Pickup Arm Design for Home Construction

by R. Ockleshaw

The pickup arm described is designed to accompany the turntable detailed in our last issue. It includes an optional bias compensator and lift mechanism. Mechanical resonance is damped by a flexible coupling between counterweight and arm. A further article will describe how to check performance of the turntable using a test record and novel wow and flutter meter.

Design of pickup arms has been well described. The articles* published in *Wireless World* May and June 1966 contain all the information required to design an arm for minimum distortion due to lateral tracking errors. In the present design, note has also been taken of the opinions of J. Walton on pickup-arm design.†

Briefly, one should try to avoid a system reproducing frequencies generally below the limits of audibility, because they may produce a disturbing Doppler effect on some loudspeaker systems whose acoustic impedance at these frequencies is low. Also, vibrations of the turntable and pickup-arm suspension should not cause excitation of the pickup arm, however damped.

A pickup arm has a natural period of oscillation of $T = 2\pi(MC)$ where M is the effective mass of the pickup arm and C is the compliance of the pickup cartridge. Mechanical impedance moves from a low to a high value around the resonant frequency peak—Fig. 1. Below the resonant frequency, because the mechanical impedance of the arm is low in comparison with the mechanical impedance of the pickup cartridge armature, the output from the pickup will be severely attenuated. Thus the arm acts like a high-pass filter, rejecting frequencies in the rumble range. The cut-off can be quite sharp but its value as an active part of a system is lost if different cartridges of varying compliance are fitted. Consequently my approach is that it is always better to ensure that rumble is reduced as much as possible at source and not rely entirely on the impedance characteristics of the arm. Damping the resonant peak is important too as the coincidence of some discrete vibration with the high-impedance resonant peak of an undamped arm may cause excitement which could damage the disc groove. This design is damped by ensuring that the counterweight is flexibly coupled to the arm. This effectively spoils any modes of mechanical resonance.

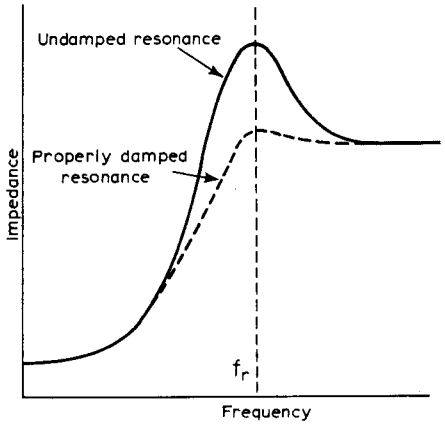


Fig. 1. Pickup arm resonance must be damped to allow for different cartridges. In this design damping is achieved with plastic 'decoupling' between balance weight and arm.

