Shock-Proof Record-Player Suspension System

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Using simple mechanical engineering principles, here is how to build a system to isolate the record player from the most severe shocks encountered in the home.

RECORD turntables or changers are usually supported by springs or elastic mounts provided by the manufacturer. These mounts isolate the record player from acoustic feedback by the loudspeakers. However, to prevent acoustic feedback, it is only necessary to isolate the record player from frequencies higher than the lowest frequencies produced by the speaker; in many record players these mountings are much too stiff to protect the record player from the effects of shock caused by people dancing, children playing, and, in the case of particularly flimsy floors, people walking near the record player. These shocks can result in record-destroying groove-jumping and annoying disturbances in the sound.

This article will describe a record-player suspension system that will isolate the record player from the effects of the most severe shocks that would normally be encountered in the home. The suspension system accomplishes this by providing extreme flexibility to motion of the turntable in all directions, *i.e.*, vertical, horizontal, and rotational. Only a few parts are needed for its construction. These parts include pulleys, strong cord or fishline, steel pegs, and extension springs—all of which can be found in a well-stocked hardware store. The unit has a simple mechanism for leveling the turntable, a necessity when a balanced tonearm is not used.

Principle of Operation

The suspension system isolates the record player from shock by permitting the record-player cabinet, or whatever structure the record player is mounted on, to move suddenly through large displacements, such as $\frac{1}{8}$ of an inch, without transmitting any appreciable motion or jar to the record player. In essence, the suspension system makes the record player behave like a seismograph; if the floor were to be suddenly jarred by an earthquake, one could notice it by observing the relative motion between the record player and the suspension system cabinet.

A very simple criterion may be used to determine how flexible the suspension system must be: this is to specify the natural frequency of free oscillation of the suspended record player when it is disturbed into motion, *i.e.*, the frequency at which the record player swings back and forth or bobs up and down. Analysis and experience have shown that a natural frequency of 2 cps or less will give adequate shock protection. At this low frequency, any vertical or horizontal oscillation of the record player will not produce forces between the needle and the record large enough to disturb the

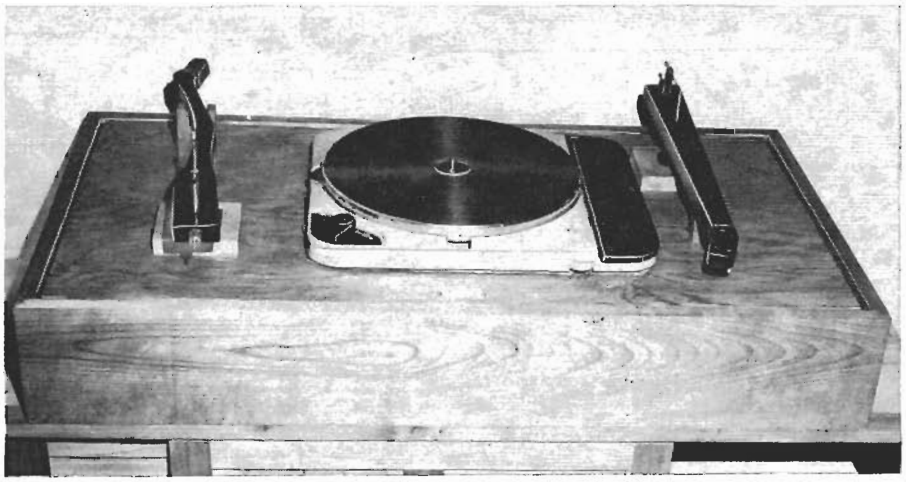
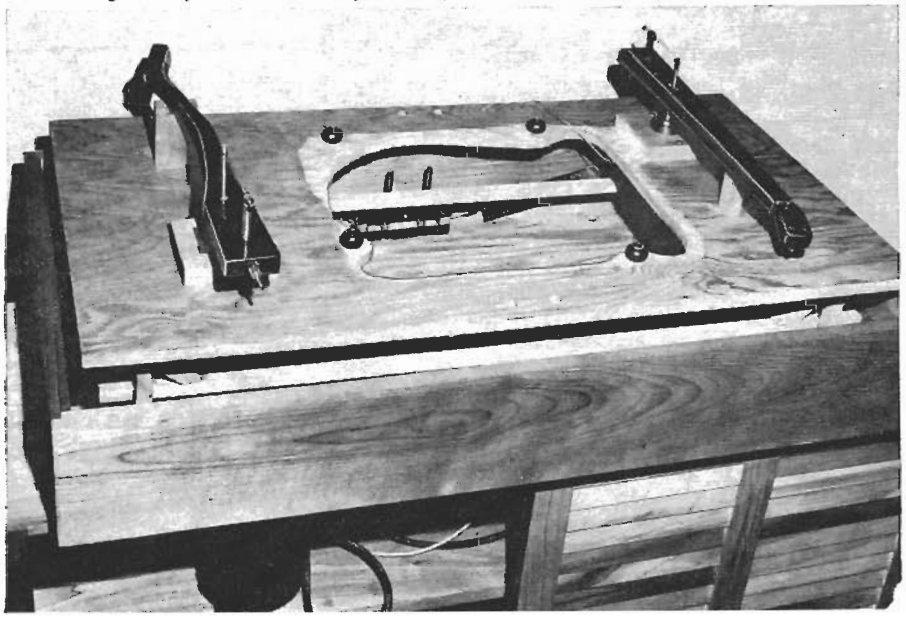


