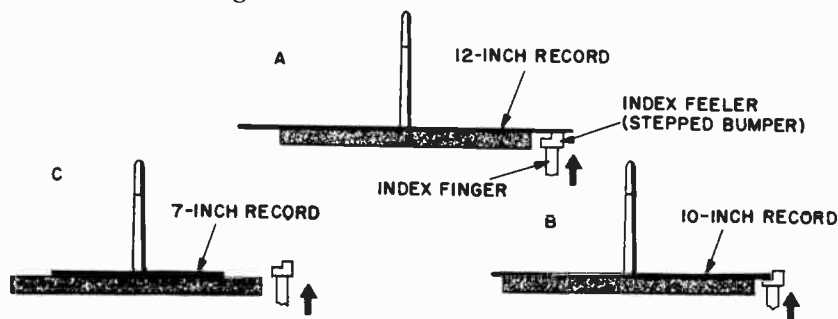


Fig. 1204-a,-b,-c. *The basic automatic non-intermix index.*

### Automatic nonintermix indexing

The basic principle of the automatic nonintermix index is illustrated in Fig. 1204. An index finger, protruding through the changer chassis near the turntable, has a stepped rubber bumper, an index feeler, which "feels" the size of the record on the turntable. During the change cycle, this feeler moves up unless it is held back. If a 12-inch record is on the turntable (Fig. 1204-a) the feeler can move up only a short distance until the top of the feeler hits the record. With a 10-inch record on the turntable (Fig. 1204-b) the feeler is permitted to move a little more until the first step on the feeler hits the record. For a 7-inch record (Fig. 1204-c), the feeler can move all the way up since the 7-inch record is too small to stop it. The height to which the feeler rises is an indication as to the size of the record on the turntable. Since the index feeler "searches" for the bottom record, all the records in a stack must be the same size.

The heart of this setdown index is the index bracket. This is the part that stops the swing-in motion of the pickup arm. (The swing-in drive is shown in Fig. 1104). The index stop assembly

obstructs the setdown finger at the proper time to stop the arm-return lever from swinging in the pickup arm. Fig. 1205-a shows the initial action of this index during the change cycle; this prepares the index to determine which size record is to be played. As the pickup arm swings out, the setdown finger moves out of whichever stop groove it was in. When this occurs, the index bracket, being rear-heavy, pivots so that the index feeler moves up as shown in Fig. 1205-a. This first pivot is unimportant. As the setdown finger continues to move back, it pushes against the curved rear of the bracket. It pushes the rear of the bracket up, as shown

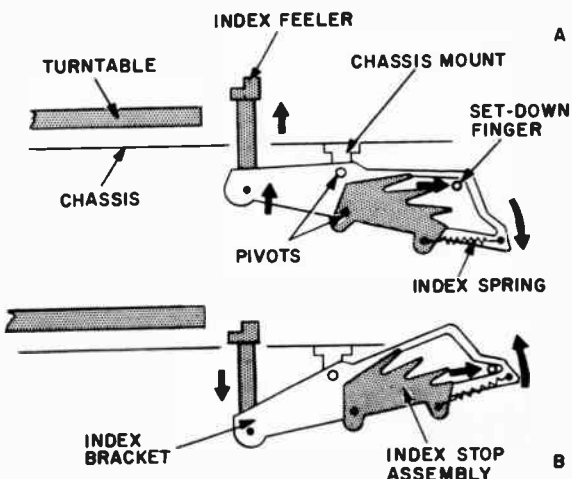


Fig. 1205-a,b. Preparation for record-size determination. The set-down finger is attached to the arm-return lever. The arm-return lever is not shown in this drawing.

in Fig. 1205-b. This action pulls the index feeler down. At this time the record is dropped to the turntable and the feeler is prepared to determine the size of the record. As the setdown finger swings in with the pickup arm, it releases the index bracket; the bracket pivots again and the feeler rises.

Fig. 1206-a shows the ensuing action with a 7-inch record on the turntable. Since the index feeler is not obstructed, it moves all the way up, permitting the bracket to turn completely. This puts the 7-inch stop directly in the path of the setdown finger. The finger pushes against the 7-inch stop and rides into the groove. The pressure of the finger turns the index bracket (Fig. 1206-b) so that the index feeler is moved down, out of the way. The set-down finger is stopped at the end of the groove and so the pickup arm is also stopped in the 7-inch position.

With a 10-inch record, the index bracket will turn only until the step on the feeler hits the edge of the record (Fig. 1207-a). In

this position, the 10-inch stop is directly in the path of the set-down finger. The finger now enters the second groove and pivots the index bracket as shown in Fig. 1207-b, bringing the feeler down. The 10-inch groove is shorter than the 7-inch one, causing the setdown finger to be stopped sooner so that the pickup arm will set down in the 10-inch position.

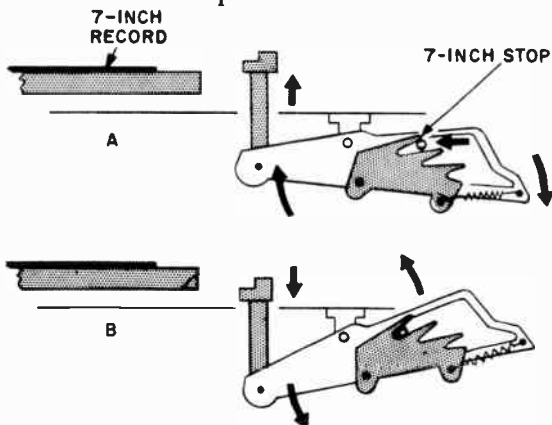


Fig. 1206-a,-b. 7-inch operation.

If a 12-inch record is on the turntable, the top of the feeler will hit the bottom of the record and the index bracket hardly turns at all. This causes the 12-inch stop to be in the path of the setdown

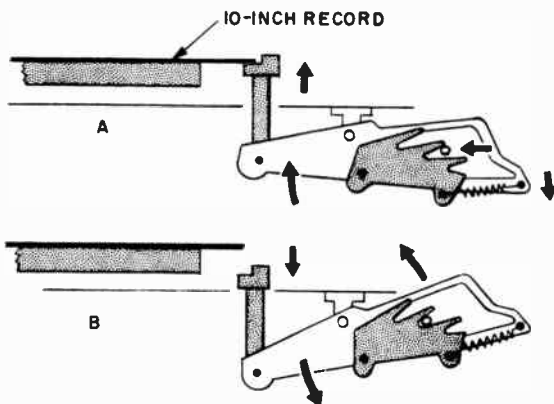


Fig. 1207-a,-b. 10-inch operation.

finger. It now moves into the shortest groove, causing it to be stopped even sooner, so that the pickup arm will set down on the beginning of a 12-inch record.

Consider a 10-inch record on the turntable. After the first record has been played and the cycle starts again, the feeler can no longer rise all the way; it moves up only to the bottom record. Then, when the setdown finger starts to move out of the stop groove, the index bracket cannot pivot enough to make the way free for the setdown finger. To compensate for this, the index stop assembly is made to pivot under pressure from the setdown finger as the finger moves out. After the finger leaves the groove, the index spring pulls the index stop assembly back into its normal position.

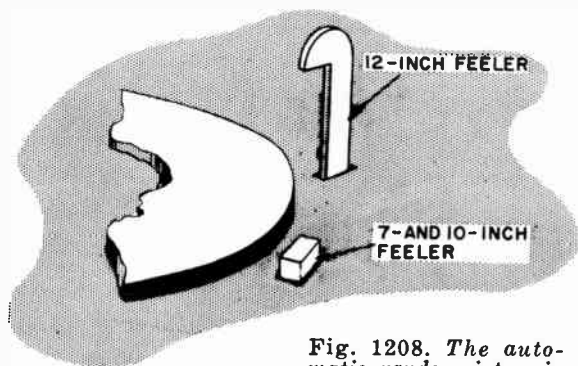


Fig. 1208. *The automatic random intermix index.*

It can be seen why this indexing method does not permit intermixing. Referring to Fig. 1204-a, if a 10-inch record is dropped on top of a 12-inch record, the feeler would never "know" it. It would still rise to meet the 12-inch record and so the pickup arm would set down on the 12-inch record again. It can be seen in Fig. 1204-b that, if a 12-inch record is dropped on top of a 10-inch record, the feeler would still have to move up too high to meet it and so the index assembly will still respond to the 10-inch record. Similar conditions prevail if 7-inch records are intermixed with 10- or 12-inch discs.

### **Automatic intermix indexing**

The automatic intermix index was developed to simplify further the operation of the record changer and give the listener a better choice of records in one stack. It appears in varied forms. The most popular is capable of intermixing 10- and 12-inch records only, with 7-inch records being played separately. Also, with some changers, the records can be intermixed in a random manner whereas with others the intermixed stack must be set up according to a definite arrangement.

## Random intermix indexing

Fig. 1208 shows the basic feeler setup for the random intermix index. A rising feeler, similar to the one previously described, is used near the rim of the turntable. This feeler, however, has no step and so cannot determine the difference between a 10- and 12-inch record. During 10- and 12-inch playings, it would move up to the same height, if it were permitted. The 12-inch feeler, though, prevents this. When a 12-inch record falls to the turntable, it strikes the feeler and pivots it. Therefore, this index determines

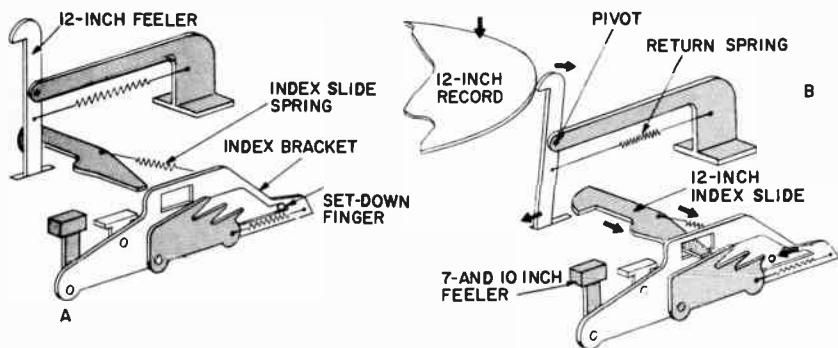


Fig. 1209-a,b. 12-inch operation. This technique takes advantage of the striking action of the falling record.

the difference between 10- and 12-inch records *while the records drop down the spindle*. No matter how the 10- and 12-inch records are placed in the stack, if a record hits the feeler, 12-inch operation is called for; if the record does not hit the feeler, 10-inch setdown will result. The 7-inch record cannot be used in the intermixed stack because the 7- and 10-inch feeler must rise all the way up to bring about 7-inch operation, and the larger records will block the way.