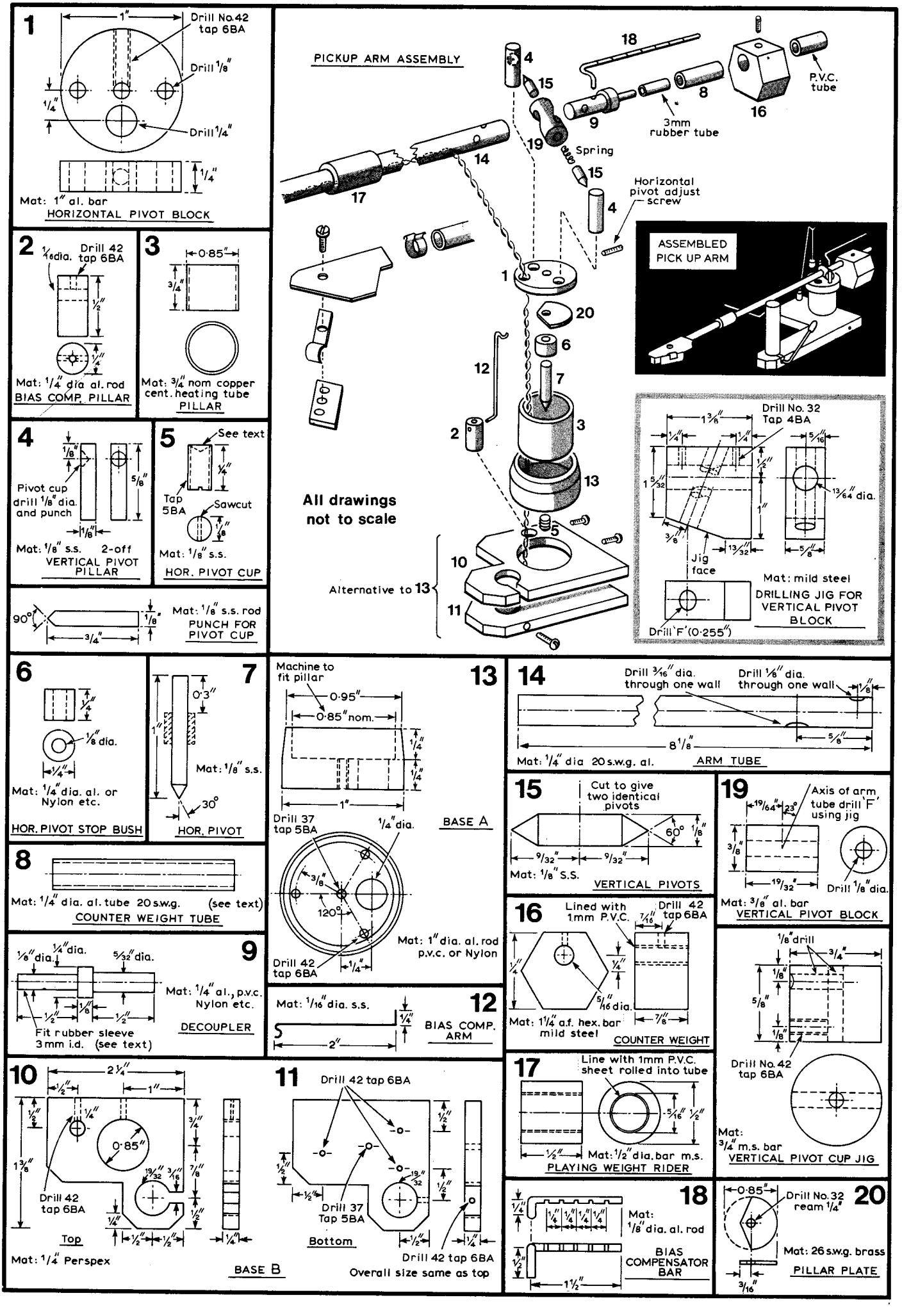
Record warp causes large vertical pickup-arm movements and it is important that the stylus remains normal to the record surface. Making the vertical pivot axis normal to the axial line of the cartridge, as in this design, gives a better approximation to correct movement than making the axis normal to the whole arm.

Construction is described in the drawings and in the supplementary notes which follow. The material for the counterweight is steel, but this can be replaced by any high-density material such as brass—though the dimensions may have to be changed to maintain the correct weight. When making the decoupler, which fits into the counterweight tube, ensure the wide end is a comfortable push fit into the arm tube. Fit a 3-mm internal dia. rubber sleeve over the smaller end and push into the counterweight tube, checking that the tube does not touch the decoupler.

The vertical pivot block is drilled at an angle to accept the arm tube. This is a difficult operation in practice without the aid of a jig and so a suitable design is shown. The material required is a 1-in length of $\frac{3}{4}$-in dia. aluminium bar which is inserted

*J. K. Stevenson, 'Pickup arm design', *Wireless World* vol. 72 1966 pp. 214-8 and 314-20.
†J. Walton, 'Turntable rumble and pickup arm design', *Wireless World* vol. 68 1962 pp. 435-7.

In this photograph, the pickup arm has a different shell to that shown in the diagrams. A drawing showing how to make this version — heavier, though possibly aesthetically more acceptable — is available from the editorial offices.


