# Chapter 4

# Turntables and Changers

Garrard 4-speed turntable has 12" steel disc, push buttons for automatic trip mechanism. Price: from $60 to $90, depending on cartridge used.

MK II, by Garrard, table and arm, comes with interchangeable plug-in heads, 45-rpm adaptor, 4-pole motor. Arm is aluminum, turntable is made of steel.

THE wiggles in a record groove, or the millions of tiny magnets on a piece of tape, will leap to life and provide sound for our loudspeakers only after they have been set in motion. In the original recording of both discs and tapes, there is mechanical movement of the recording medium. This movement must be recreated in the home before these records will speak back to us.

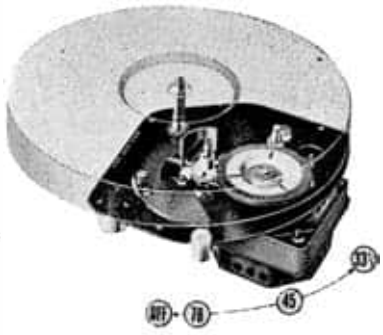
Because of their primary requirement of very close speed regulation, phono drive mechanisms have developed closely along the lines first established for clocks and timepieces. Even today, clocks are driven by either of three types of mechanisms: weights, springs, or electric motors. And all of these have been used in recording. The newest method of telling time, the atomic clock, is still confined to advanced research laboratories, but perhaps in time to come that, too, will find its way into home hi-fi systems. Who knows?

In the early days of acoustical disc recording, when the record groove was engraved in a thick slab of wax, the mechanism which kept that wax rotating was a heavy, slowly descending weight, similar in principle to those in a grandfather's clock. In the home, the earliest machines were simply hand cranked, but soon the spring-wound motor took over, again much like those in clocks.

Later, clocks were introduced using the *telechron* principle, in which a self-starting AC motor runs in exact synchronism with a central-station generator. This principle is used in all electric clocks today—and in all turntables, record changers and tape transports as well.

Thus the speed of rotation of an electric power generator, at a central station possibly many miles away from your home, is the sole determining factor of the rotational speed of the motors in your hi-fi equipment. Electric motors which follow in step with generators are called *synchronous*, and it is nothing more than a happy

Garrard 301 "Professional" has cast aluminum turntable, variable speed control, resistor-condensor network to eliminate motor shutoff noise.



General Industries' DSS, shown here in cutaway view, has 10-inch turntable, 45-rpm adaptor, radially operated shift lever, oilless bearings.

H. H. Scott comes with push-button speed selector, built-in stroboscope, aluminum-cast turntable. Rumble, wow and flutter are well below audability.

Rek-O-Kut B-12GH, hysteresis-motor turntable, has lathe-turned cast aluminum table, built-in strobe disc, sells for $99.95, without tone arm or base.

coincidence that we are able to use them in hi-fi equipment.

For the speed of the generator determines the frequency of the AC voltage on a power line, and the electric power companies maintain this frequency exceedingly constant, for reasons which have nothing to do with hi-fi. It just happens that the generation and transmission of electric power is most economical when the frequency is held constant, and the power plants maintain this constancy through the use of exceedingly accurate master clocks. So once again we see what a debt the hi-fi art owes the science of horology.

Although all electric motors used in hi-fi applications are of the synchronous type, there are several categories within this type with which the audiophile should be familiar. (See Fig. 1). The first of these is the two-pole type, and the most important thing for the hi-fi fan to remember is NOT to use it. But since the other motors evolved from it, we'll spend a little time in an analogy which will show the two-pole disadvantages, and the advantages of the more refined types.

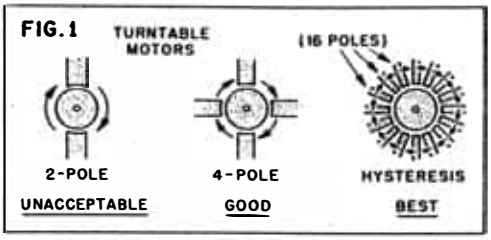
To understand something of the operation of the two-pole motor, think of a see-saw, the fancier type which will rotate on a central pivot as well as go up and down. Now suppose that you and I stand on the ground at opposite ends of the board, giving it a push to swing it around in a circle. Every time either end moves past us, we each give it another push to keep up the motion. Then the board gets a new push every half revolution, while its own momentum carries it the rest of the way. Such a motion would obviously be one of spurts and slowing down, which in hi-fi language spells *wow*.