One method of using the striking action of the falling record is shown in Fig. 1209-a,b. This is an advanced version of the setup described under "Automatic nonintermix indexing." The setdown position here is determined in just the same way as in the earlier index. The setdown finger will move against the 7-, 10- or 12-inch stop according to the tilt position of the setdown bracket. The 7-inch records are played separately. When a 7-inch record is on the turntable, the 7- and 10-inch feeler moves all the way up, turning the index bracket completely.

For 10- and 12-inch records, the feeler would ordinarily rise to the same height for both sizes. But, the 12-inch feeler prevents this. Consider first a 10-inch record dropping to the turntable. The

setdown index would function just like the index shown in Fig. 1207. The feeler rises until it hits the bottom of the record and holds the index bracket in a position that puts the 10-inch stop in the path of the setdown finger. Therefore, when a 10-inch record drops, this index also functions the same as the earlier device.

For 12-inch operation, however, the newer index functions differently. Since the 7- and 10-inch feeler moves up to the same height for 10- and 12-inch records, the problem is to prevent the index bracket from moving up at all. This will keep it in a position that puts the 12-inch stop in the path of the setdown finger. When

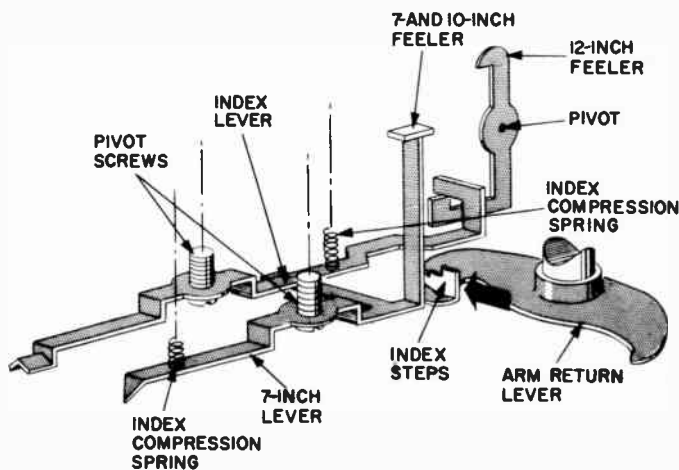


Fig. 1210. *Basic V-M automatic random intermix index.*

a 12-inch record is dropped, it strikes the 12-inch feeler on the way down. This causes the feeler to pivot, as shown in Fig. 1209-b. In pivoting, the feeler releases the 12-inch slide and permits the slide spring to pull the slide into the hole in the index bracket. As a result, the index bracket cannot turn. So when the setdown finger swings in, it moves into the 12-inch groove, causing the pickup arm to set down on the beginning of a 12-inch record. As the setdown finger moves into the groove, the mechanism pushes the 12-inch slide back so that it latches the 12-inch feeler, ready for the next change cycle.

As a result of these actions, if any combination of 10- and 12-inch records is used in a stack, whenever a record hits the feeler, 12-inch set-down will take place. Or, if a record does not hit the feeler, 10-inch setdown will occur. Therefore, this index will function with 10- and 12-inch records intermixed at random.

Another popular random intermix index is shown in Fig. 1210. It is relatively more complicated, but the basic principles are just about the same as the previous unit. This index is used with the swing-in drive shown in Fig. 1105. The setdown position is deter-

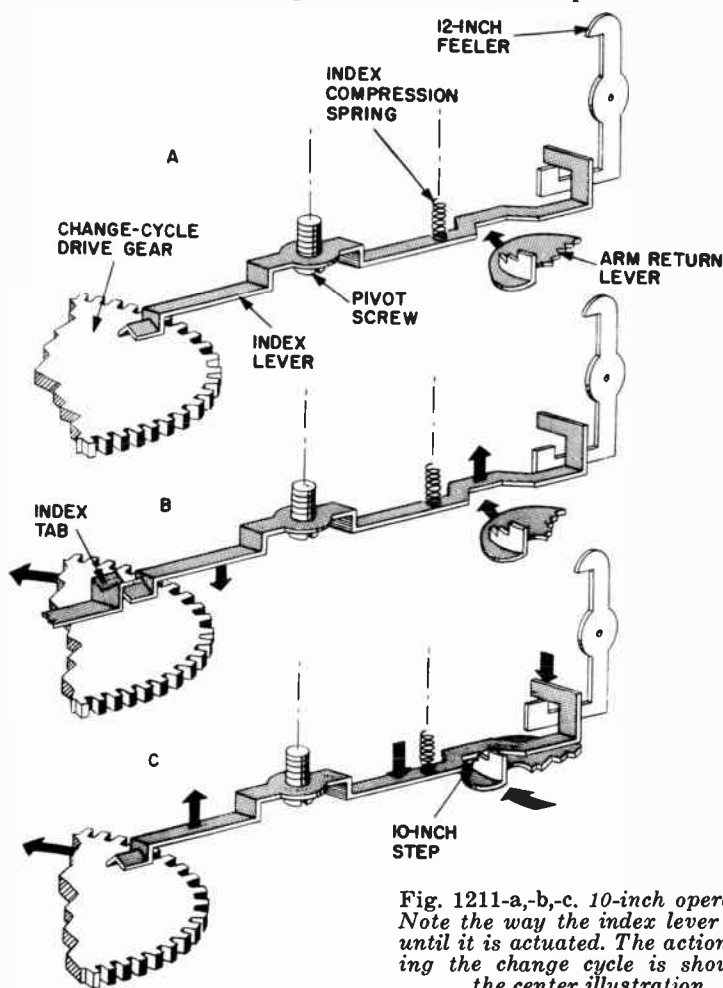


Fig. 1211-a,b,c. 10-inch operation. Note the way the index lever seats until it is actuated. The action during the change cycle is shown in the center illustration.

mined by the index lever contacting the first, second or third index step on the arm-return lever. The index lever, then, must be raised to a different position for each record size. With this device, 7-inch records cannot be intermixed in the stack for the same reasons given for the previous setdown index.

The 10-inch operation of this index is shown in Fig. 1211. For 10- and 12-inch operation, the 7-inch lever is unimportant and is

therefore not shown. Fig. 1211-a shows the way the index lever normally seats until it is actuated. The compression spring pushes down on the index lever, but it is held up by the top of the hooked portion of the 12-inch feeler. In this position, it is in the path of

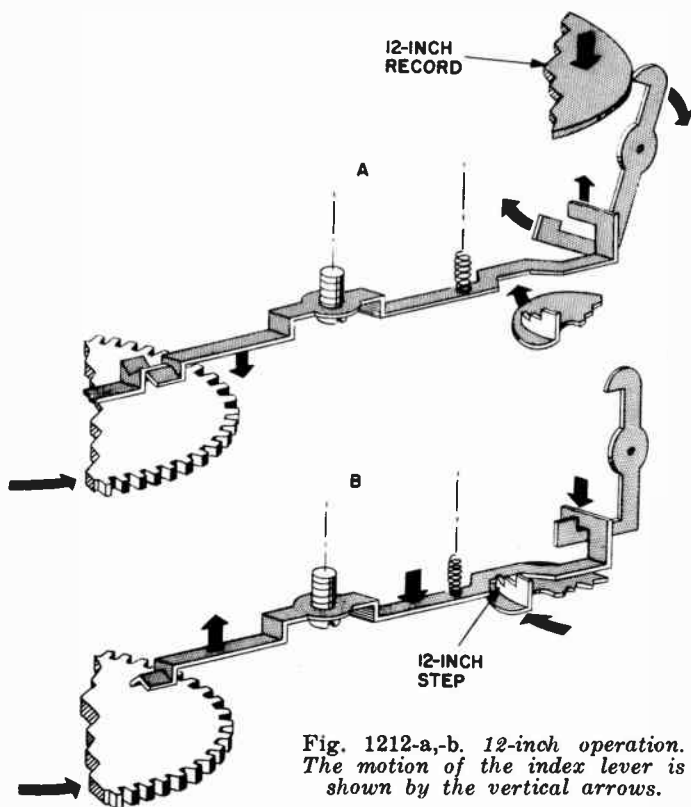


Fig. 1212-a,-b. 12-inch operation. The motion of the index lever is shown by the vertical arrows.

the second (10-inch) step. During the change cycle, as shown in Fig. 1211-b, an index tab on the change-cycle drive gear comes around and pushes down on one end of the index lever. The other end of the lever rises. When a 10-inch record drops, no other action takes place. As the change-cycle drive gear continues to turn, the index tab moves off the index lever. The compression spring then pushes the lever back to the top of the hooked portion of the 12-inch feeler, the same position it was in at the start of the cycle. This is shown in Fig. 1211-c. The arm-return lever will swing in the pickup arm until the second index step moves against the index lever. The pickup arm will then stop and hover in the 10-inch position.



Now assume that the next to be played is a 12-inch record. The index tab comes around and pushes down one end of the index lever, pivoting the other end up. Then the record is dropped. As the record slides down the spindle, it strikes the 12-inch feeler. The feeler pivots, as shown in Fig. 1212-a. At the same instant, the index tab moves away and releases the index lever. The compression spring pushes the lever back. However, since the 12-inch feeler is in a tilted position, the index lever falls into the recess of the hooked portion of the 12-inch feeler, as in Fig. 1212-b. As a result, the index lever is in a lower position. As the arm-return lever swings in the arm, the index lever contacts the first (12-inch) step

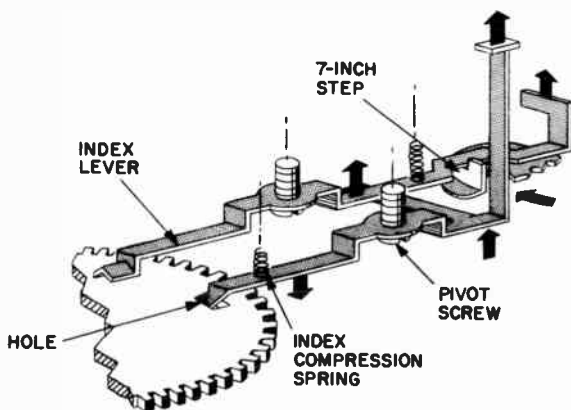


Fig. 1213. This illustration shows how the index works for 7-inch records.

so that the swing-in action is stopped sooner, for 12-inch setdown. During the next change cycle, when the index lever is again caused to move up by the index tab, the index feeler will be permitted to straighten itself out, unless another 12-inch record strikes it.