1
Drill No.42 tap 6BA
Drill 1/8"
Drill 1/4"
Mat: 1" al. bar
HORIZONTAL PIVOT BLOCK
PICKUP ARM ASSEMBLY
P.V.C. tube
3mm rubber tube
Spring
Horizontal pivot adjust screw
ASSEMBLED PICK UP ARM
All drawings not to scale
Alternative to 13
2
Drill 42 tap 6BA
Mat: 1/4" dia al. rod
BIAS COMP. PILLAR
3
Mat: 3/4" nom copper cent. heating tube
PILLAR
4
Pivot cup drill 1/8" dia. and punch
Mat: 1/8" s.s. 2-off
VERTICAL PIVOT PILLAR
5
See text
Tap 5BA
Sawcut
Mat: 1/8" s.s.
HOR. PIVOT CUP
Mat: 1/8" s.s. rod
PUNCH FOR PIVOT CUP
Drill No. 32 Tap 4BA
Jig face
Drill 'F' (0·255")
Mat: mild steel
DRILLING JIG FOR VERTICAL PIVOT BLOCK
6
Mat: 1/4" dia. al. or Nylon etc.
HOR. PIVOT STOP BUSH
7
Mat: 1/8" s.s.
HOR. PIVOT
8
Mat: 1/4" dia. al. tube 20 s.w.g. (see text)
COUNTER WEIGHT TUBE
9
Mat: 1/4" al., p.v.c. Nylon etc.
Fit rubber sleeve 3mm i.d. (see text)
DECOUPLER
10
Top
Drill 42 tap 6BA
Mat: 1/4" Perspex
11
Drill 42 tap 6BA
Drill 37 Tap 5BA
Bottom
Drill 42 tap 6BA
Overall size same as top
BASE B
13
Machine to fit pillar
Drill 37 tap 5BA
1/4" dia.
Drill 42 tap 6BA
Mat: 1" dia. al. rod p.v.c. or Nylon
BASE A
12
Mat: 1/16" dia. s.s.
BIAS COMP. ARM
14
Drill 3/16" dia. through one wall
Drill 1/8" dia. through one wall
Mat: 1/4" dia 20 s.w.g. al.
ARM TUBE
15
Cut to give two identical pivots
Mat: 1/8" S.S.
VERTICAL PIVOTS
16
Lined with 1mm P.V.C.
Drill 42 tap 6BA
Mat: 1 1/4" a.f. hex. bar mild steel
COUNTER WEIGHT
17
Line with 1mm P.V.C. sheet rolled into tube
Mat: 1/2" dia. bar m.s.
PLAYING WEIGHT RIDER
18
Mat: 1/8" dia. al. rod
BIAS COMPENSATOR BAR
19
Axis of arm tube drill 'F' using jig
Drill 1/8" dia.
Mat: 3/8" al. bar
VERTICAL PIVOT BLOCK
1/8" drill
Drill No. 42 tap 6BA
Mat: 3/4" m.s. bar
VERTICAL PIVOT CUP JIG
20
Drill No. 32 ream 1/4"
Mat: 26 s.w.g. brass
PILLAR PLATE

into the jig. Lock it into position by two 4BA screws. Using an F(0.255in) drill, pierce the aluminium bar by inserting the drill into the hole in the jig face with the jig held in a vice. After piercing, shorten the pivot block to the dimensions given.

A jig is also used to make the vertical pivot pillars. Hold the pillar in the jig while preforming the cup with a $\frac{1}{8}$-in dia. drill. The pillar should not be removed from the jig, however, before the pivot cup is formed using the punch shown. Heat the punch to cherry red, quench and polish. After punching, likewise harden the pivot cups. Form the horizontal pivot cup in the same way, harden both pivot and cup, and finally polish the pivot.

Two versions of pillar base are shown. Use version A—best made on a lathe—if the lift mechanism is not required. Base B accepts both the lift mechanism and bias compensator pillar. Bond the two parts of base B after they have been made with Evostik and spray if desired.

