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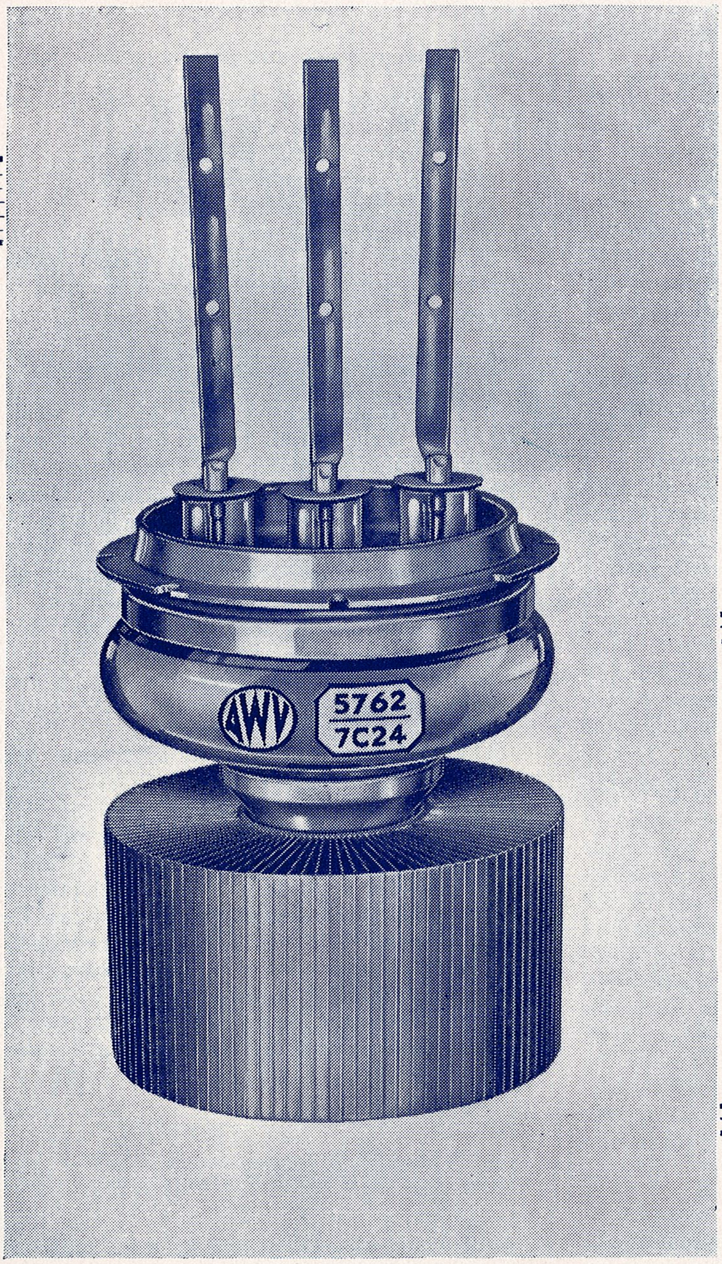
For internal construction & assembly details, see Jan. '57 issue, P.8.



THE NEW AWV 5762 NOW IN PRODUCTION AT THE VALVE COMPANY'S ASHFIELD WORKS

See Page 27. & also P.45 for complete data.

Diamond and Sapphire Stylus Wear

by F. Langford-Smith

We have frequently been asked to give some indication of the life to be expected from diamond and sapphire styli. The subject has been covered in the R.D.H. (Ref. 1) but, since the date of publication, additional information has become available.

The writer is strongly opposed to the use of the term "permanent" stylus, because this gives the public the idea that they never need be replaced — a very wrong impression with sapphire, and not really true even with diamond styli. Good service would be done to the whole industry if salesmen and servicemen do their best to educate the public to the importance of replacing styli before they get badly worn, for good fidelity and low record wear — that is in their own interests.

It is helpful to know some of the facts about the extremely arduous conditions of operation of a stylus tip and the adjacent record groove. It has been calculated that the pressure at the contact area between microgroove stylus and record groove with a vertical force of 7 grams is 26 tons per square inch (Ref. 6). Moreover, the stylus tip must travel well over one half mile of surface each time a 12 inch LP record is played. High temperatures are reached through friction at the point of contact.

The first effect of stylus wear is to produce "flats" on two opposite sides of the stylus. The amount of wear is not the same on both sides because of the sidethrust created by the method of mounting the tone arm.

The amount of stylus wear is affected by many factors, and for any one type of record (standard or microgroove) there are variations in the degree of wear caused by the characteristics of the pickup, the type and condition of the records, and by the stylus material. Some styli are synthetic sapphire and others natural sapphire — and they differ very much from one another in their wear-resisting capabilities. There are also large variations between diamonds from different sources. However, the wear in all cases can be minimized by correct operation of the pickup and turntable, correct vertical force at the stylus tip* and freedom from dust on the record. It is advisable to remove all dust etc. from the stylus tip after playing each LP record.