Suppose now that we add a second board at right angles to the first to form a cross, or a huge + sign. And suppose we have two companions at the ends of that board to help us with the spinning. Now the

N-33H by Rek-O-Kut comes with hysteresis motor, aluminum deck, belt drive 33⅓ rpm speed. Noise is 53 db below recording level. Sells for $69.95.

A synchronous hysteresis motor is featured in the Rek-O-Kut B-12H. Noise level is 57 db below recording level; $129.95, less arm and base.

Lafayette 4-speed turntable sells for $37.50, has 3 lb. aluminum table, 4-pole motor. Noise and rumble is 50 db below average recorded level.

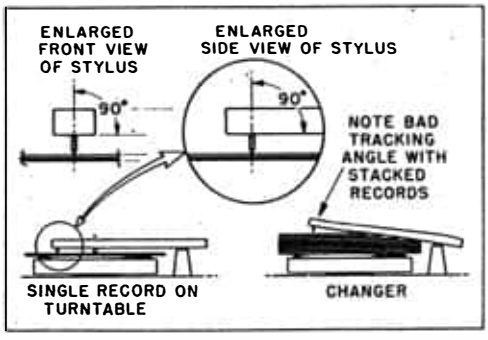



boards get a new push every quarter turn, as each one of us applies new force to each end as it comes by. The motion will now be very much smoother, just as it will in the four-pole turntable motor as compared with the two-pole variety. The four-pole motor is standard equipment on all medium-priced hi-fi equipment, and you shouldn't settle for less.

We can add even more poles to the motor, ultimately coming to the hysteresis synchronous type, which may have 16 poles. Although the four-pole type is probably the most widely used motor in hi-fi, it does generate some noise in the 30-60 cps range, the important second octave in the bass region. This low-frequency noise, known as *rumble,* is measurably reduced by the use of a hysteresis motor in place of the four-pole type.

In the Rek-O-Kut Rondine line, for example, tables which are otherwise identical show that the hysteresis model has 7 db less noise than the comparable four-pole type. It should also be noted, however, that the use of the hysteresis motor also involves an increase of about 50 per cent in initial cost. The hi-fi fan must therefore

Drawing below shows one big disadvantage of record changer as compared to manual turntable. For best results arm should be parallel to disc.



decide whether 7 db less noise is worth half again as much money.

The speed of the motors used for hi-fi often is in the vicinity of 1,800 rpm. This represents about the best compromise for efficiency, smoothness of operation, and adequate cooling. For turntables operating at two, three or four different speeds, it is obvious that changing speeds of the motor would involve even further compromises. Such a motor might be subject to overheating, vibration or poor speed regulation. The better approach to multispeed turntable operation is one where the motor speed is kept constant, while the turntable speed is varied by adjusting the power linkage between motor and table.

Thus there must be some sort of intermediate power linkage between the motor and table, rather than a direct connection between the motor shaft and the turntable spindle. Even the so-called direct-drive turntables are not actually that, as they have a set of step-down gears and mechanical vibration filters between the motor shaft and the table shaft.

Direct-drive systems used to be popular in commercial practice. They are quite good, provided their components are machined throughout to an exceedingly high degree of precision. The primary advantage of such a system, if any, is that it is probably better able to withstand the wear and tear of heavy-duty service, as in broadcast stations, film studios and wire music services. But you will never be subjecting your equipment to such abuse, and so the expense of such a system is unwarranted.

The problem of an inexpensive power linkage, which at the same time meets the requirements of smoothness and quietness, is neatly solved by the friction drive system. This is the one used most extensively in present hi-fi systems. It is a completely gearless method, in which a smooth motor pulley turns against a smooth rubber idlewheel, or idler, which in turn bears against the turntable rim, on either the inside or the outside.

When properly designed and built, this system will perform every bit as well as the most expensive direct-drive assemblies. And it can be purchased at a much more reasonable price, simply because there are fewer precision parts. The rubber idler may in time acquire flat spots, or generally become worn, but it can be replaced easily and inexpensively.