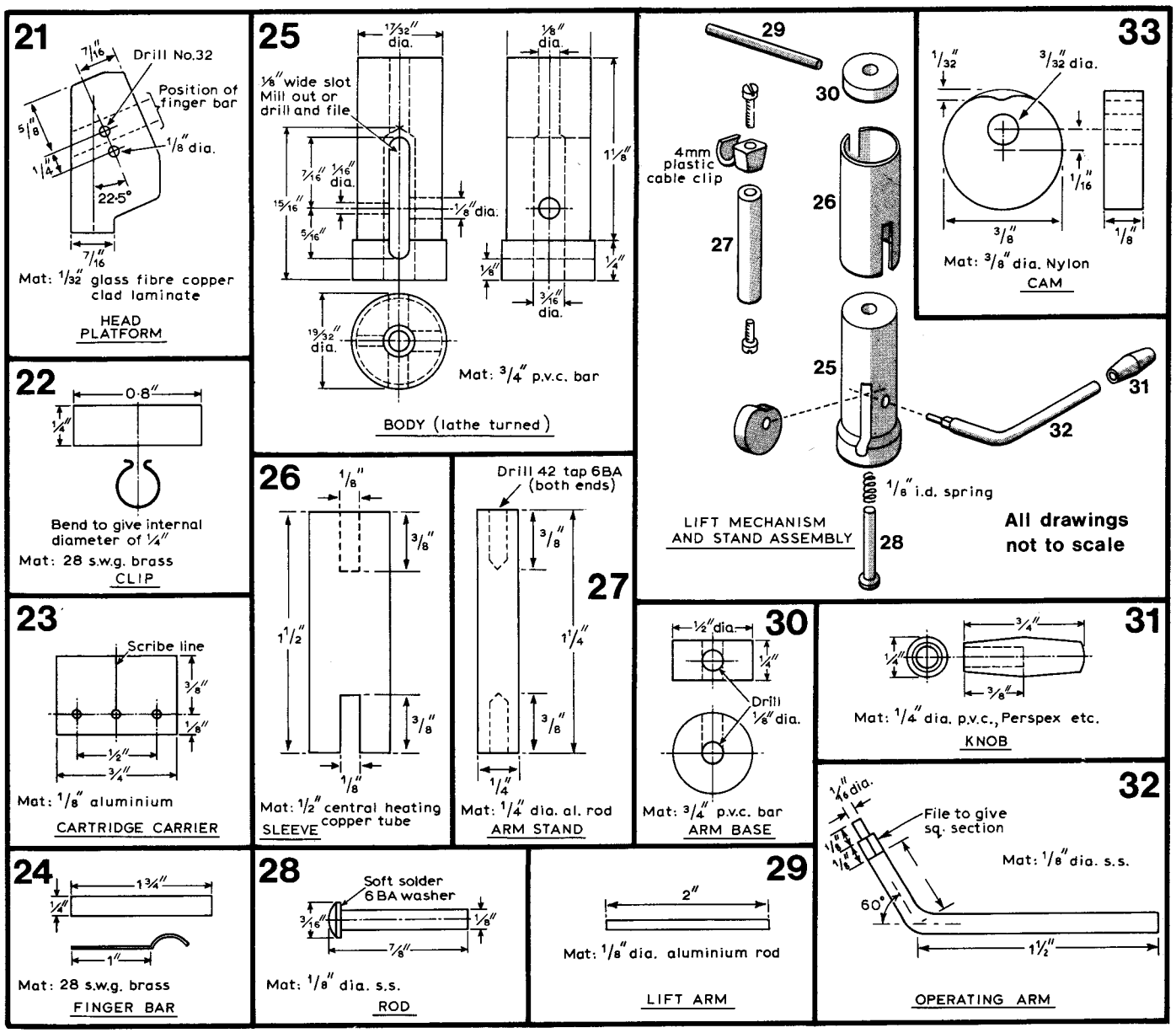
Assembly

Once the vertical pivot block and decoupler are assembled on and in the arm tube

Parts list

All turntable and pickup arm parts are available from Longdendale Technological Products, Hadfield, Hyde, Cheshire.