With an intermixed record stack, then, as the index lever rises, the position to which it drops will be the result of whether a record strikes the 12-inch feeler or not. If no record hits the feeler, the index lever will lower to the top of the hooked portion of the 12-inch feeler. If a record hits the feeler, the index lever will drop into the recess.

Fig. 1213 shows how this index works for a stack of 7-inch records. The 7-inch lever has a lift extension that extends out under the index lever. Therefore, if the 7- and 10-inch feeler allows the 7-inch lever to move up, the lift extension will carry the index lever up also. A compression spring pushes the 7-inch lever against

the change-cycle drive gear. As the change-cycle drive gear turns around, a hole in the drive gear moves under the end of the 7-inch lever. This permits the spring to push that end of the lever down. Consequently, the 7-inch lever has a tendency to pivot. If a 7-inch record is on the turntable, there will be no obstruction in the path of the 7- and 10-inch feeler, and so the 7-inch lever does pivot. Because of this, the lift extension pushes up the index lever and puts it in the path of the third (7-inch) step. This allows the pickup arm to swing all the way in to the 7-inch position before the index lever stops it. As the hole in the change-cycle drive gear moves on, the 7-inch lever is forced back to its original position. The index lever cannot lower, though, because it is held up by the index step.

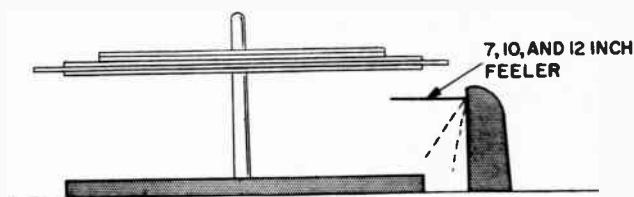


Fig. 1214. *Fully automatic random intermix index.*

When a 10- or 12-inch record is on the turntable, the 7- and 10-inch feeler cannot go up because the records are in the way. Therefore, the 7-inch lever has no effect when larger records are being played.

The two previous setdown indexes illustrated that, to obtain a random intermix index, a record must be "felt" while it is dropping. These indexes allowed intermixing of only 10- and 12-inch records because the feeler at the rim of the turntable was used to determine if a 7-inch record was on the turntable. One popular changer uses only one feeler for all three record sizes and indexes them while they are falling. This is shown in Fig. 1214. The feeler is a straight spring that extends out under the record stack in its ready position. The feeler is linked to the 7-, 10- and 12-inch index stops under the chassis. The position of the feeler right after the record is dropped picks out the index stop to be used. The feeler is long enough to pass under 10- and 12-inch records but just too short to meet a 7-inch record.

When a 12-inch record is dropped, it pushes the feeler almost all the way down. When a 10-inch record is dropped, it pushes the feeler about halfway down. The 7-inch record does not touch the feeler, so it remains in the horizontal position. The feeler always starts off in the horizontal position.

Even though this setdown index does allow a random intermix of all three record sizes, it is recommended that 7-inch records be placed last on the stack. This is because 10- and 12-inch records tend to tilt when they are on a 7-inch record. This, of course, will cause poor needle tracking.

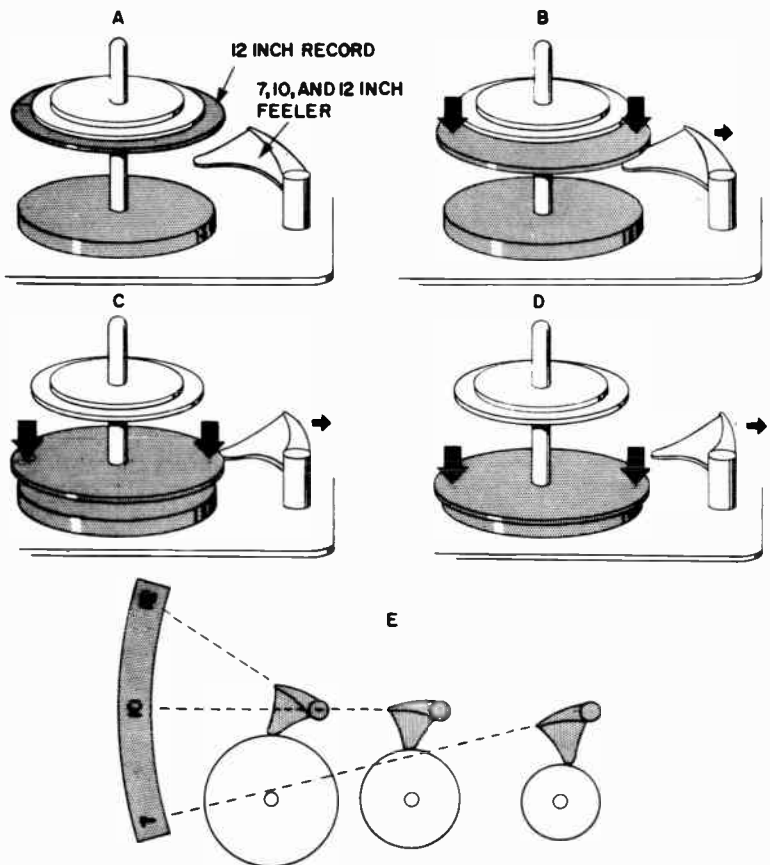


Fig. 1215 a to e. *The basic swinging index feeler.*

Another method of obtaining a completely automatic random intermix index is shown in Fig. 1215. With this device, instead of the falling record pushing the feeler down, the force of the record swings the feeler back, out of the path of the record. The feeler is always positioned under the stack of records during the change cycle so that it can determine the size of the record that drops down the spindle. The surface of the feeler that contacts the records is sloped; as a dropping record moves against this sloping surface, it pushes the feeler back. Fig. 1215-a shows this action with

a 12-inch record dropping down the spindle. As shown in Fig. 1215-b, the record covers most of the feeler and so its edge contacts a high portion of the sloping surface. Freely pivoted, the feeler swings out under the force of the dropping record. The record keeps pushing the feeler until the feeler is out of the path of the record. This is shown in Fig. 1215-c,d. Since this was a 12-inch record dropping down the spindle, the feeler had to swing all the way out to make the way clear for the record. For a 10-inch record, the feeler will swing only halfway out; for a 7-inch record it will not swing back at all. This is shown in Fig. 1215-e.

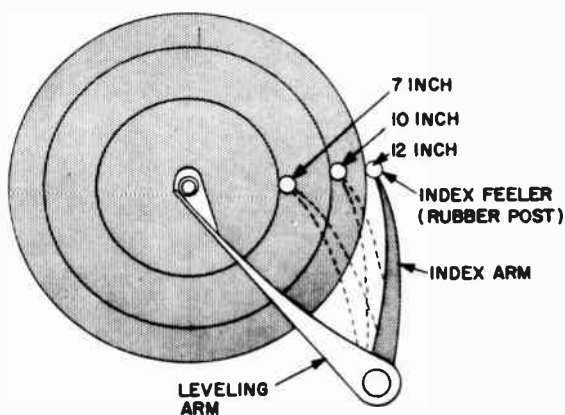


Fig. 1216. *The automatic arranged intermix index.*

Since the index feeler turns to a different position for different-size records, the setdown index below the chassis turns with it, automatically bringing about the proper setdown position for the pickup arm.

### **Arranged intermix indexing**

With arranged intermix indexing, different-size records can be played in one stack but only in a pre-determined manner. The basic principle of this index is shown in Fig. 1216. The device utilizes an index arm that swings around the same axis as the leveling arm. The index arm is spring-loaded and so has a tendency to be pulled in toward the spindle. However, while a stack of records is on the spindle, the records hold out the index arm. A 12-inch record holds the arm out the farthest, a 10-inch record allows the arm to move in a little closer and a 7-inch record allows the arm to move even closer to the spindle. Therefore, the position of the index arm is an indication of what size record is on the bottom of

the record stack. But this is so only if the record stack is arranged with the largest records at the bottom and the smaller ones at the top. For instance, if a 10-inch record is at the bottom, and a 12-incher on top of it, the 12-inch record will hold out the index arm and so the pickup arm will set down in the 12-inch position even though the 10-inch record is dropped. On the basis of this, then, the record stack must be made up with the 12-inch records on the bottom, the 10-inch next, and the 7-inch on top. After the last 12-inch record is dropped, the index arm will swing in to the 10-inch record. After the 10-inch records are finished, it will swing in to the 7-inch records. The index feeler at the end of the index arm is a rubber cap, so that the shock of the arm striking the record is absorbed. There is a tendency for the impact to vibrate the pickup; this is more noticeable on long-playing records where light needle pressure is used. For this reason, if the records and needle are not in the best of condition or if the turntable is not level, the needle may jump a groove or two when the index arm swings in to the smaller record.

Fig. 1217-a shows the pickup arm after it has been swung out. Attached to the pickup arm shaft are a bushing and arm-control plate. The index steps are on the arm-control plate and the pickup arm will be allowed to swing in until one of them moves against the index stop on the stop plate. The stop plate is attached to the bottom of the index-arm shaft and so its position is determined by the position of the index arm. The index spring pulls the plate so that the feeler is pressed against the record. Since a 12-inch record is being played, the index stop is in the path of the first step on the arm-control plate. As shown in Fig. 1217-b, the pickup arm will swing in until the first step hits the index stop; the pickup arm will stop in the 12-inch position.

For 10-inch records, the index feeler moves right in against the 10-inch record and turns the index stop plate. The stop is now in the path of the second step so that the pickup arm is allowed to swing in to the 10-inch position before it is stopped. With a 7-inch record on the spindle, the index arm turns the index stop plate so that the stop is in the path of the third index step. The pickup arm will swing in to the 7-inch position before it is stopped by the setdown index.