Certain factors in stylus installation were found by Weil (Ref. 2) to be specially important in minimizing wear. The stylus compliance must be great, and the arm must introduce no restraint on stylus movement across the disc. Also, the stylus must be straight up and down with respect to the groove; it must not lean to right or left, towards either wall of the groove.

Stylus wear with standard records

Operation with a typical lightweight pickup with 12 inch discs (Ref. 7):—

50 playings, wear just noticeable,
200 playings, 1 mil flats,
750 playings, 2 mil flats,
1500 playings, 2.5 mil flats.

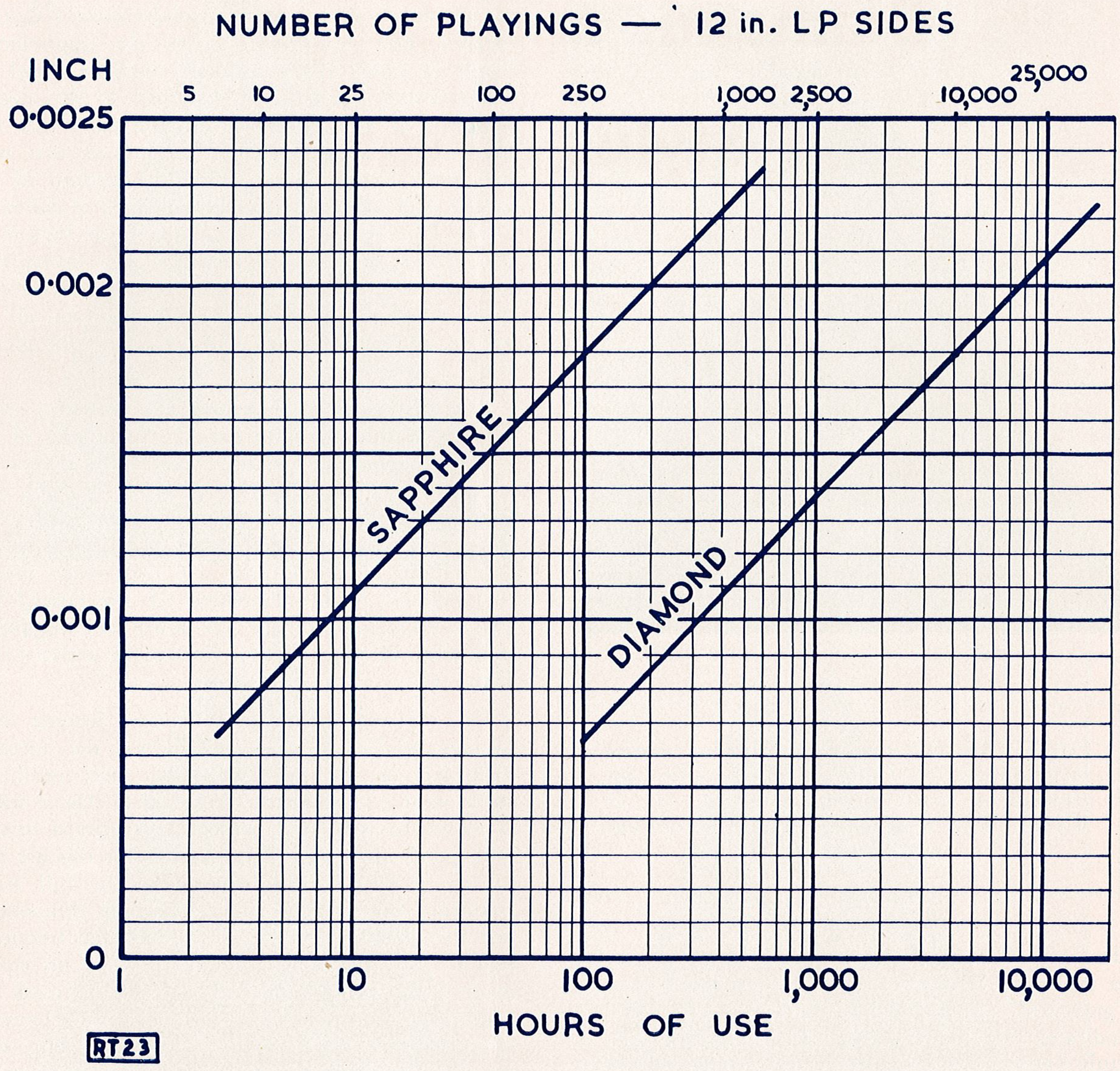
A modern high compliance pickup would undoubtedly produce less stylus wear than quoted above.