part	description/material
arm tube	$\frac{1}{4}$-in dia. × 20 s.w.g. Al tube (12-in)
vertical block	$\frac{3}{8}$-in dia. × $1\frac{1}{2}$-in Al bar
decoupler	$\frac{1}{4}$-in dia. × 1-in Al bar
bias compensator bar	$\frac{1}{8}$-in dia. × 3-in Al bar
horizontal pivot block & base A	1-in dia. Al bar (2-in)
horizontal pivot stop	$\frac{1}{4}$-in dia. Al bar
horizontal pivot and cup, vertical pivot & pillar	$\frac{1}{8}$-in dia. silver steel (13-in)
pillar plate, finger bar & clip	28 s.w.g. brass or copper
pillar	$\frac{3}{4}$-in dia. nom. copper central-heating tube (2-in)
head platform	$\frac{1}{16}$-in copper-clad laminate
base B	$\frac{1}{4}$-in Perspex sheet
counterweight	$1\frac{1}{4}$-in a.f. mild steel hex. bar (1-in)
cartridge carrier	$\frac{1}{8}$-in Al
playing weight rider	$\frac{3}{4}$-in mild steel bar
vertical pivot loading spring	from Longdendale Technological Products
bias compensator pillar	$\frac{1}{4}$-in dia. Al rod
bias compensator arm	$\frac{1}{16}$-in dia. s.s. (13-in)
socket-head grub screw	6BA × $\frac{1}{4}$-in (6 off)
pickup-arm wire nylon thread	about 18-in
bias compensator weights	appropriate lengths of $\frac{1}{4}$-in dia. brass rod
lift mechanism	
body & arm base	2-in × $\frac{3}{4}$-in p.v.c. bar
lift and operating arm & rod	$\frac{1}{8}$-in silver steel (7-in)
cam	$\frac{3}{8}$-in nylon
sleeve	$\frac{1}{2}$-in nom. copper central heating tube ($1\frac{1}{2}$-in)
spring	$\frac{1}{8}$-in i.d. × $\frac{1}{4}$-in long from Longdendale Technological Products
knob	$\frac{1}{4}$-in dia. p.v.c., Perspex etc. (1-in)



respectively, use the vertical pivot block as a jig to complete the $\frac{1}{8}$-in dia. axial hole through the arm tube and decoupler. A small amount of Araldite or Evostik ensures a permanent assembly. Now insert the spring and two pivots into the axial hole of the pivot block as shown.

Bond the vertical pivot pillars into the pivot holder with Araldite with the cups accurately aligned inwards. After setting, insert the vertical pivot block between the pillars by squeezing the pivot loading spring in the pivot block over the pivots. This is a tricky operation requiring a little patience and, hopefully, only one spring! The resulting pivot should be completely free from sticking and quite stable.

Bond the horizontal pivot-stop bush to the horizontal pivot after it has been hardened and polished. Insert the square-cut end through the $\frac{1}{8}$-in hole in the pillar plate. Assemble the base to the pillar.

Fix the vertical pivot pillar holder on to the horizontal pivot by the grub screw. Screw the horizontal pivot cup to the pillar base until the bush tightens against the top of the pillar. Slacken off $\frac{1}{4}$ turn and lock with cellulose paint. Adjust the vertical pivot block to give a clearance of about 0.025in.

Wiring should present no problem if it is done before the arm is fitted to the pickup-arm board. Remember to mark one of the wires at both ends for identification. It may help if a piece of stiffer wire is threaded first so it can be used to pull both of the coaxial wires through at once. The two wires can be terminated on a small tagboard underneath the pickup-arm board or on to a plinth-mounted socket.

Performance of the arm is improved by using the bias compensator. Possibly the best way of setting up the compensator, for a spherically-tipped stylus at least, is with an unmodulated disc. But be prepared for some experimentation.

Setting up the arm

A jig for assembling the arm to the pickup-arm board is shown in Fig. 2. It should be used with the turntable in place, the small hole being placed over the spindle. The other end should be slipped over the pickup-arm pillar. The arm's position should then be selected and marked.

Effective arm length should be nine inches — i.e. the distance from stylus tip to centre line of vertical pivots. To do this slide the head of the arm either forward or backward along the arm tube. The overhang is designed to be 0.625in and is measured as the distance the stylus overhangs the centre of the turntable. Using the adjusting screw on the head, adjust offset angle to give zero tracking angle—i.e. angle of stylus to groove at a distance of 2.4in (2.375) from the turntable centre and then at a distance of 4.6in (4.606) from the turntable centre. There should be very little difference in tracking angle. If it is discernible check the positioning of the arm base, the effective length and overhang.

Calibration

The playing weight rider can be omitted, in which case the playing weight must be set up each time using a suitable balance. If the rider is used the arm can be calibrated against either a 'pressure' gauge or a set of weights. In either case stick a piece of plasticine to the cartridge platform. Its weight is not important but it should be roughly equal to the weight of a cartridge—say 6 or 7g.

If you use a pressure gauge, adjust the counterweight to balance the arm with the rider as close to the pivots as possible. Moving the rider away from the pivots will unbalance the arm and increase the playing weight. Relate distance from the pivots to playing weight using the pressure gauge.