There is another mechanism associated with this setdown index. It is necessary for two reasons: (1) if the index feeler remains pressed against the edge of the bottom when the record is ejected, it will prevent the record from falling flat; (2) if a 12-inch record is on the bottom of the stack and a 10-inch record is right over

it, when the 12-inch record is dropped the index arm would ordinarily swing in to the 10-inch record and so the setdown index

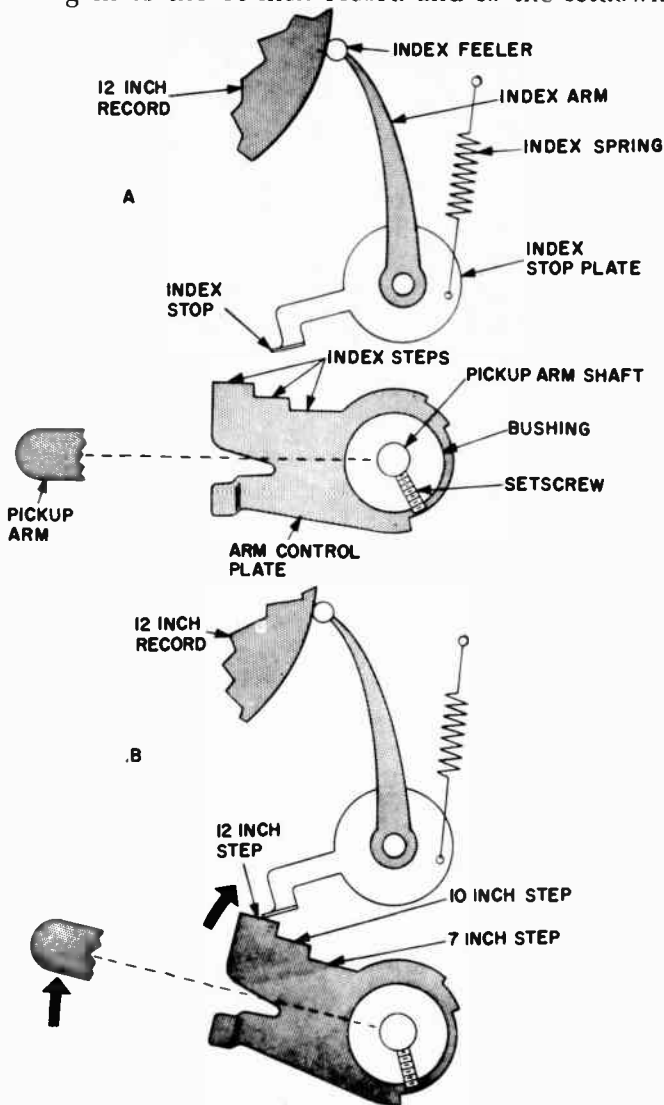


Fig. 1217-a,-b. 12-inch operation. The top illustration shows the pickup arm swung out while the bottom one shows the arm in playing position.

would indicate 10-inch operation even though a 12-inch record has dropped. To prevent these two things from occurring, the index arm must be pulled slightly away from the edge of the bottom record and held that way until the pickup arm has set down.

Fig. 1218-a,b shows how this is accomplished. The index plate has three indentations in it, one for each record size. The parts are shown with a 10-inch record on the spindle. During the change cycle, just before the record is dropped, the hold-out lever moves into the 10-inch indentation, and pushes the index stop plate. This moves the index arm back slightly, causing the index feeler to move away from the edge of the record. The record then drops flat. The hold-out lever keeps the index arm in this outward position throughout the rest of the change cycle. When the pickup

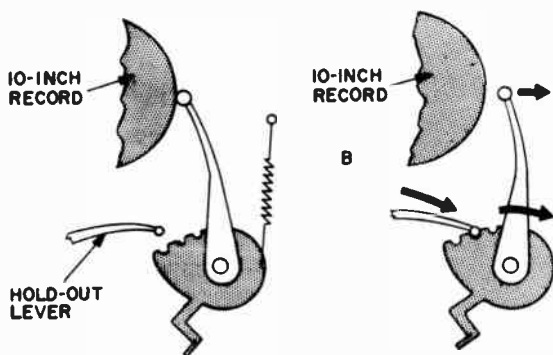


Fig. 1218-a,-b. Holding out the index arm.

arm has been lowered to the record, the holdout lever releases the index stop plate, permitting the feeler to move against the next record.

### Setdown adjustment

To allow the technician to set accurately the position at which the needle lands on the record, all record changers have a fine adjustment that permits the shifting of the pickup arm toward or away from the spindle. In most changers, the setdown adjustment (sometimes called the *landing adjustment*) is located at the pickup arm hinge bracket. In some units, however, the adjustment is at the underside of the changer chassis, at the setdown index. (An example of this is shown in Fig. 1106). In the case of the latter, the adjustment is usually accessible through a screwdriver access hole located near the pickup arm or shelf.

The most popular type of setdown adjustment employed is shown in Fig. 1219. The hinge bracket and hinge plate carry the pickup arm in to the position of the setdown point. Therefore, if the position of the pickup arm is changed in relation to the hinge plate, the setdown position will be changed. The setdown plate is rigidly fixed to the pickup arm. The setdown adjustment screw

passes through an ear on the setdown plate to another ear on the hinge plate. Turning this screw in or out will shift the position of the setdown plate and so move the pickup arm toward or away from the spindle. If the screw is turned in, as shown by the arrow,

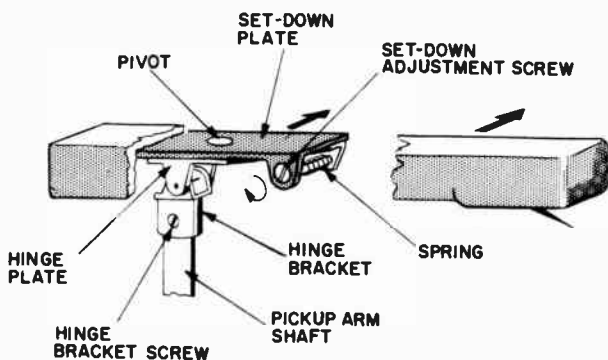


Fig. 1219. *Admiral set-down adjustment.*

the setdown plate and pickup arm will move away from the spindle. In some changers, this screw is accessible through a hole in the side of the pickup arm, but in others, the pickup arm must be lifted up to gain access to the screw.

Another method of changing pickup arm setdown position is

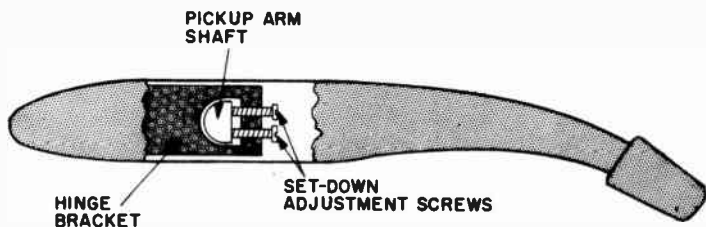


Fig. 1220. *Collaro set-down adjustment.*

shown in Fig. 1220. Here the position of the hinge bracket is changed in relation to the pickup arm shaft. The hinge bracket is attached to the pickup arm shaft by two setdown adjustment screws. If one screw is loosened and the other tightened, the hinge bracket will assume a new position. Since the pickup arm is hinged to the bracket, the pickup arm will move with it so that a new setdown position will result. To move the pickup arm the other way, loosen the second screw and tighten the first.



Shown in Fig. 1221 is another method of changing the position of the hinge bracket. The safety plate is attached to the pickup arm shaft and the safety spring presses the plate against the set-down adjustment screw. This screw is eccentrically pivoted on the hinge bracket. When the screw is turned, it moves the hinge bracket and pickup arm.

These are vernier adjustments; that is, they are capable of moving the pickup arm only small amounts. At times, it will be found that they do not have enough range to put the pickup arm in the right position. In this case a coarse adjustment will have to be made so that the vernier adjustment will work. This can be done in a few ways. In some record changers (referring again to Fig. 1219) the hinge bracket is attached to the pickup-arm shaft with a screw. If this screw is loosened, the bracket and pickup arm can be swung to any position. In other changers, the arm-control plate (or lever) attached to the bottom of the pickup arm shaft can be handled in the same manner. One example of this is shown in Fig. 1217. The bushing and arm control plate are held to the pickup arm shaft with a screw. With this screw loosened, the pickup arm can be turned to a new position. Another method is the bending of the index stop, so that it will make contact earlier or later.

### **Adjusting the setdown position**

A large number of manufacturers specify that adjustment should be made so that the needle lands a definite distance from the spindle; for instance,  $3\text{-}1/4$  to  $3\text{-}5/32$  inches for a 7-inch record;  $4\text{-}10/16$  to  $4\text{-}11/16$  inches for 10-inch, and  $5\text{-}19/32$  to  $5\text{-}22/32$  for 12-inch. It can be done in this manner using a ruler. However, it is much easier to make the adjustment with a record. The setdown adjustment should be made so that the needle lands in the middle of the lead-in groove area at the edge of the record. Any record can be used for the adjustment; the needle should automatically set down properly on the other sizes. Make the adjustment as follows: (1) Shut off the power; (2) Trip the record changer, either with the reject control or by swinging the pickup arm close to the spindle; (3) Rotate the turntable by hand so that the pickup arm rises, swings out and then in again; (4) Rotate the turntable slowly, lowering the pickup arm halfway to the record; and (5) See if the needle is landing in the proper position. If it is not, make a slight adjustment until the needle is directly over the center of the lead-in groove area.

With some record changers, handling the pickup arm will undoubtedly move it to a new position and so the effect of the ad-

justment cannot readily be seen. If this is the case, make only a slight adjustment and then repeat the entire procedure of cycling the changer. Check the setdown position of the needle again and make another adjustment if necessary. Repeat this action as often as required until the needle sets down properly.

### Servicing and cleaning the setdown index

The setdown index is one of the critical assemblies in the record changer. With most other sections, if a slight misadjustment exists, there may be no noticeable effect on the operation of the changer. With the setdown index, however, the trouble would be noticed almost immediately. The lead-in groove area of a record is very small and so, even if the defect is only minor, the pickup needle may not land on the record or it may set down on the playing grooves.

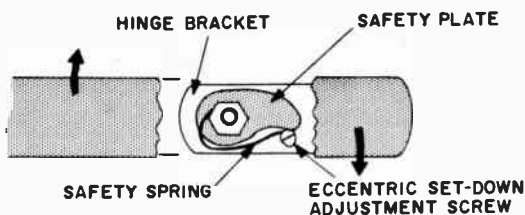


Fig. 1221. V-M set-down adjustment.

Setdown indexing is directly related to the swing-in drive and so trouble in that drive may appear to be an indexing fault. Therefore, first make sure that the pickup arm swings in properly before checking the index.

When trouble is encountered with the setdown index, first try adjusting it. If this cannot rectify the trouble, then the most important parts to check are the index springs. These are responsible for placing the index stops (or steps) in the proper position. Replace them if they are weak, broken, or missing.