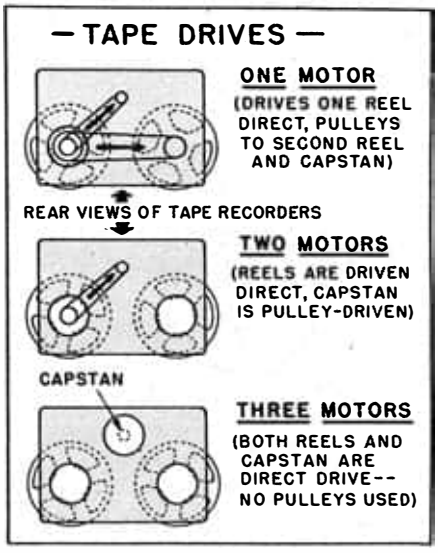
The table itself, if properly designed, can assist in the smooth rotational movement, by acting as a flywheel and opposing any

**Argonne Model AR-340 is a single-speed 33⅓ rpm turntable with hysteresis motor, has die-cast aluminum turnable, comes with a rubber disc mat.**

**Miraphon XMS-210 4-speed player costs $47.50, has 4-pole motor, plug-in cartridge heads and automatic shutoff at the end of photo record.**

**Bogen-Presto T-3 operates at 33⅓ rpm with endless belt drive system. It has a built-in strobe disc for checking of speed. Price, less arm, $59.95.**

Lafayette 4-speed hysteresis turntable with 16-pole motor. The 12-inch aluminum table weighs 4 lbs.; rumble and noise is 50 db below average.




Drawings above show typical arrangements of motors on tape recorders. As can be seen, the 3-motor recorder is best, but most expensive.

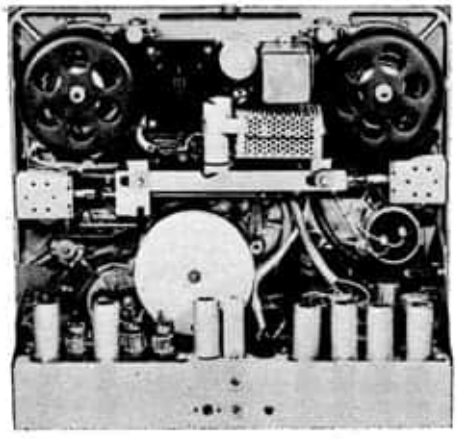
tendency toward speed fluctuation. A cheap turntable is simply a flanged disc stamped out of a piece of sheet metal. But a really good table is made of a heavy casting, precisely machined for perfect balance and smooth fit of its moving parts.

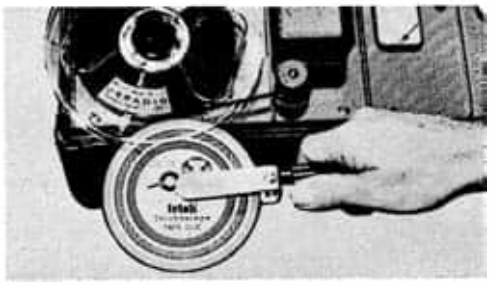
Since many hi-fi phono pickups operate on magnetic principles, the table should be made of nonmagnetic material such as aluminum or brass. When the pickup tracks a record, it is separated from the metal table only by the thickness of the mat, the record, and the length of the stylus, a fraction of an inch at best. Laying this close to the metal table, the magnetic pickup operation would be very seriously affected by magnetic fields in the table. Furthermore, the magnetism of the cartridge is attracted by a steel table to such an extent that the stylus pressure is increased markedly and the record wear correspondingly increased.

The record changer is a turntable which changes its own records. Only it isn't that simple. The record changer is actually a very complicated piece of machinery, the underside of which looks like one of Rube Goldberg's wildest inventions.

Juke box designers have concocted a wide assortment of changer mechanisms, but nearly all of the changers for home use are some version of the drop mechanism type, in which a stack of records is supported several inches directly above the turntable, and the records dealt one by one off the bottom and onto the table. The drop mechanism is usually some variation of the pusher platform, with the stack supported at two points, by a fixed platform at the edge and by an offset in the

Strobe disc made by Irish Tapes is used to check on speed of your recorder when viewed under 60-cycle lamp. Strobe wheel is held against tape.