Stylus wear with microgroove records

A very comprehensive series of tests were made by H. D. Weiler (Ref. 5) and his results are shown in graphical form in Fig. 1. These were taken with three popular brands of pickup cartridges, each used an equal number of times, alternately on a Garrard record changer and a Thorens single record player. Stylus vertical force was 7 grams on all tests. The tests were repeated under three conditions for the records — all initially new, half new and half used, and all used — and the results agreed within a tolerance of $\pm$ 12%. These results can therefore be regarded as a typical average.

One deduction to be drawn from these results is that a diamond lasts about 40 times as long as a sapphire stylus. This must be compared with the ratio of about 10 times determined by M. Weil (Ref. 2). In practice, on account of the many variables, we can expect to find the ratio of life between diamond and sapphire anywhere between 10 times and 40 times, or even more, and a ratio of about 20 times seems to be a reasonable figure to work with. This is in agreement with the statement made by the General Electric Company for the GE variable reluctance pickup, that the ratio is at least 20 to 1.

* The G.E.C. Tension Gauge, sold in Australia by British General Electric Company, is very suitable for measuring the vertical force at the stylus tip. This is available in several ranges, of which 4-24 grams will be most suitable for all light-weight pickups.



(*Fig. 1. Average wear of sapphire and diamond styli showing flats in inches versus hours of use (alternatively number of playings of 12 inch LP sides). Based on H. D. Weiler, Ref. 5. RT23.*

Some most illuminating microphotographs of microgroove sapphire styli are reproduced by special permission from H. D. Weiler (Ref. 5) in Figs. 2 and 3. Fig. 2 shows a perfect, unused 0.001 inch sapphire stylus tip. Fig. 3 shows four degrees of wear — (a) with 0.00075 inch flat after 3½ hours; (b) with 0.001 inch flat after 7½ hours; (c) with 0.00125 inch flat after 17 hours; (d) with 0.0015 inch flat after 38 hours. These have been reproduced to be a guide to all our readers in interpreting their own stylus wear. Some remarks on how to test for stylus wear are given later in this article.

How long should a stylus last?

Two effects are caused by the flats worn on the sides of the stylus tip — increased distortion and increased record wear. Normally, the acceptable limit to the stylus wear is the maximum tolerable distortion. The tolerable distortion is determined by two factors — the maximum frequency range of the equipment, and the critical sense of the listener. With a critical listener and a frequency range up to 10,000 c/s or beyond, the stylus life will be distinctly less than that with the same listener and a frequency range limited to, say, 5,000 c/s. Pickups with good transient response show up distortion earlier than others — this is part of the price to pay for good reproduction.

With a non-critical listener and a limited frequency range, the life will be much longer than with a critical listener. In fact, in the former case there is a risk of the stylus wear being so serious that

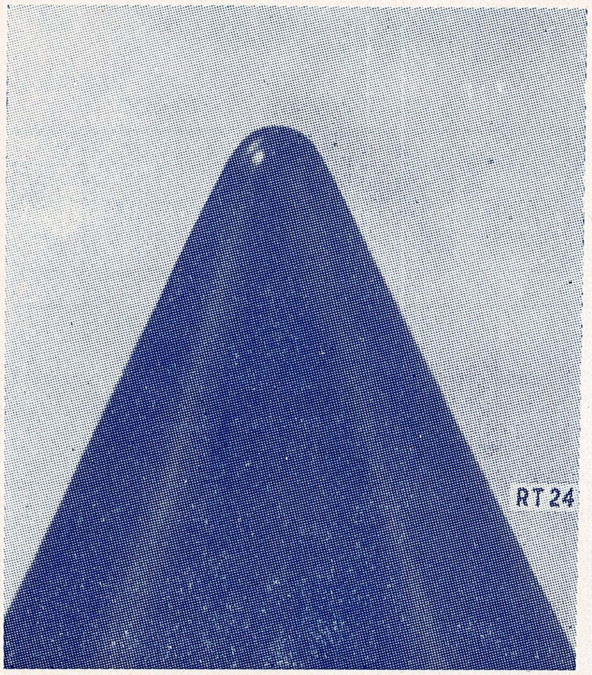


Fig. 2. Microphotograph of a new, unused microgroove 0.001 in. sapphire stylus tip. Reproduced with permission from H. D. Weiler, "The wear and care of records and styli," Ref. 5. RT24.

damage will be done to the record before the stylus is replaced. Weiler (Ref. 5) investigated a stylus "graveyard" and found that the average size of flats indicated 500 hours average wear for sapphire. A truly stupendous figure when compared with Table 1

There is no doubt that when a stylus becomes badly worn, it has a very damaging effect on records. On the other hand, record wear under proper conditions is very slight. Tests have shown that there was no detectable difference between a new record and an identical LP pressing which had been played 250 times under properly controlled conditions, using a really first-class quality pickup with the stylus changed as soon as the distortion became perceptible. We thus are left with two criteria for determining the length of stylus life — distortion and record wear. The writer has collected data from many sources, American English, European and Australian, in search for true criteria for stylus length of life. These have been carefully considered, duly "weighted" in the light of all relevant circumstances, and summarized in the form of tables. Those who are sufficiently interested will find the relevant information in the Appendix.