Fig. 1. Over-all view of record-player mounting arrangement described in the article. A pair of home-built tonearms complete the author's playback system.

Fig. 2. Top view of the suspension system with the record player removed.



sound, cause groove jumping, or harm the record. Moreover, the small amount of friction in the suspension system will quickly damp out these oscillations. Natural frequencies much lower than 2 cps, corresponding to a more flexible suspension, are usually not necessary and they may become impractical due to space limitations and difficulty in getting extremely soft springs that are capable of supporting the weight of the record player.

Design

The suspension system illustrated in Figs. 1 through 6 consists of a cradle that is suspended at each corner by 80-lb.-test Dacron fishing line running over ball-bearing pulleys. The other ends of the cords are fastened to extension springs. The other ends of the springs are anchored by cord to the steel pegs in the record player leveling windlasses. The record-player mounting board rests on four posts extending up from the cradle. The flexibility of the system is achieved through pendulum action in the horizontal direction and through spring action in the vertical direction.

The cradle can be made of thin strips of oak, or other strong wood, and glued together with a good glue.

The leveling windlasses, shown in Figs. 4 and 5, consist of ½-inch diameter steel pegs clamped in a wood block by steel straps. The pegs are kept from rotating by the clamping friction. Their action is similar to that of the pegs of a violin. A slot is cut in the upper ends of the pegs to accept a screwdriver. Any corner of the record player may be raised or lowered by inserting the screwdriver through properly placed holes in the record-player mounting board and rotating the pegs.

The natural frequency of oscillation of the record player in the horizontal direction is $f = 3.12/\sqrt{l}$ cps, where l is the length in inches of the portion of string A-B (Fig. 6) between the pulley and the cradle. A minimum length of 2 inches will give a frequency of about 2.2 cps. If space permits, longer lengths will provide better isolation.

The Springs

The choice of springs depends on the total weight of the suspended record player, mounting board, and cradle. The greater this weight, the heavier and stiffer the springs must be.

Determine the total suspended weight and divide this quantity by 4 to get the approximate load carried by each spring. Call this quotient W. For example, the total suspended weight for the *Thorens* turntable used by the author was about 20 pounds, so $W=5$.

Now specify a spring on the basis of its spring constant, called K pounds per inch. K is given by the formula: $K = W f^2/9.75$, where f is the natural frequency. For example, with $W=5$ pounds and $f = 2$ cps, $K = 5 \times 4/9.75 = 2.05$ pounds/inch.