Left: Rear view of American Concertone Series 60 model with direct hysteresis-motor tape drive for great timing accuracy. No belts or gears are used.

center spindle. When the next record is called for, a small arm in the outer platform pushes the edge of the bottom record sideways until it, like Humpty Dumpty, falls off the edge and slides down the spindle.

Some changers provide such additional features as a muting which kills the audio during the changing process, and an automatic stop switch which turns off the changer power after the last record has finished playing. These automatic conveniences are very handy, but they must be paid for in terms of increased record wear, perhaps even record damage. All changers have at least some of the following disadvantages:

1. Abrasion between grooved surfaces when records are dealt off the stack.
2. Nicks in the center holes or edges, caused by the platforms.
3. Wear on the center hole, since the spindle remains stationary during playing.
4. Change of stylus angle with respect to the record groove as the stack of records on the table varies in height.
5. Possible sacrifice of motor smoothness in favor of power to operate changer mechanism.
6. Slippage of the record when on a stack rather than on a mat.
7. Slowing down of turntable as weight of stack increases.
8. Excessive groove wear at inner section of record, as sub-chassis extension of tone arm bears against pawl and ratchet mechanism.
9. Exceedingly difficult maintenance and adjustment.

The big advantage of the record changer is, of course, its great convenience. This is undeniable, and many hi-fi afficiandos feel that this one advantage outweighs all the disadvantages. Whether or not you agree is strictly a matter of personal choice.

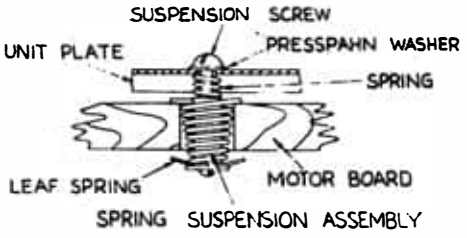
Unlike the turntable, but more like the changer, the transport mechanism in a tape machine is fairly complex. This is true because of the several functions which the mechanism must perform. Not only must the tape be moved past the heads at a constant speed, but it must also bear against those heads accurately, must play out of the supply reel smoothly, and must be reeled in on the takeup side after passing the heads. And when playing or recording is finished, it must be rewound from the takeup reel back to the supply reel.

These functions are best performed by three separate motors, one on each reel and a third on the transport itself. Although this is the best arrangement, and invariably found on professional equipment, it is all too seldom found in home hi-fi gear. But when one or two motors are required to do the job which should logically be assigned to three, the sub-chassis of the tape machine is a mechanical nightmare, and performance will be less than the best.

The types of motors used are the same as those found in turntables, hysteresis synchronous being the best, and four-pole motors being used more commonly because they are cheaper. Both idle-wheel and belt drives are used, with belts probably in the majority.

In a turntable the motion is imparted to the disc by friction. The disc and table move as one, while the cartridge moves across the face of the record in scanning the grooves. But in a tape machine the head does the scanning, and the head remains stationary. Thus fresh tape must be pulled continuously across the head.

The special tape pulling machanism is known as capstan drive. The tape winds partly around the revolving capstan, while a pressure roller squeezes the tape against




**Careful engineering is extremely important to obtain good performance from automatic changers. Above, left, is template included with Garrard changers for checking accuracy of critical spindle angle. Right, spring suspension method used to isolate the Garrard and similar units from shock and vibration.**


Shown on this page are: 1 and 2, Garrard RC 98 changer, $67.50, minus cartridge, and underside view of mechanism. Automatic changers are very complicated pieces of machinery, must be precision-engineered to perform their many functions smoothly and without impeding the sound reproduction; 3. Garrard RC 88, 4-speed automatic and manual player is wired for stereo, sells at $54.50, without cartridge, incorporates accurate speed control; 4. Garrard RC 121 automatic 4-speed changer is this company's economy model; 5. Voice of Music player comes with ceramic stereo cartridge, plays four speeds, will handle records of all sizes. Magnetic stereo pickup is also available; 6. Miracord XS-200 is priced at $67.50, has 10-inch table, push-button control, plays all four speeds, comes with 4-pole motor; 7. Glaser-Steers GS-77 features stereo wiring, permits stacked records of various speeds and size. It comes with 4-pole motor, sells for $59.50; cartridge is extra; 8. United Audio Dual-1006 changer intermixes records, has four speeds with push-button control. The unit is wired for stereo cartridges and comes with a built-in gauge for measuring of stylus pressure. Prices of all models shown do not include base.