Under the heading "Distortion reaches the limit of tolerance" there are two subdivisions: "Critical listener, best equipment" gives the approximate length of stylus life under these conditions, and the stylus would normally be discarded at this degree of wear. It will be seen from the table that this life point is approximately the same as that with the stylus beginning to scrape the bottom of the groove, and the stylus tip showing signs of flattening — see Fig. 3 (c). This scraping of the bottom of the groove is most undesirable. The stylus digs into the accumulation of dust, grit and stylus particles which always collect at the bottom of the groove, and uses them as abrasive against the groove walls.

There are thus two serious effects which occur as soon as the stylus tip scrapes the bottom of the groove — appreciable record wear and a greatly increased noise level. In fact, a critical listener with good records and good equipment can easily hear the increased noise level when the stylus scrapes the bottom of the groove. He may make use of the slightest visible flattening of the tip of the stylus, using an ordinary low-power microscope, as indication of the time to replace the stylus — e.g. Fig. 3 (c).

On the other hand the average listener with average equipment does not notice the inceased distortion or the increased noise level until the stylus wear is considerably greater than that at which it would have been discarded by a critical listener with good equipment. The reasons for this are that his equipment does not reproduce the full audio frequency range, hence the distortion components and the noise — both largely in the high frequency region — are not fully reproduced, while his equipment is producing sufficient distortion to mask the additional distortion from stylus wear. Hence it often happens that a stylus is retained long after the point at which it has been doing serious damage to the record.

We now come to the heading "Danger from serious record wear." It was found necessary here to insert three subdivisions to cover all types of users, and the reasons for this elaboration may not be immediately apparent. A badly worn record which has had some of the sharp corners chiselled off by a worn stylus may still sound fairly right on average equipment, but when tested in high fidelity equipment its defects are enormously magnified, and its high noise level shown up. Hence the three subdivisions, and the undesirability of lending records to be played by someone in one of the lower group.

Sapphire microgroove Stylus

The anticipated length of life of a sapphire microgroove stylus, expressed in 12 inch LP sides and hours of playing may be summarized as in Table 1:

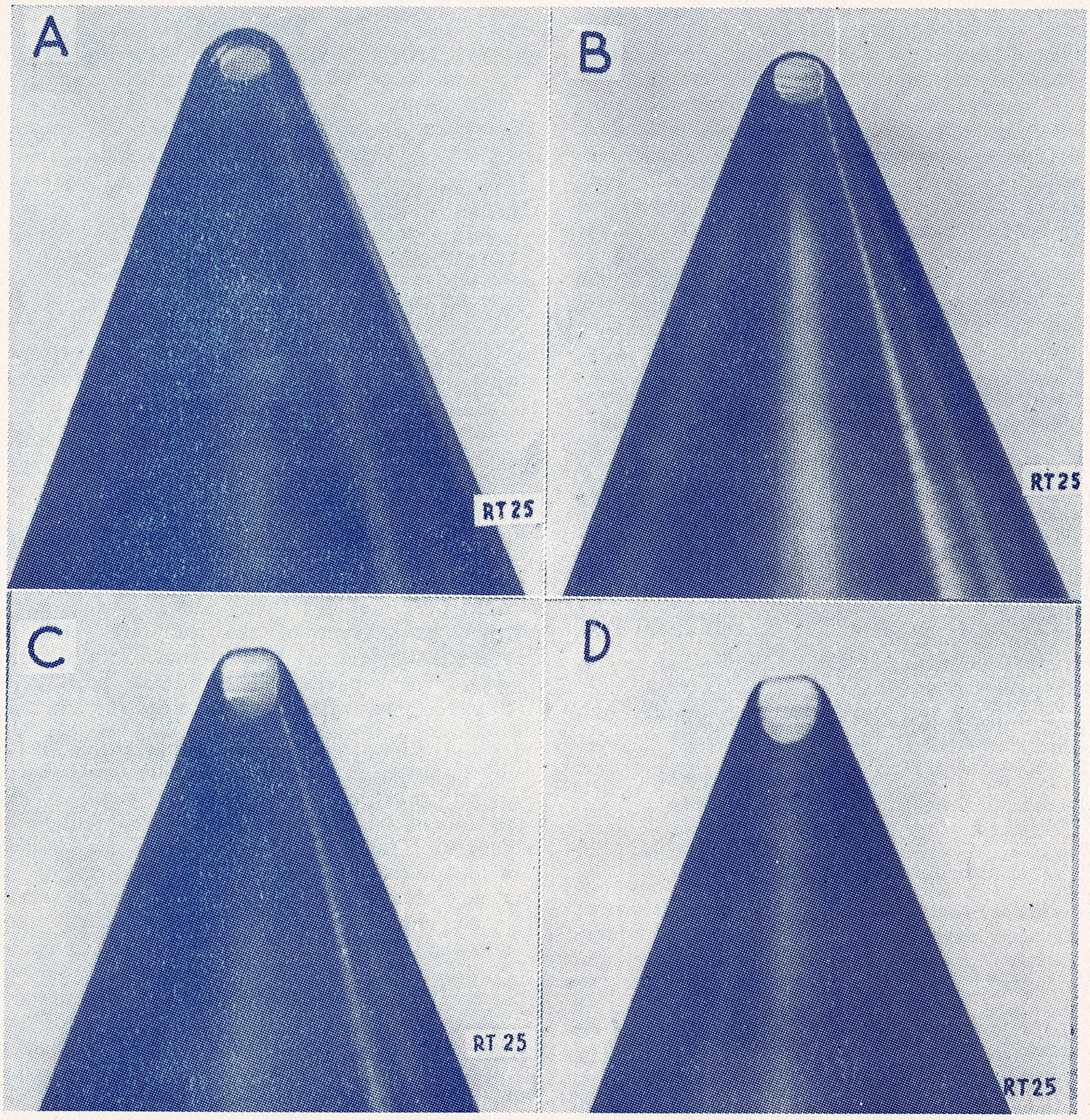


Fig. 3. Microphotographs of a worn microgroove sapphire stylus tip. (a) with 0.00075 in. flat after $3\frac{1}{2}$ hours; (b) with 0.001 in. flat after $7\frac{1}{2}$ hours; (c) with 0.00125 in. flat after 17 hours; (d) with 0.0015 in. flat after 38 hours. Reproduced with permission from H. D. Weiler, "The wear and care of records and styli," Ref. 5. RT25.

TABLE 1
MICROGROOVE: SAPPHIRE STYLUS

	Sides *	Hrs.	Authorities †
Distortion discernible on a high fidelity system with a critical listener	20	8	A
Distortion reaches the limit of tolerance:			
Critical listener, best equipment	50	20	B
Average listener, average equipment ..	100-125	40-50	C
Stylus scrapes bottom of groove	43	17	D
Danger from serious record wear:			
Critical listener, Best Equipment	100-125	40-50	E
Average listener, average equipment	125-200	50-80	F
Non-critical listener	200-300	80-120	G

* 12 inch LP. † See Appendix.

Sapphire Standard Stylus

Information on sapphire stylus life with standard 78 r.p.m. records is rather meagre, and the results given in Table 2 are therefore to be regarded with caution. One of the objects of the investigation was to determine the ratio of stylus wear between standard and microgroove. The General Electric Company gives a ratio of approximately 2.1 times between standard and microgroove, based on average listener, average equipment (Ref. 13). On the other hand Marcus (Ref. 3) gives a ratio of about 3 to 1. Thus we have the established fact that the life of a stylus on standard 78 r.p.m. records is two or three times that on microgroove, on a time basis. This does not seem to be fully appreciated by many past users of standard records who seem to expect their styli to last as long on microgroove as on standard records.

Table 2 is based on 12 inch sides, allowing approximately 12 records per hour:

TABLE 2
STANDARD: SAPPHIRE STYLUS

	Sides *	Hrs.	Authorities †
Distortion discernible on a high fidelity system with a critical listener	250	21	H
Distortion reaches the limit of tolerance:			
Critical listener, best equipment	500	42	I
Average listener, average equipment ..	1000	83	J
Danger from serious record wear:			
Critical listener, best equipment	1000-1250	83-106	K
Average listener, average equipment ..	1250-2000	106-166	
Non-critical listener	2000-3000	166-264	

* 12 inch LP. † See Appendix.

Diamond Microgroove Stylus

Information on diamond stylus wear is rather limited, and Table 3 may be taken as fairly typical.