If a rising index feeler is employed, make sure the rubber bumper is in place. These consistently come loose and are sometimes lost. Make sure the feeler is seated all the way on the lever. If it mounts loosely, glue it in position.

Make sure the detail parts of the index are mounted properly. The parts that should be rigidly mounted, *must* be rigidly mounted. Tighten the necessary screws or nuts. On the other hand, the parts that must be loosely mounted, so that they can slide or pivot freely, must not bind. The pivot or sliding areas must be kept clean.

To clean, apply carbon tet liberally. With manual index positioning, clean all foreign matter off the index stops and steps. This should also be done with automatic indexes, but particular attention should be given to the other parts.

Clean the pivot point of the index bracket (Fig. 1205). Clean the point that pivots the index feeler and the index stop assembly. To dislodge hidden dirt, rotate the parts while cleaning them. Scrub the index stop points on the stop assembly.

Thoroughly clean the pivot of the 12-inch feeler shown in Fig. 1209, making sure that it tilts freely. Push the feeler back by hand and see that it returns promptly when released. Clean the area around the 12-inch index slide. Make sure that it slides freely when the 12-inch feeler is tilted.

Clean the 7-inch and index levers shown in Fig. 1210. Dissolve all dirt which has accumulated at the pivot screws. Clean the pivot of the 12-inch feeler. Make sure it tilts freely. Clean out the recess at the bottom of the feeler. Check that the index feeler shown in Fig. 1215 swings freely. Clean its shaft. This feeler can bind slightly yet still move to the proper position. But the extra force required to push it will cause the record to tilt as it falls, so make sure the feeler offers no resistance.

Make sure the index arm (Fig. 1216) swings freely. Inject cleaning fluid down the index arm shaft while swinging the arm back and forth. Hold the index arm out and then release to see that it swings in close to the spindle.

Do not use a lubricant at the pivot points of the index feelers, lever or brackets. A lubricant will make these too sensitive and therefore erratic. Just keep these points clean and dry and they will function properly. A light grease can be used on the index stop and steps but it is normally not required.

# automatic shutoff mechanism

**A**UTOMATIC shutoff is an optional feature usually incorporated in the more expensive changers. The mechanism must determine when the last record has been played, return the pickup arm to the rest post at the edge of the changer chassis and shut off the power. Some changers employ only a partially automatic shutoff mechanism—the pickup arm is returned to the rest post but the turntable is permitted to revolve indefinitely until the power is turned off manually. Needless to say, an automatic record changer without a shutoff feature will play the last record on the stack over and over again.

The automatic shutoff mechanism is probably the most complicated part of the changer. This is primarily due to the fact that it has more to accomplish. Besides lowering the arm to the rest post and shutting off the power, the shutoff activity must have an inherent delay so that the last record can be played. All automatic shutoff devices determine that the last record has been played by sensing that there are no more records on the spindle. Directly after the last record drops, *there are no more records on the spindle* but we want the *last* record to be played. Hence, a delay is incorporated.

In actuality, the automatic shutoff mechanism has four basic functions: (1) To determine when there are no more records on the spindle; (2) To delay the shutoff activity until the last record has been played; (3) To lock out the pickup arm (prevent it from swinging in); and (4) To shut off the power.

There are three popular ways of determining that there are no more records on the spindle: (1) Leveling-arm height; (2) Index arm position; (3) Spindle weight.

## Leveling arm height control

The leveling arm is used with changers that have no shelves to keep the records on the spindle in a level position and is placed on top of the stack of records when the changer is first used. As the records drop to the turntable, the stack on the spindle gets smaller and the leveling arm lowers accordingly. When there are no more records on the spindle, the leveling arm will be in its lowest position, indicating that the last record has been dropped.

### No-record determination

Fig. 1301-a is a leveling arm shutoff mechanism. The last record is on the spindle and so the leveling arm is still kept high enough so that it cannot actuate the shutoff parts. (The dashed lines show its position with a full stack of records.) The leveling arm spring supplies the force that pulls the leveling arm down. In some changers this spring is not used; the weight of the arm itself causes it to lower. The shutoff lever is the part that actually locks out the pickup arm. To do this, the lever must block the path of the arm-return lever to prevent it from swinging in the pickup arm. This is similar to the operation of the setdown index.

Fig. 1301-b shows the parts during the next change cycle. The change-cycle slide cam causes the pickup arm to swing out, and then the last record drops. Upon dropping down the spindle, the record releases the leveling arm, causing it to lower to the shutoff position. The bottom of the leveling arm shaft hits the stop arm, which turns. In turning, the stop arm attempts to turn the shutoff lever. This action indicates that there are no more records on the spindle.

### Shutoff delay

Even though there are now no more records on the spindle, we want to delay shutting off the record changer until the last record is played. To do this, the shutoff lever is prevented from being turned so that it cannot at this time block the path of the arm return lever. As shown in Fig. 1301-b, the change-cycle slide cam has moved all the way out; in this position, a delay stop, also known as an *escape lever*, prevents the shutoff lever from pivoting. This keeps the lockout stop away from the arm-return lever. If it were not for the delay stop, the bottom of the shutoff lever would fall into a slot in the slide cam.

When the slide cam starts moving back (Fig. 1301-c), the delay stop releases the shutoff lever. But, at the same time, the arm-re-

turn lever is swinging in the pickup arm. The return lever is in the path of the shutoff lever now so that the shutoff lever still cannot turn. The lockout stop merely slides along the bottom of the arm-return lever as it swings in the pickup arm. The delay has now been incorporated and the last record is being played.

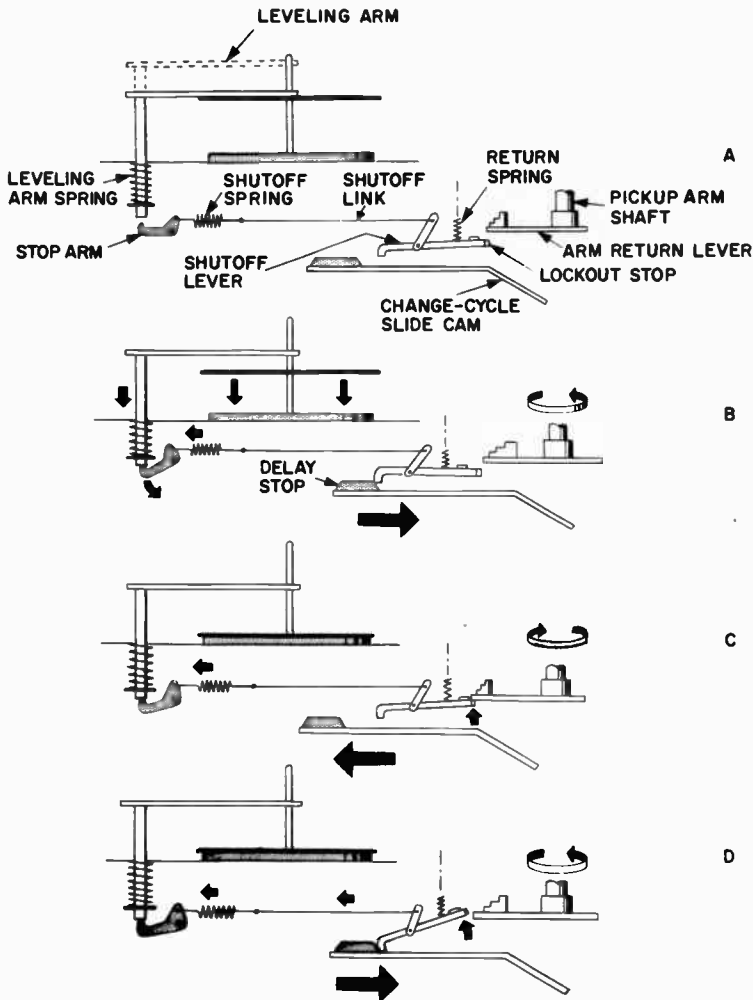


Fig. 1301-a,-b,-c,-d. Leveling arm automatic shutoff mechanism.

**Pickup arm lockout**

Since the stop arm has been turned and the shutoff lever is still prevented from being turned, the shutoff spring is stretched. Its tension will pivot the shutoff lever the moment the lever is re-

leased by the arm-return lever. When the last record being played is finished, the change cycle starts and the pickup arm is raised and swung out. At this time, as shown in Fig. 1301-d, the arm-return lever releases the shutoff lever. The shutoff lever turns. The bottom of the lever falls into the slot in the change-cycle slide cam before the delay stop reaches it. With the shutoff lever in this position, when the arm-return lever attempts to swing in the pickup arm, it is obstructed by the lockout stop. The pickup arm is

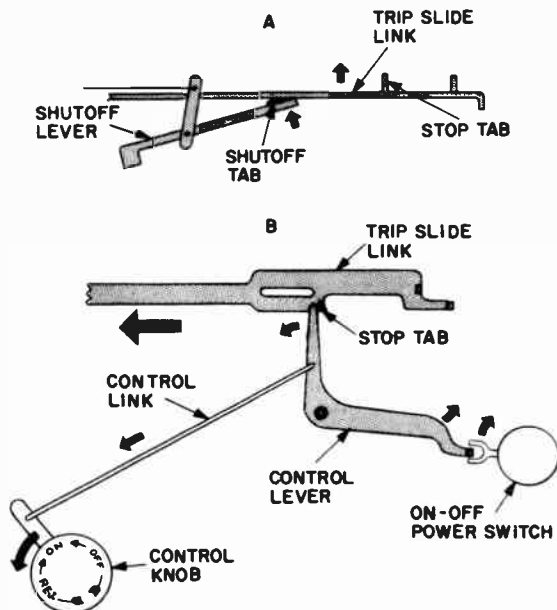


Fig. 1302-a,b. Automatic control lever power shutoff.

held at the outer edge of the chassis above the rest post and the safety drive allows the rest of the change-cycle mechanism to continue. At the end of the cycle, the pickup arm is lowered to the rest post and the power is shut off.