Enough space must be provided in designing the system to allow for the stretch of the spring due to the sus-

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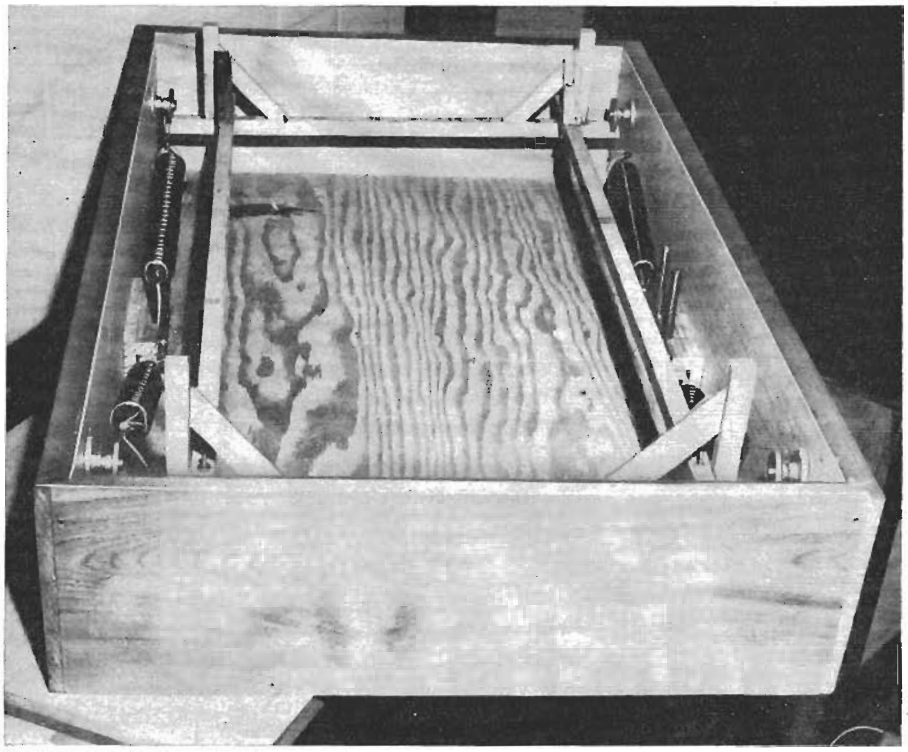


Fig. 3. Inside view showing the arrangement of the four suspension springs.

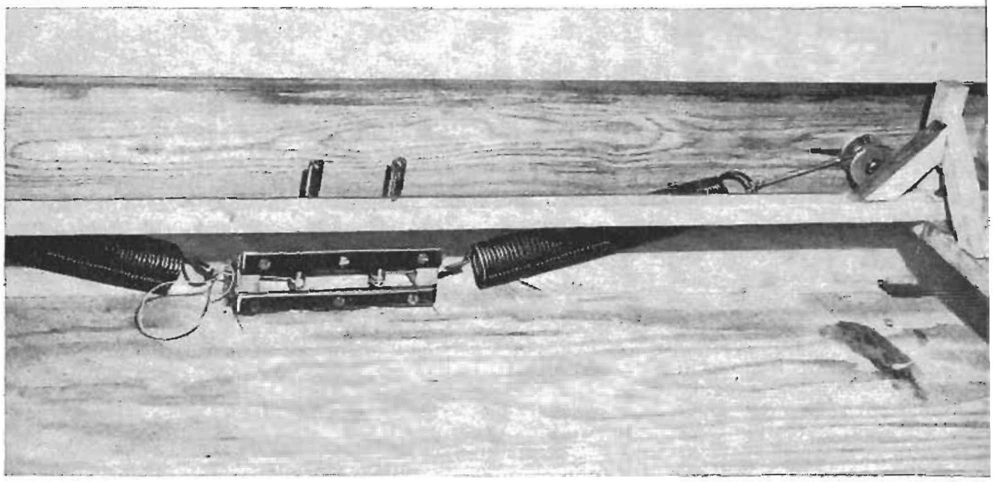
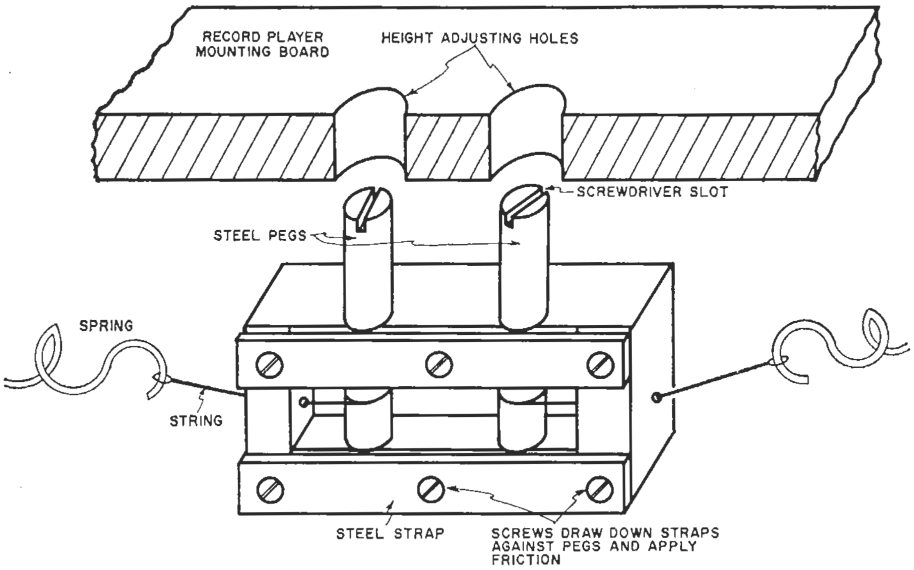