TABLE 3
MICROGROOVE: DIAMOND STYLUS

	Sides *	Hrs.	Authorities †
Distortion discernible on a high fidelity system with a critical listener	400	160	L
Distortion reaches the limit of tolerance:			
Critical listener, best equipment	1000	400	L
Average listener, average equipment ..	2000-2500	800-1000	L
Danger from serious record wear:			
Critical listener, best equipment	2000-2500	800-1000	L
Average listener, average equipment ..	2500-4000	1000-1600	L
Non-critical listener	4000-6000	1600-2400	L

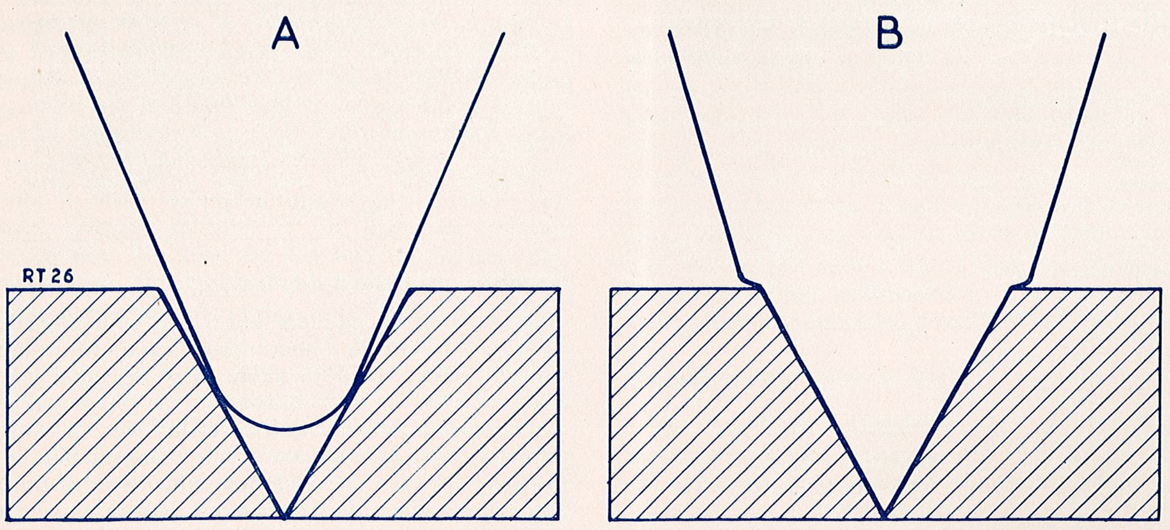
* 12 inch LP. † See Appendix.

How to test for stylus wear

The figures quoted above are all based on the anticipated life of a stylus, and they cover a wide range on account of the many variables. The question then arises, how to measure a stylus for wear. The remarks following have been written from the point of view of a home-user.

1. A listener who is known to be critical in judging distortion can usually determine the end of life by a listening test. If the pickup is one in which the stylus can be removed and replaced without any danger of rotation, the same record can be played with a worn stylus and immediately afterwards with a new stylus, listening for "fuzziness" to develop in the reproduction of heavily modulated grooves near the centre of the record. Many recordings have distortion which will be reproduced by either a new or old stylus, and only a record known to have low distortion should be used in tests for stylus wear. If a new stylus gives increased high frequency output, reduced surface noise or reduced high frequency distortion, it should be left in place.

Fig. 4. (a) How a perfect stylus fits into the record groove; (b) with the sides of a stylus worn so that the tip touches the bottom of the groove. RT26.



2. Some manufacturers (e.g. M.B.H.) and some agents (e.g. Amplion Australasia Pty. Ltd.) examine styli and advise when they should be replaced. In making use of such a service it is important to state whether the purchaser is considering the length of life before damaging the record, or the life before the distortion becomes noticeable — in the latter case he should also state whether his equipment is high-fidelity or normal.

3. One manufacturer in U.S.A. (Andak) produces a "Stylus-Disk" which may be used to determine when to change the stylus to avoid damage to the record, but it does not seem to be available in Australia. A badly worn stylus is said to leave a grey trace, but it does not appear to indicate when a stylus in a high-fidelity system begins to distort.

4. The flats may be observed with the use of a low-power microscope having a magnification of 40 or 50 times. Styli with cylindrical shanks may be mounted in a jig at an angle of about 45°, and they may then be rotated for observation. The point under observation must be illuminated from a light source by means of a focussing lens or a concave mirror (glass or metallic). The most serious fault is a chip which has flaked away, leaving a sharp cutting edge. The development of slight flats does not appear to have any appreciable effect on record wear, provided that the stylus is never removed from the pickup, or that it is fitted with some device to ensure it being put back in the original position. The flats on microgroove styli may be compared with illustrations in this article. For high fidelity use, the flattening at the end of the stylus, as in Fig. 3 (c) may be used as an indication when to remove the stylus.

5. The shadowgraph is also used.

6. Scrape the stylus across the finger nail — it should move smoothly without leaving a scratch and without taking a shaving. The stylus needs to be placed in the position or positions where the greatest "chisel-action" occurs. This test is more easily made on standard styli (78 r.p.m.) than on microgroove.