### Power shutoff

The shutoff lever, besides containing the lockout stop, also has a shutoff tab that actuates the power shutoff parts. When the shutoff lever in Fig. 1302-a is released by the arm-return lever, the shutoff tab pushes the trip-slide link up. When the trip-slide link moves up (Fig. 1302-b) the stop tab on the link is placed in line with the control lever. This action takes place at the same time that lockout occurs. Now, as the change-cycle mechanism continues, the trip-

slide link is moved in the direction of the arrow. At the end of the change cycle, as the pickup arm starts to lower to the rest post, the stop tab engages and turns the control lever. The other end of the control lever turns off the on-off switch and so the changer is de-energized. The mechanism continues to move slightly, due to inertia, until the pickup arm lands on the rest post. The control

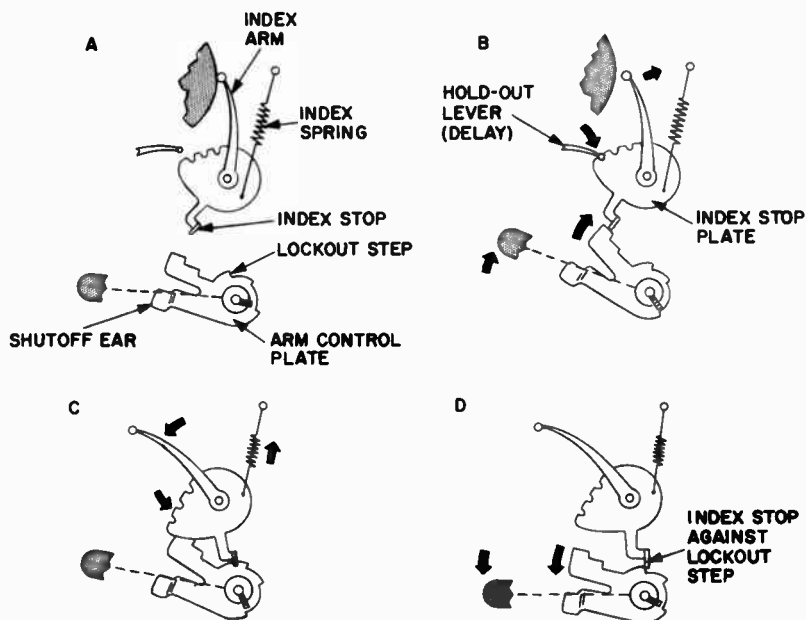


Fig. 1303-a,-b,-c,-d. *Index arm automatic shutoff mechanism.*

lever also turns the control knob to the OFF position by means of the control link.

### Next stack of records

When the next stack of records is placed on the spindle, the leveling arm is put in a high position. This releases the stop arm and, hence, the shutoff lever. The return spring tries to push the shutoff lever back to the neutral position. The shutoff lever cannot yet pivot back to the neutral position, though, because the arm-return lever is in the way. But, after the control knob is turned first to ON and then to REJECT, the change cycle starts. During the cycle, the arm-return lever is swung out slightly, enough to permit the shutoff lever to turn back to its neutral position. The pickup arm then swings in and sets down on the beginning of the record. The changer will now play the entire stack of records.



## **Index arm control**

Index arm control of shutoff is very similar to setdown index operation. In fact, the device discussed here utilizes the setdown index parts to bring about automatic shutoff.

### **No-record determination**

Since the index arm distance from the spindle indicates what size records are on it, this distance can also be used to indicate that there are no records at all. When the last record is being played, the tension of the index spring causes the index arm to swing in close to the spindle. This position of the index arm indicates that no more records are on the spindle.

### **Shutoff delay**

Fig. 1303-a shows the position of the parts with the last record on the spindle. The change-cycle mechanism has swung the pickup arm out and the ejector mechanism is ready to drop the last record. The shutoff delay must prevent the index arm from swinging in toward the spindle when the record drops so that the record will be played. This is accomplished by the hold-out lever in Fig. 1303-b. Just before the record is dropped, the hold-out lever moves into an indentation on the index stop plate and pushes the plate, causing the index arm to move away from the record. The hold-out lever keeps the index arm out this way during the rest of the change cycle. This delays shutoff so that the pickup arm can swing in and set down on the last record. Then, while the last record is being played, the delay is no longer necessary. The hold-out lever releases the index stop plate and the index arm swings in close to the spindle, as shown in Fig. 1303-c.

### **Pickup arm lockout**

With the index arm close to the spindle, the index stop plate turns and moves the index stop to the lockout position. When the playing of the last record is finished, the pickup arm is raised and swung out, as shown in Fig. 1303-d. In this position, the index stop is directly in the path of the lockout step. Therefore, the pickup arm cannot be swung in again. The pickup arm remains locked above the rest post and the safety drive permits the rest of the change-cycle mechanism to continue. At the end of the cycle, the pickup arm is lowered to the rest post and the power is shut off.

### **Power shutoff**

Power shutoff in this device is accomplished in a much simpler

manner than in the previous mechanism. No extra motions are required. As shown in Fig. 1304-a,-b the arm-control plate has a shutoff ear that is directly above the ON-OFF switch while the pickup arm is over the rest post. When the pickup arm is lowered, the shutoff ear lands on the switch button; this opens the switch and shuts off the power.

### Next stack of records

When a new stack of records is put on the spindle, the index arm is swung out of the way and so the index stop is turned out of

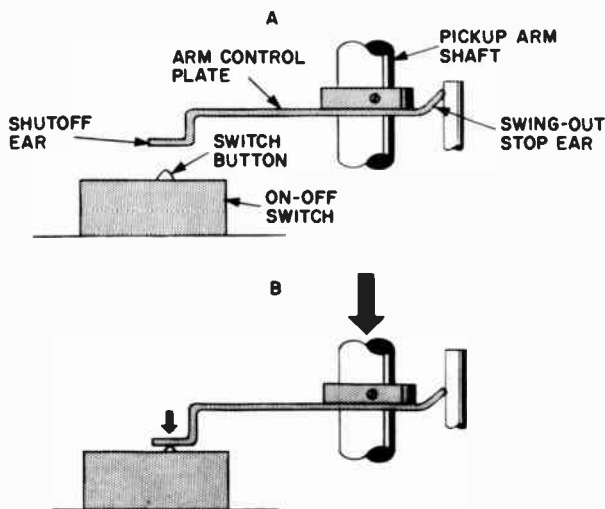


Fig. 1304-a,-b. Automatic control plate power shutoff.

its lockout position to its normal indexing position. Then, when the reject button is depressed, the ON-OFF switch is momentarily pivoted away from the shutoff ear, causing the switch button to be released. This turns on the power and the change cycle starts. The pickup arm is raised, causing the shutoff ear to be moved away from the switch button. Now the record changer will play the full stack of records.

### Spindle weight control

This is a unique method of determining when the shutoff mechanism should function. It makes use of the fact that the weight of the records on the spindle increases the effective weight of the spindle. In some record changers, the same technique was used with the shelf weight as a reference.

As shown in Fig. 1305-a, a shutoff lever is used to move into the path of the lockout stop on the arm-control plate after the last record has been played.

#### **No-record determination**

The spindle is mounted in the record changer so that it can move freely up and down. As shown in Fig. 1305-b, when there is a record on the spindle, the weight of the spindle presses down on one end of the shutoff lever, causing the other end of the lever to be held in a raised position. Since the lever is held up, it cannot contact the lockout stop on the arm-control plate. When the last record drops, however, the weight of the spindle is insufficient to hold the other end of the shutoff lever up. That end of the lever, then, tends to drop, indicating that no more records are on the spindle. However, the lever dropping must be delayed so that the last record can be played.

#### **Shutoff delay**

To permit the last record to be played, the shutoff lever must be held up. This is accomplished by the delay ear on the shelf-ejector assembly (Fig. 1305-c). At the same time that the record drops, the shelf ejector assembly has pivoted forward (this is what caused the record to drop). The delay ear, then, is directly under the shutoff lever and so it holds the shutoff lever up during the rest of the change cycle. The pickup arm can now swing in and set down on the last record. After it has done so, the shelf moves back to its neutral position. See Fig. 1305-d. The delay ear releases the shutoff lever and permits it to drop. However, since the pickup arm has been lowered, the arm-control plate has been lowered also. The shutoff lever still cannot contact the lockout stop and so shutoff has been delayed.

#### **Pickup arm lockout**

When the last record is finished, the last change cycle starts. The pickup arm is raised and swung out over the rest post. The shelf nods again to drop a record but, as shown in Fig. 1305-e, the shutoff lever is too low to be contacted by the delay ear and so this action has no effect. Then, when the pickup arm starts to swing in, the shutoff lever contacts the lockout stop and holds the pickup arm in the lockout position above the rest post. The safety drive allows the change cycle to continue, the pickup arm is lowered to the rest post and the power is shut off. Power is shut off in the same manner as in the previous mechanism (Fig. 1304).

## Next stack of records

When a new stack of records is placed on the spindle, the spindle is pushed down. The shutoff lever pivots out of the lockout position. When the reject button is depressed, the ON-OFF switch is momentarily pivoted away from the shutoff ear. This releases the switch button and power is applied. The change cycle then

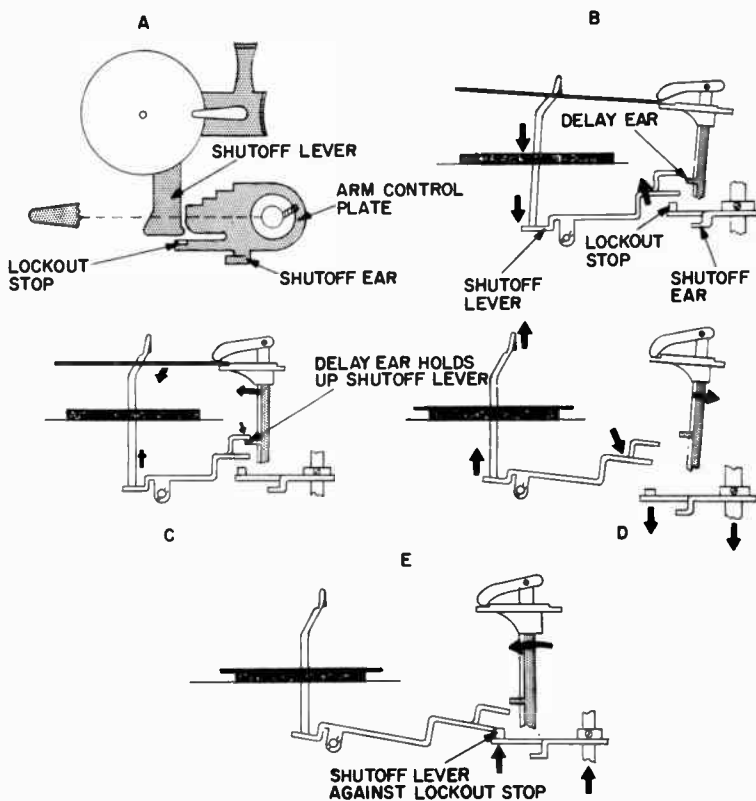


Fig. 1305 a to e. Spindle weight automatic shutoff mechanism.

starts and the pickup arm is raised, causing the shutoff ear to be moved up away from the switch button. The record changer will now play the full stack of records.