Fig. 4. Close-up of the leveling windlass with its two height-adjusting screws.

Fig. 5. Details of the leveling windlass. Two of these assemblies are required.



Shock-Proof Suspension System

(Continued from page 43)

pended weight plus some additional amount for motion of the suspension system. Call the spring stretch due to the suspended weight x; then $x=W/K$ or $x=9.75/f^2$. In terms of the previous example, $x=2.44$ inches for 2 cps. This means that if the unstretched length of the spring were 6 inches and $x=2.44$ inches, you must have enough space to accommodate 8½ inches of spring. Most extension springs have some initial tension so that x may be a little less than the value given by the formula just cited.

If a variety of extension springs is available, a simple experimental procedure may be used to select the desired spring. First apply sufficient force or weight to the spring to overcome its initial tension and open up the coils. Then load the spring with P additional pounds of weight and measure the additional stretch due to P, say s inches. The spring constant will be $K=P/s$. For example, if $P=2$ pounds and $s=1$ inch, then $K=2$ pounds/inch. Another way of going about this is to add a load of K pounds and see if the spring stretches approximately 1 inch. If it does, then this spring has the desired spring constant.

Of course the spring selected must be strong enough to support the suspended weight without taking a permanent set. Because of variations in the strength of spring materials, no precise rule, outside the "try it and see" method, can be given. However, you can use this approximate and fairly conservative formula for selecting the spring on the basis of its actual weight. The weight of the spring should not be less than: $m=0.1\ W^2/K$ ounces, where W=load carried by the spring and K is the spring constant. Any spring that weighs more than m will be strong enough. Example: if the supported load is $W=5$ pounds and $K=2$ pounds/inch, then $m=0.1 \times 25/2=1.25$ ounces.

It is advisable to get the springs for the suspension system before building the cabinet so that proper space and a proper arrangement for them can be provided.

Other Construction Notes

Sufficient clearance, between 3/16" and ¼", should be left between the record player mounting board and its outside housing to allow for relative motion between the two.

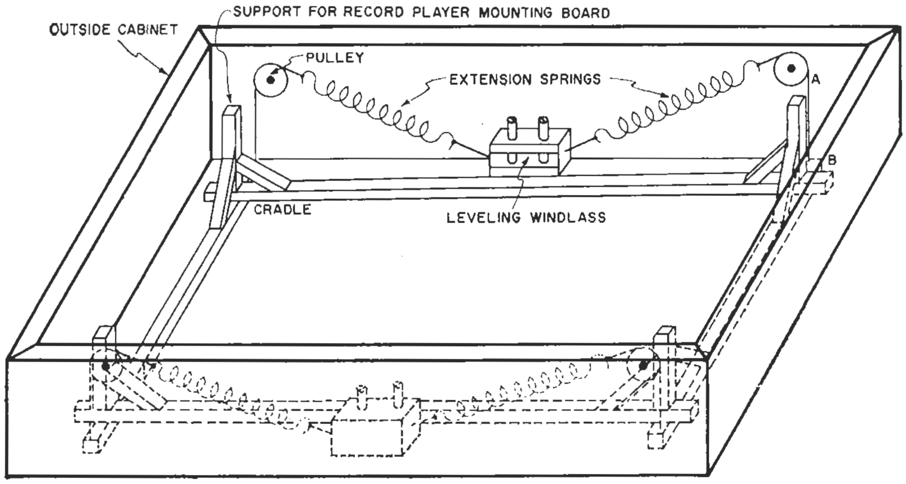
In mounting the record player on the suspension system, the elastic mounts provided by the manufacturer should be used in addition to this suspension system since they will continue to serve their purpose of isolating the record player from acoustic feedback and can only improve on the isolation provided by this suspension system.