Diamond versus sapphire

The following remarks apply only to first-class diamond styli. The diamond can stand five times more pressure on a radius than can sapphire (Ref. 15). The diamond has only about half the bearing friction of sapphire (Ref. 16). A diamond stylus has a smoother finish than a sapphire. A diamond stylus is always considerably cheaper to buy than a sapphire, on the basis of cost per hour of playing time.

Tolerances in radii of styli

There are rather wide tolerances in the tip radii of all styli. These tolerances complicate the length of life of the styli and result in generally poorer performance.

Maintenance cost of styli

When proposing to purchase a pickup it would be wise for the intending purchaser to consider two factors which influence maintenance cost. A good pickup with very high compliance would be expected to have less stylus wear than a cheaper pickup, and hence the styli would last longer before requiring replacement. Secondly, the stylus replacement cost may vary from about 12/6 to £3.10.0 (the latter includes both standard and microgroove styli complete with armature, but replacement of both is necessary as soon as one is worn). The higher cost of replacements for styli in high fidelity pickups may, of course, be considered as part of the price to be paid for the improved performance.

In some cases a manufacturer will regrind a sapphire stylus.

Comments welcome

Our readers are invited to submit any relevant information on this subject, which will be published in a future issue.

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Appendix

1. Microgroove, sapphire stylus

A. Distortion just becomes discernible, critical listener, high fidelity.

Burke (Ref. 8) tested eight sapphire points for LP "Average duration before audible wear 523 minutes; longest duration 910 minutes; shortest duration 240 minutes." His average was about nine hours.

Fidelman (Ref. 9) quotes 10 to 30 hours for "more critical listener, wide range" for replacing the stylus.

Harris (Ref. 4) states "using good equipment, distortion became just discernible after playing . . . 20 12 inch LP sides." This is equivalent to 8 hours.

Weiler claims distortion audible after 7½ hours (Ref. 5 pp. 36-37).

Hence the figure of eight hours given in the table is in close agreement with these four authorities.

B. Distortion reaches limit of tolerance, critical listener, best equipment.

Harris (Ref. 12) recommends the replacement of the stylus after 16 to 20 hours, with 24 as the limit.

Fidelman (Ref. 9) quotes 10 to 30 hours for "more critical listener, wide range."

Weil (Ref. 2) gives the actual replacement times for a substantial group of music lovers as 18 hours. See Appendix **M** for details.

Hence the figure of 20 hours given in the table is in close agreement with these authorities.

C. Distortion reaches limit of tolerance, average listener, average equipment.

The General Electric Company, U.S.A., quotes 40 hours as the life for a sapphire stylus, average listener, average equipment (Ref. 13).

Weil (Ref. 2) gives the actual replacement times for three groups of music lovers as 18, 32 and 49 hours. See Appendix **M** for details.

Fidelman (Ref. 9) quotes 40 to 120 hours for average equipment, average listener. The higher figure quoted is the extreme limit for record wear, and is therefore not applicable to the point at issue.

Columbia, in their small booklet (Ref. 11), show a photograph of a stylus after 50 hours of play and state that it is "worn out."

A.W.A. replace styli in all broadcast stations after 40 hours.

Goldring "Needle stylus reference chart" states that a good quality sapphire stylus "should survive . . . at least one hundred playings for LP records before wear causes damage to records and inferior reproduction." This is equivalent to 40 hours.

Thus the figure of 40 to 50 hours given in the table is in close agreement with these authorities.

D. Stylus scrapes bottom of groove.

Weiler states that the stylus scrapes the bottom of the groove, and a clearly visible flat has developed after 17 hours (Ref. 5). His photograph is reproduced in Fig. 3(c).

Danger from serious record wear

Information based on specific tests is very scarce.

E. Critical listener, best equipment.

Weiler (Ref. 5) states that a considerable amount of record wear occurs at 38 hours.

The General Electric Company quotes 40 hours as the life for a sapphire stylus, average listener, average equipment, but do not state specifically that record wear is serious beyond this point.

There is no clear-cut evidence, based on tests, that serious record wear begins at 40 or 50 hours. However, since record wear begins gradually, and there is no point in life at which the record wear suddenly starts from zero, it seems advisable for those who wish to protect their records from damage to limit stylus life to 40 or 50 hours.

F. Average listener, average equipment.

Columbia (Ref. 11) give 50 hours for "worn out" and substantiate this by a photograph.

Jensen quote 60 hours as the final limit for record wear.

G. Non-critical listener.

Acos quote 120 hours as the limit for preventing record wear with the GP20 pickup. Since this pickup is known to be light in record wear, the figure may be taken as the extreme limit.

Fidelman (Ref. 9) quotes 40 to 120 hours for average equipment, average listener. It is inferred that 120 hours is the extreme limit for record wear.