## Servicing and cleaning automatic shutoff mechanisms

When trouble develops in the automatic shutoff mechanism, it is conspicuously evident. Four basic symptoms can accompany a defect in this assembly. They are: (1) The record changer keeps

repeating the last record; (2) The pickup arm is locked out but the turntable keeps revolving; (3) Automatic shutoff occurs immediately after the last record is dropped; and (4) Automatic shutoff occurs while records are still on the spindle.

Because the shutoff assembly is so sensitive, dirt causes a lot of trouble. Any one of the symptoms just listed can develop because of dirt, depending, of course, on which part is affected. Lubrication of the parts is not required; they need only to be kept clean and dry to function properly.

Cleaning the shutoff mechanism involves injecting carbon tet on and around the pivot and sliding points with an eye dropper. While doing this, the parts should be moved to help the cleaning action. Also, while cleaning, inspect the parts closely so that, if dirt is not the cause of the trouble, the part at fault may be seen.

With the type of mechanism shown in Fig. 1301, start with the leveling arm shaft. Send a few drops of the solvent down the shaft and keep moving the leveling arm up and down to help dislodge dirt. Keep moving the arm and apply the fluid to the stop arm as it is being pivoted. Apply the cleaning fluid to the shutoff lever and then pivot the lever a few times, making sure that it pivots freely.

With the shutoff device shown in Fig. 1303, the only part to clean is the shaft of the index arm. Hold the arm out and allow it to swing of its own accord while applying the solvent.

With the type of unit illustrated in Fig. 1305, first inject the solvent around the spindle in the turntable. While doing this, intermittently push down on the spindle and then allow it to rise of its own accord. Continue moving the spindle in this manner and apply the fluid to the pivot of the shutoff lever. See that the shutoff lever follows the motion of the spindle.

### **Changer repeats last record**

With the setup of Fig. 1301, make sure the leveling arm drops all the way down to turn the stop arm when no records are on the spindle. See that the leveling arm spring does not cause the shaft to bind. Make sure the stop arm is not bent and that it couples the leveling arm shaft firmly. If the stop arm does turn, check that this motion is transmitted to the shutoff lever. See that the shutoff spring or link has not broken or come loose. Make sure the bottom of the shutoff lever falls into the slot in the change-cycle slide cam at the proper time. That part of the lever may be bent, preventing this from happening. Make sure the shutoff lever is not binding.

With the arrangement shown in Fig. 1303, see that the index

arm swings all the way in when no records are on the spindle. Make sure the index spring has not weakened. Inspect the lockout step portion of the arm-control plate for damage.

With the unit shown in Fig. 1305, make sure the spindle moves up and down when no records are on it. See that the shutoff lever pivots accordingly. Check that the shutoff lever is not bent, preventing it from lowering in to the path of the lockout stop. Make sure the lockout stop is not bent, causing the same thing to happen. Also make sure that the delay ear is above the shutoff lever when lockout should occur.

#### **Pickup arm locked out but turntable revolves**

It is much easier to locate this trouble because it is isolated to one small section of the mechanism. With the type of device shown in Fig. 1302, make sure that the shutoff tab raises the trip slide link sufficiently when the shutoff lever pivots. See that the tab is not bent. Check that the slide link moves up to the proper position; the link may be bent. Make sure the stop tab on the trip slide link engages the control lever. If all these parts are functioning normally and the control lever actuates the ON-OFF switch, then the switch itself is defective. See that the control link turns the control knob to the OFF position.

With the setup shown in Fig. 1304, make sure the shutoff ear lands on the ON-OFF switch button when the pickup arm is lowered to the rest post. The ear may be bent, preventing this. This will also occur if the pickup arm does not swing out far enough. The swingout stop ear on the arm-control plate determines how far out the pickup arm will swing. Bending this ear will permit the pickup arm to swing to the proper position. Make sure the switch is seated under the shutoff ear. If proper contact is made, then the switch is defective.

#### **Automatic shutoff immediately after last record drops**

This trouble indicates that the shutoff delay is not working right or that the mechanism is actuated while there is still a record on the spindle. For the mechanism shown in Fig. 1301, first make sure the leveling arm is not bent upward at the spindle. If it is, the leveling arm shaft will turn the stop arm while a record is still on the spindle. If these parts are all right, see that the delay stop functions properly when the last record drops. Make sure the shutoff lever is not bent, causing it to miss the delay stop and fall into the slot in the slide cam.

With the setup shown in Fig. 1305, inspect the part of the shutoff lever that should contact the delay ear. If it is bent down,

the delay ear will miss it and so the shutoff lever will not be held up to delay the shutoff action. Also, if this part of the shutoff lever is bent upward a great amount, the same trouble will occur. (It is important to note that some off-standard records are made too thin and light. One of these records on the spindle may not be able to hold the spindle down; therefore, shutoff will occur before that record is played.)

#### **Automatic shutoff with records still on the spindle**

This trouble is just about the same as the previous problem. The only difference is that its cause is more severe. For instance, if a part is only slightly bent, it may cause the difficulty discussed in the previous paragraph; if the part is bent a great deal, the trouble discussed here will occur. Therefore, use the information given previously if automatic shutoff occurs while records are still on the spindle. It is important to note that if the return spring shown in Fig. 1301 is weak, broken or missing, the shutoff lever will not return to the neutral position when a new stack is to be played. Therefore, the changer will shut off even before the first record is played.

With changers that use the shutoff device shown in Fig. 1304, if the pickup arm swing-in assembly is not functioning, power shutoff will occur if the pickup arm is lowered to the rest post. Therefore, make sure there is no trouble in the swing-in drive.

# service checklist

**R**EGARDLESS of why a record changer needs repairs, each important function should be checked. First, repair the record changer, of course, but then, rather than just tagging it for delivery, inspect it. Use the following checklist to make sure that no other hard-to-notice defect is present or perhaps developing. From a business standpoint, a full report given to the customer implies competency, consideration and thoroughness. A fault may be noticed which may require only a minor repair or simple adjustment. Taking care of it at once will make a longer-lasting repair and as a result a satisfied customer. In the long run, this is most profitable. Before allowing any automatic record changer to leave the service bench, check out its overall operation as follows:

1. **START IT UP.** Place a stroboscope disc on the turntable and then turn on the power to the record changer. See that the turntable comes to the proper speed in a very short time.

2. **CHECK EACH SPEED.** Make sure the stroboscope disc indicates the proper speed at all speeds. Remove the stroboscope disc.

3. **LOAD THE CHANGER.** Place twelve 10-inch records on the spindle. Press the reject button and see that the change cycle starts smoothly.

4. **WATCH THE PICKUP ARM RISE.** See that it goes up smoothly, that it does not bounce and that it goes high enough but not so high as to hit the record stack.

5. **WATCH THE RECORD DROP.** Only one record should drop. It should drop flat. There should be enough clearance between the dropping record and the pickup arm.



6. **WATCH THE PICKUP ARM SWING IN.** See that it swings in smoothly.

7. **WATCH THE PICKUP ARM SET DOWN.** See that it lowers smoothly. Make sure the needle lands on the lead-in groove; it should not set down too close to the edge because it may slide off at times. Adjust for setdown in the middle of the lead-in groove area.

8. **CYCLE THE STACK.** Press the reject button again and watch items 4 through 7 again. Repeat this for each record in the stack. Let the last record start playing.

9. **CHECK THE SPEEDS AGAIN.** Carefully lift the pickup arm off the record and place it on the chassis near the edge of the turntable. Put the stroboscope disc on the top record; see that it indicates the proper speed for all speeds with a full load on the turntable.

10. **CHECK AUTOMATIC SHUTOFF.** Press the reject button. The pickup arm should lock out above the rest post and lower to the rest post. Power should shut off. (This assumes that the record changer has an automatic shutoff feature.)

11. **CHECK SETDOWN INDEXING.** Remove the 10-inch records and play a couple of 12-inchers. Then remove the 12-inch records and play several 7-inch ones. See that the needle sets down as described in item 7 for all three sizes.

12. **CHECK INTERMIXING.** If the record changer is designed for it, place an intermixed stack of records on the spindle. See that the intermix index functions properly.

13. **LISTEN TO THE SOUND.** Make sure a clear tone is reproduced. Play a 1,000-cycle-tone test record and listen for rumble, wow and scratch.

14. **WATCH IT TRIP.** Let the record changer play a few records. See that the trip mechanism functions normally, not too early or too late.

15. **INSPECT THE NEEDLE.** Shut off the record changer. Inspect the needle with a magnifying lens. See that the tip is not worn or damaged. Make sure the needle is not bent. Check its perpendicularity. Measure needle pressure.

16. **INSPECT THE RECORD CHANGER.** Glance over the detail parts for signs of excess dirt, rust or corrosion.

17. **INSPECT THE MAIN LUBRICATION POINTS.** Check for lack of lubrication and if necessary apply SAE No. 20 oil or motor cup grease, as required. Use the lubricant sparingly and do not allow it to contact any rubber or plastic surfaces. Examine the following parts: pickup arm shaft; motor bearings (SAE No. 10 oil); turn-

table thrust bearing; drive assembly shafts; pickup-arm hinge; change-cycle drive; all gear teeth; all driving edges; and detail pivot points.