The outside dimensions for the housing or cabinet of the suspension system are not included because these must be determined by household space considerations, the size of the springs, and the dimensions of the record player. The turntable for which the system described was designed is unusually heavy, thus the suspension system is heavier and bulkier than one that could be designed for a lighter, more compact record player.

In summing up, the important feature of a shock isolation system is that the suspension be very soft in all directions. The natural frequency of oscillation is the criterion of how soft the suspension is and how good a shock isolator it is. The lower the natural frequency the better. The system described here is simple and makes it possible to get very good shock isolation, especially in the horizontal direction where it is usually needed most—but it is not the only way of doing the job. The author built a rather complicated combination torsion-bar, pendulum suspension that worked very well. Hence you can design your own system such as, for example, hanging your record player in pendulum fashion from four vertical springs that would be concealed in the cabinet.

With the described system you should be able to jump several inches from the floor in front of the record player and land fairly hard without hearing any disturbance in your hi-fi system, even with needle pressures as low as 1½ to 2 grams. —30—

Fig. 6. Details of the cradle and the suspension system designed by the author.



Techni-Guide

Garrard Lab 80 Automatic Turntable

Alan Redmont

This month's techni-guide is somewhat of a deviation from our normal servicemans' manual and should more properly be called a consumer report, for this is really what it is. However, due to the exciting newness of the many features incorporated in this new concept in changers we feel that this change of pace is justified.

The Lab 80 will certainly be a stranger to the average reader because it is not on the market yet, and may not be for another month or more. This then, is something of a sneak preview of the top of the new line of Garrard changers being introduced this Fall.

Rather than trying to turn a record changer into a turntable, the Garrard people has taken a step in the right direction in trying to convert a turntable into a record changer.

The designers started with a heavy non-magnetic table, a very well mounted four-pole motor, and a non-resonent wood pick-up arm — the makings of a better than average transcription turntable — and went on from there to add a complete set of standard changer functions, and a couple of new ones too. While the record dropping mechanism is not entirely new in principal, it has been improved and refined to such a degree that the record hardly knows it has been dropped. (See picture #1) At the start of a cycle, a plastic cam protrudes slightly from the upper part of the spindle and firmly grips all but the bottom record. The three metal arms, as shown in the illustration, then retract, allowing the bottom record to fall. The plastic cam also senses the absence of records and activates the mechanism that turns the machine off after the last record has played. The operation is so gentle that there is virtually no wear on the records' centre holes.

An excellent feature is that after the record changing cycle ends, the dynamically balanced arm is completely freed from the changing mechanism. This allows tracking pressures to be as low as you would expect from the best transcription units. To further aid the tracking process, a "bias compensator" is mounted to the side of the arm, with a simple adjustable weight so mounted as to make the arm swing outward, serving the very useful purpose of compensating for the tendency inherent in all arms with offset heads to swing toward the centre of the turntable. When properly adjusted, there is no lateral pressure on the stylus.

A very nice touch is lent to the manual operation by the addition of an arrangement whereby the stylus is mechanically dropped on to and lifted off of the surface of the record. An ingenious arrangement incorporating a piston moving in viscid grease results in very smooth operation. This is one feature that could be installed in every transcription turntable to advantage — and probably eventually will be.