the capstan to ensure adequate traction. The capstan is usually a precisely machined metal shaft and the roller is a rubber puck which very much resembles the idle wheel on a turntable. Rubber has been used for the capstan, too, but the wow and flutter are too great for hi-fi reproduction.

While the phono turntable itself acts as a flywheel to damp out speed irregularities, the tape capstan is so small that the addition of a flywheel is essential. This is made a part of the capstan shaft, out of view below the mechanism chassis.

The speed of both turntables and tape mechanism is checked by making use of the stroboscopic effect, in which a flickering light can make a moving object appear to be standing still. Once again we use the steady frequency of the AC power line as our reference. With conventional 60-cycle mains, electric lights actually flick on and off 120 times each second, once for each alternation of the current.

This flicker rate is too fast for the eye to see normally, but it shows up in the case of rapidly moving objects. Ordinary light bulbs, which are incandescent, actually


only grow brighter and dimmer, because of a thermal lag. But gas tubes, such as fluorescent or neon, do actually extinguish twice each cycle. Thus these types are best for speed checking.

The basic idea of the stroboscopic effect is simply this: if a moving object happens always to be in the same place when it is illuminated by a rapidly flickering light, then it will appear to be there constantly. We don't actually see it when it is anywhere else, because the light is off. With the proper flicker rate, we can even make the treacherously spinning teeth of the buzz saw look like they are standing still. But just put a piece of wood against them and see what happens!

In speed checking on discs and tape, we use the motion of alternate black and white segments, or of black dots, as an indicator. Many turntables now have stroboscopes built in. For those that don't, it is a simple matter to get a separate disc and place it on the turntable, just like a record. When the segments or dots appear to be standing still when under the proper neon illumination, then the table is operating at correct speed. But if they appear to be creeping forward or back, then the table is off speed.

Since there are several power frequencies still in use in this country, including 25, 50 and 60 cycles, and since there are at least four record speeds, the stroboscope disc which allows for all of these eventualities may have up to a dozen different bands of segments on it. But since any given record has only one speed, and since it is the speed of the record itself in which we're interested anyway, one wonders why the record manufacturers don't all imprint stroboscopic patterns right on their labels.

This principle is followed in the strobotape, in which the segments are imprinted right on the tape backing. The "tiger tape" used by amateur cinematographers for synchronizing movie projectors to tape recorders can't be used for accurate speed checking, however, because its segments are geared to the flickers set up by the projector shutter, which are not the same as those from an AC power line.

Another means of checking tape speed is the stroboscopic disc, which is held against the moving tape or capstan. Irish Tape makes such a gadget, which is segmented for the three most popular tape speeds. The idea was first used at RCA Victor in 1950, and it really works.

### The Stereo Story

Stereo imposes no new requirements on the tape transport, and any mechanism which is good for monophonic tapes will be just as good for stereo. But this is not necessarily true for the turntable or changer. The biggest difference is in the new limitations on noise or rumble.

Previously the phono cartridge was not required to respond to motion in the vertical direction. In fact, it was purposely made insensitive to vertical movement. But as we shall see in the next chapter, the stereo cartridge must respond to both vertical and lateral movement.

Now suddenly vertical rumble, which has been virtually ignored in the past, becomes a serious factor. This means that, when considering purchase of a turntable, one must be sure that the noise figures claimed by the manufacturer are for stereo conditions. The signal-to-noise figure as registered by a conventional lateral pickup may be quite different from that with a stereo pickup.

Since a lot of idle-wheel tables can't measure up, there has been renewed interest in belt drive as the linkage between motor and table. In this case an endless belt wraps around the motor shaft and the outer rim of the turntable, or a sub-chassis drum attached to the turntable shaft. Although the belt drive is often less attractive in appearance than the idler type, all things being equal, the belt in many cases is the quieter of the two. •