### Ordering replacement parts

Discounting springs, screws, nuts, washers and other minor detail items, the parts of any individual record changer model are

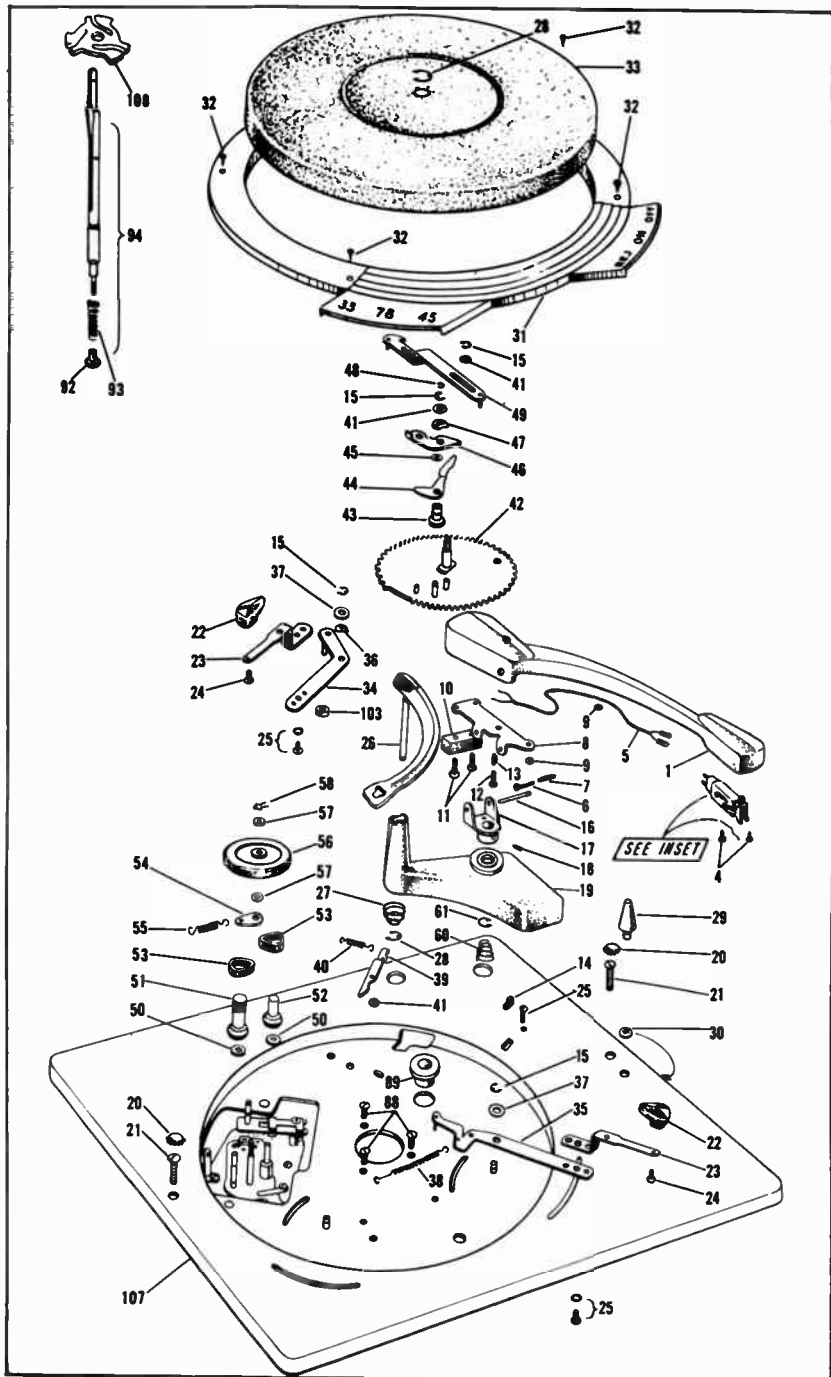
PARTS LIST		
REF. No.	PART No.	DESCRIPTION
1	403C 60	Tone Arm
2	409A 13	Pickup Cartridge with Needle and Knurled Nut
	409A 13-1	Pickup Cartridge with Needle (push-in type)
2	409A 13-2	Cartridges (with needle) are interchangeable Pickup Cartridge (export type) with Needle and Knurled Nut
	98A 15-19	Needle for 409A 13 Cartridge
3	98A 15-18	Needle for 409A 13-1 Cortridge
4	1A72-1-20	Cartridge Mfg. Screw Shakeproof Type 25 (2 req.)
5	G400A 529-1	Tone Arm Lead and Pin Jack Assembly
32	1A 26-54-57	Screw (for mtg. Esc.) #2x¼
33	G400B 602	Turntable
34	G400A 607	Speed Selector Link Assembly
35	G400A 608	Switch and Reject Arm Assembly
65	402A 284	Lift Rod
66	405A 144	Engagement Spring
67	4B 1-67-47	Washer (.196x5/16x1/32)
68	405A 146	Set-Down Arm Return Spring
69	G400A 618	Set-Down Index Assembly
70	405A 143	Set-Down Index Return Spring
71	G400A 621	Control Plate Assembly
72	401A 355-2	Retaining Ring

[Note: This is just a partial listing.]

*Courtesy Admiral Corporation*

Fig. 1401. Typical record changer parts list.

special units. The changer parts of different manufacturers are almost never interchangeable. This is the same type of problem that is associated with automobiles. The parts must be obtained from the manufacturer's local representative or, if this is not possible, from the manufacturer directly. These parts are distributed by parts numbers, also known as stock numbers. Each item has its own number. Therefore, when ordering, do it by number and not



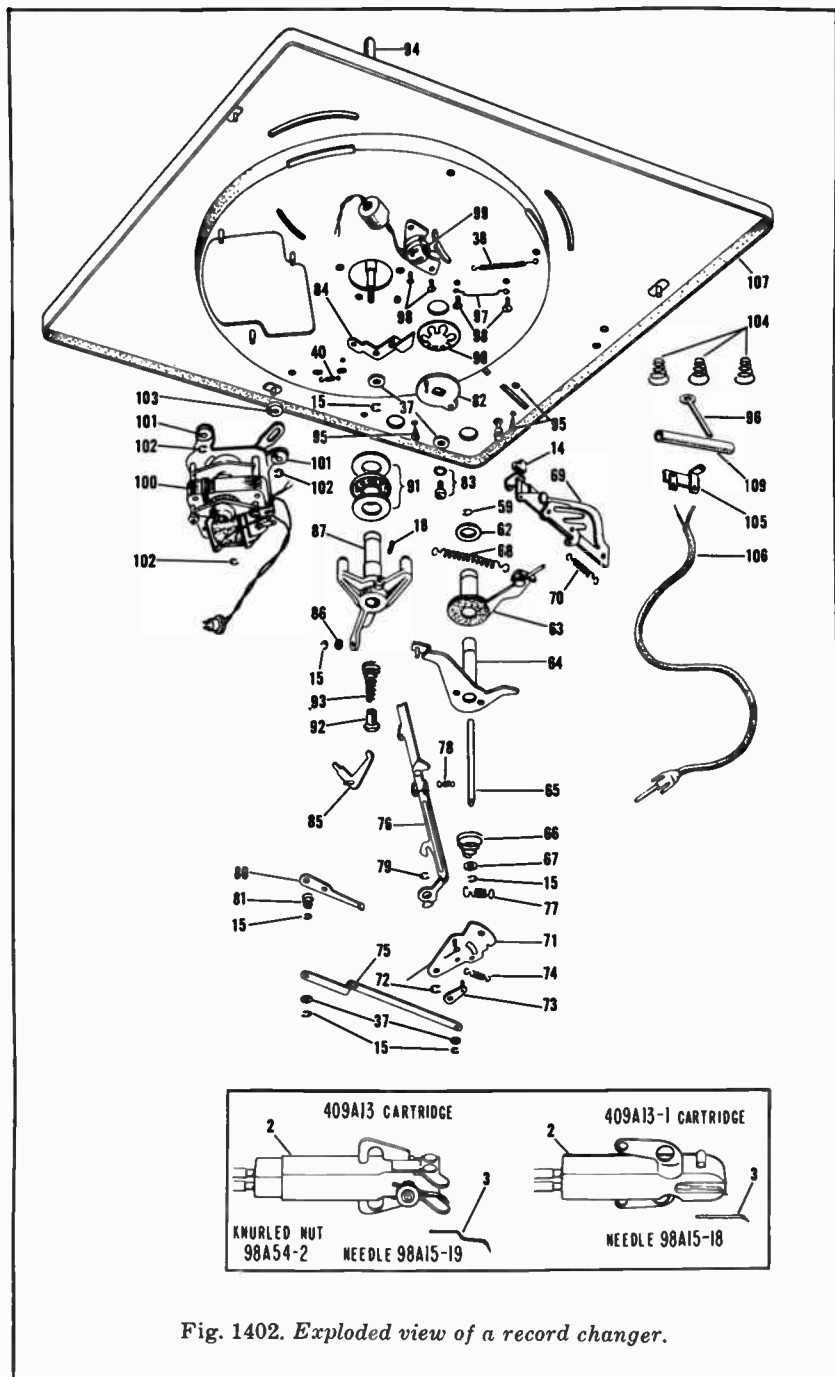


Fig. 1402. Exploded view of a record changer.

by name. *Never order a part by name.* If a setdown index is asked for, most likely a pickup-arm shaft or something like that will be sent. When ordering, *give the part number and the record changer model number.*

The model number is usually stamped on the underside of the changer chassis. The part number, though, is a little more difficult to determine. To start with, the service manual for the record changer must be on hand. It can be obtained by writing to the manufacturer or his local representative. The parts list and an exploded view of the record changer are generally in the back part of manuals. An example is shown in Fig. 1401 and Fig. 1402.

The exploded view shows all parts detached and spread out, as if the record changer had exploded. Each part is drawn to look like the actual unit itself, so that it is easily recognized. Also, an attempt is made to place the parts in the same relative position they occupy on the chassis, so that they can be more easily found. It would simplify matters further if they did place all the parts in their relative position, show them on a larger illustration and make liberal use of guide lines to show which parts are mounted together. However, for some reason, possibly cost, this is not often done.

First, let us try to find the part number of an easy item, for instance, the turntable. Looking at the exploded view, the turntable is easy to recognize. Pointing to it is number 33. This is the *reference number*. Other manufacturers call it the *illustration, diagram, or index number*. This is the guide to finding the part number in the parts list. The reference numbers in the parts list are listed in numerical order and so are easy to find. After locating number 33, the part number of the turntable is read in the next column. The part number is G400B 602. Therefore, the turntable is ordered from the Admiral Corp. by asking for part G400B 602 for the model RC600 record changer.

Let us say that while servicing a record changer the setdown-index bracket is found to be defective and must be replaced. In the exploded view of the underside of the chassis, we see that the reference number for the setdown index bracket is 69. Referring to 69 in the parts list tells us that the part number is G400A 618. Admiral calls this the setdown-index assembly.

Probably the only parts that need not be obtained from the manufacturer are the drive wheels or rubber tires in the motor's drive assembly. These have such a high failure rate that companies have found it profitable to make interchangeable replacements. These can be obtained at almost any distributor.

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