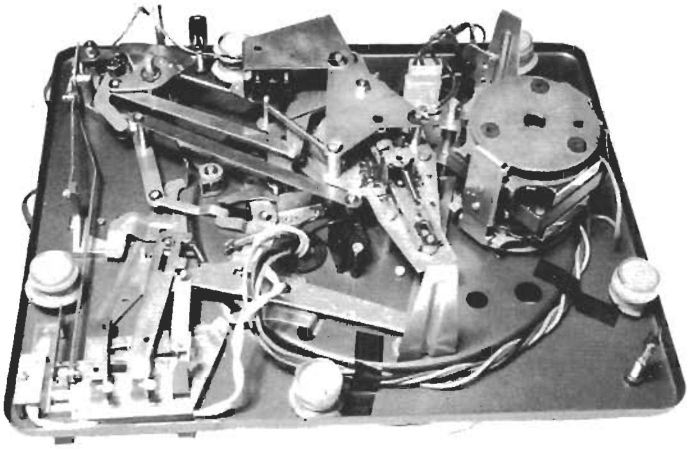
On the whole, this is the best yet in an automatic turntable, if not the best possible. The only weaknesses that might be discovered would be due to the fact that this unit is mass produced to sell well below the prices asked for other transcription units. Naturally you can't expect and won't get the same performance as the Rek-O-Kut, Fairchild or Weathers transcription turntables, and here are a few of the reasons why. For a turntable of this size and weight, the four pole motor is slightly underpowered. True, wow and flutter are amazingly low, but the over all speed regulation could be affected under some conditions. A variation in line voltage for example will cause a slight variation in turntable speed. On my test, a change of 6 volts, from 115 to 121 volts caused a slight variation in speed.

The only other sacrificing of quality for cost that I coult find was that although the turntable is massive enough, the base plate is fairly light, with the result that the over-all weight is fairly low. Consequently the immunity to external vibration is not perfect, and when tracking under 3 grams, the stylus could be easily made to jump the grooves. So if your planning any wild parties, it would be advisable to either mount your turntable in a shock proof place, or possibly set it on a bed of foam insulation.

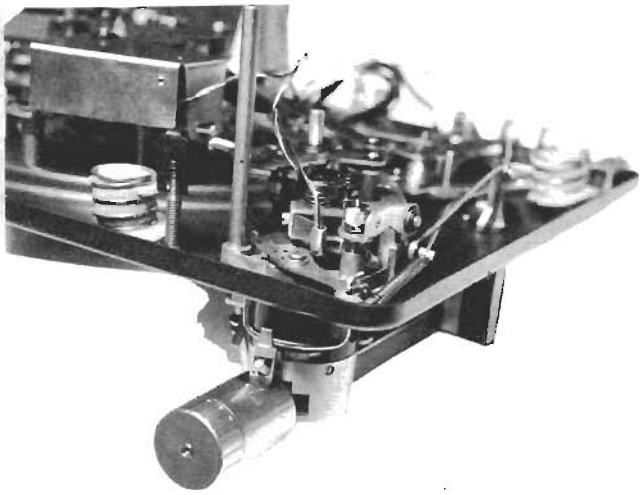
In summation, this is definitely the best automatic changer available today in my estimation. I really had to dig deep to find any faults, but in high fidelity it's the details that mean so much. Some of these faults can be found in the best transcription turntables.

The Garrard Lab 80 is sure to be a "big one" for Garrard. It plays sweet music to the customer's eye and wallet, as well as his ear ! And, in its price range, I must admit that there's not much else to compare.