If you use weight, stick four 1-g weights to the plasticine (assuming a maximum playing weight of 4g). Adjust the counterweight to balance with the rider close to the pivots. Remove one of the weights and move rider away from pivots to rebalance. Mark the arm. Repeat this procedure removing one weight at a time until all have been removed. Half-gram markings can be inserted by interpolation as the scale will be linear.

A third article will describe a wow and flutter meter and how to check turntable performance.

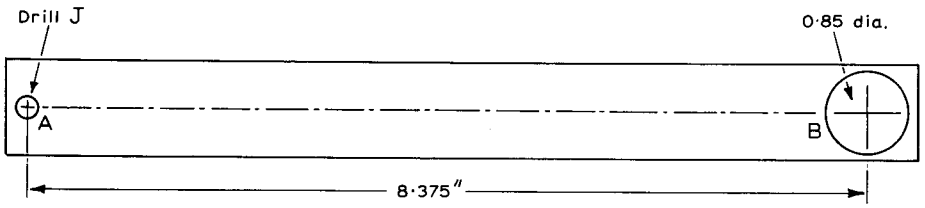


Fig. 2. When turntable and pickup arm are assembled place hole A over spindle and hole B over pickup arm pillar. Draw round the base to mark selected position.

Wide-stage stereo

Some readers of E. J. Jordan's article 'Loudspeaker Stereo Techniques' (*Wireless World* Feb. 1971) may like to know that the author has developed a practical design based on the 'reflector delay-line system', which can be adapted to suit individual requirements. Readers interested in having such a system built should write direct to E. J. Jordan, 22 Hyde Green, Marlow, Bucks.

Announcements

An equipment contract worth over £10M for Europe's largest international telephone exchange, has been awarded by the British Post Office to Plessey Telecommunications. The equipment is for part of the first unit at Mondial House — the new international telephone exchange under construction on a $2\frac{1}{2}$ acre site adjacent to Cannon Street Station, London. Apart from the massive switching complex, Plessey will design, develop and install International Accounting and Traffic Analysis Equipment. The heart of the I.A.T.A.E. is an on-line computer which will provide information on a call duration/route/destination basis for the clearing of international charges.

Blueline Electronic Components, a new distributor company at Refuge House, River Front, Enfield, Middx, (Tel. 01-366 6371), has been set up by ITT Components. It is completely independent of ITT Electronic Services and has been formed as a franchised distributor — 'not to sell ITT lines'. Blueline has six franchises: Texas Instruments; Bourns; Plessey capacitors; Union Carbide solid tantalum capacitors; International Rectifiers; and Keyswitch Relays.

The BBC has placed an order with Pye TVT for **'sound-in-sync' equipment** comprising 40 encoder and 61 decoder units. The system enables both sound and vision signals to be transmitted over a single land line in place of the current two-line system.

British Communications Corporation Ltd, of Wembley, have been awarded a contract by the Ministry of Defence covering the pre-production aspects leading to the supply of **v.h.f./f.m. manpacks** for the 'Clansman' military communication project.

Computer Automation Inc., of California, designers and manufacturers of minicomputers and associated equipment, have formed a **U.K. subsidiary company** called CAI Ltd, at 95a High Street, Rickmansworth, Herts.

Guest International Ltd, Nicholas House, Brigstock Road, Thornton Heath, Surrey CR4 7JA, have signed an agreement to market in the United Kingdom the **semiconductor and thin film** products manufactured by A. S. Akers Electronics, of Norway.

Granger Associates Ltd, of Weybridge, has been appointed exclusive sales representative for Jampro Antenna Company, of California, manufacturers of **broadcast aerials** for v.h.f. and u.h.f. applications and associated equipment.

The McMurdo Instrument Co., Rodney Road, Portsmouth PO4 8SG, in conjunction with Alliance Technique Industrielle, of France, are marketing a range of **miniature connectors** built to the French CCTU 0811 specification.

Data Devices Ltd, Abbey House, Farnborough Road, Farnborough, Hants, has been appointed exclusive U.K. agent for the range of data terminals, modems and input/output devices manufactured by **Terminal Equipment Corporation,** of New Jersey, U.S.A.

Euro Electronic Instruments, Shirley House, 27 Camden Road, London N.W.1, has been appointed sole agent in the U.K. for **Electro Optical Industries Inc.,** of Santa Barbara, California, makers of wave analysers, digital voltmeters, amplifiers and noise measuring equipment.