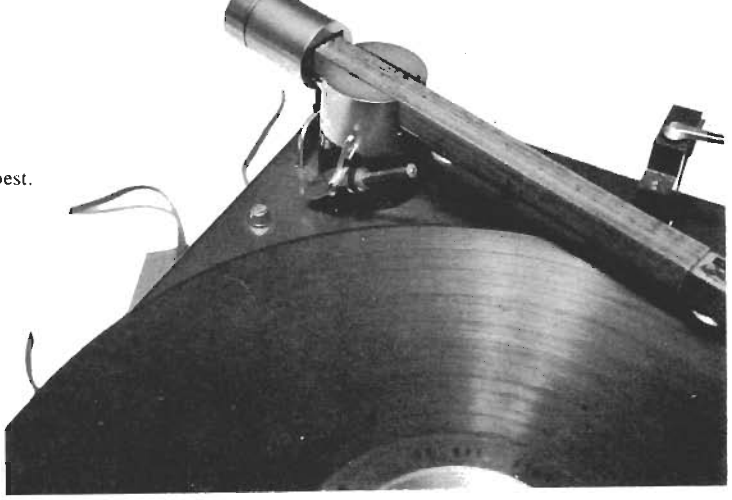
Garrard Lab 80 Automatic Turntable



Below decks. Certainly not uncomplicated. Leave servicing to Garrard, Inc.



Once the change cycle is complete, the arm is freed of the mechanism, and is completely "free wheeling".



"Bias compensator" lets her track with the best.

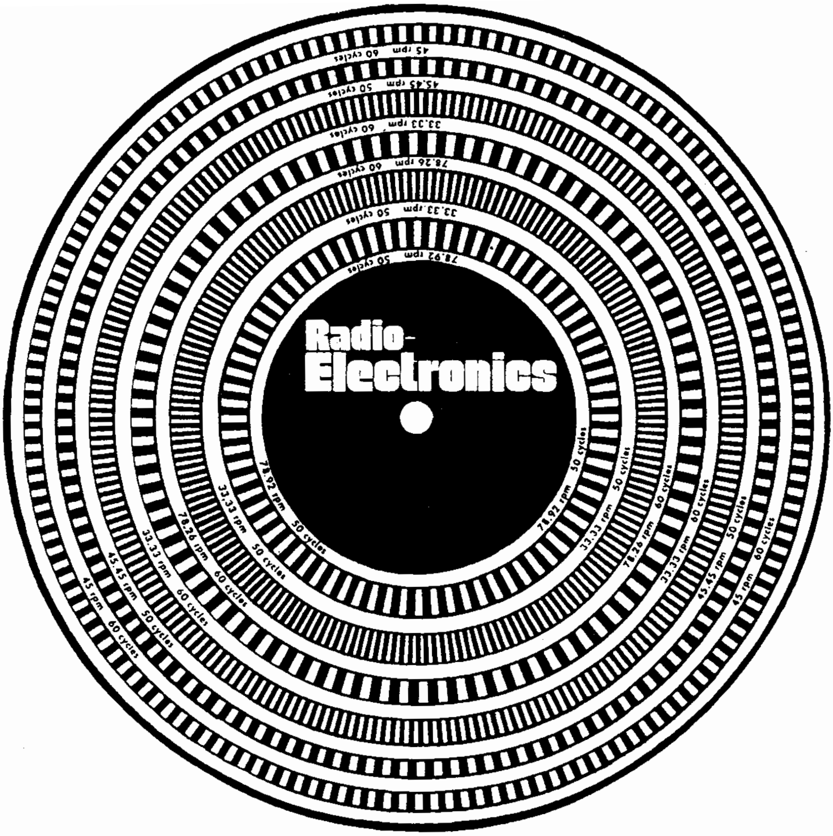


FIG.1

Please print the circuit details for a simple hand-held strobe light that can be used for checking the speed of a turntable. Dealers in my area don't stock a useful strobe.—R. J. E., Delta, OH.

Here's a stroboscope you can throw together in a few minutes. You can use a commercial neon-lamp tester or you can assemble your own by wiring a 220K resistor in series with an NE-2 lamp and a 117-volt line cord. For convenience and safety, assemble the components in a plastic tube; the barrel of an old felt-tip or ball-point pen will serve nicely.

If your turntable has stroboscopic markings around its perimeter, you're all set. Otherwise, cut out the disc shown in Fig. 1 and mount it on a piece of stiff cardboard. Our disc has markings for RPM's of 33⅓, 45, and 78, and it can be used in both the U. S. and Europe, because it contains separate sets of bands for both 50 and 60 Hz.

Apply power to your turntable and hold the neon-tester near the band of interest. The markings on the disc should appear to be stationary, or very nearly so. Use your turntable's speed control to adjust speed so that the markings appear perfectly still. That's all there is to it!