The writer is not aware of any published figure higher than 120 hours as the limit beyond which record wear becomes really serious.

2. Standard records, sapphire stylus

H. Distortion becomes just discernible.

The General Electric Company states "a critical listener using wide-range equipment will notice distortion due to stylus wear when as few as 250 12 inch (78 r.p.m.) sides have been played" (Ref. 13).

Harris (Ref. 4) states that distortion became just discernible after playing 400 12 inch 78 sides.

The discrepancy between the two figures is not very serious, and 250 sides has been used in Table 2.

Distortion reaches limit of tolerance

I. Critical listener, best equipment

No direct information was available. The figure in Table 2 was taken as the geometric mean between **H** and **J**.

J. Average listener, average equipment

The General Electric Company states that "an average listener with average equipment should be able to play approximately 1,000 12 inch (78 r.p.m.) sides . . . before the stylus will need replacement."

The Acos GP20 pickup is stated to give "reasonably good" reproduction at 800 sides. This does not conflict with the G.E. figure, which was adopted in Table 2.

K. Danger from serious record wear

Very little information is available. Ronette state that "we could not notice — as a rule — any harmful wear after playing about 2,000 sides of standard new 78 r.p.m. records. This with needle pressures in the vicinity of 5 grams" (Ref. 14). Acos state that the GP20 response is 5 db down on a test record at 10,000 c/s after playing 2,000 12 inch 78 r.p.m. sides.

The figures in Table 2 were obtained from those in Table 1 multiplied by a factor of about 2.1. All these values are rather uncertain.

3. Microgroove, diamond stylus

L. All items in Table 3 are derived from equivalent values in Table 1 multiplied by 20. This is, in general, substantiated by the following data:

Columbia (Ref. 11) — No visible wear at 478 hours.

Burke (Ref. 8) — No audible wear and only slight visible wear at minimum 400 and maximum 700 hours, out of 4 styli.

Marcus (Ref. 6) — very slight visible wear at 2,000 sides (800 hours).

Ratio diamond to sapphire:

Weiler (Ref. 5) — over 40.
G.E. (Ref. 13) — not less than 20.
Weil (Ref. 2) — about 10.

The results by Weil (Ref. 2), see Appendix **M**, fall far short of these figures, and cannot be reconciled unless the quality of the diamonds was very inferior.

M. Test by M. Weil

Weil (Ref. 2) gives details of a series of test figures compiled by the Audak Company, assisted by 108 co-operative home-music enthusiasts. Three makes of cartridge were represented; diamond and sapphire styli were used in each. The test comprised two years of normal home use. The results seemed to fall into three groups — low, medium and high — and hence have been tabulated this way:

Jewel (1 mil)	Low (hours)	Medium (hours)	High (hours)	Average (hours)
Diamond	190	294	382	288
Sapphire	18	31	49	32

Unfortunately no indication was given of the type of equipment wide-range or otherwise or the type of pickup. The results can be interpreted as the length of life of styli at the time when they were removed, that is to say when the distortion became objectionable to a music lover.

Loudspeaker Divider Networks

Revision noted

Since the article on this subject appeared in our July 1954 issue, we have received a letter from Mr. A. Meyer of The Baldwin Piano Company, Cincinnati, Ohio, whose original curves were redrawn Figs. 1, 2 and 3 of our article. The letter is reproduced here in full as an aid to designers.

Our article (page 77, col. 1) stated that the curves determining the number of turns are based on perfect layer winding and that as this cannot be obtained in practice, the indicated number of turns may be increased by a factor of, say 10%; the inductance should be checked on a bridge and any surplus turns removed. Mr. Meyer points out that this is incorrect, since his curves were based on random winding. The curves of Fig. 2 may therefore be treated as accurate for random winding. This was checked in our laboratory by winding two coils, 1 and 10 millihenrys respectively, and the maximum error was under 1.6% of the number of turns. It should be borne in mind that some variations are inevitable with random winding since the method of winding — hand or machine, and care in winding — affect the space factor. We add below Mr. Meyer's letter a table giving the turns possible per square inch of cross section, and the space factors assumed. This information was used in compiling Fig. 2.

In the final paragraph of his letter, he gives some useful information on the allowable d.c. resistance of the coil for specified insertion loss.

"Dear Sir,

The article on (Loudspeaker Divider Networks) in the July issue of Radiotronics is quite complete, and for this the authors are to be complimented, but I feel I must point out an error in the description of the curves. In my paper in the Transactions of the I.R.E. P.G.A., for φ (number of turns possible per square inch of cross section) I used the figures given by F. E. Terman in his Radio Engineers' Handbook (p. 103) for random wound coils, and so Fig. 2 is not based on perfect layer winding. Thus no allowance need be made on this score.

"The simplified inductance formula of Wheeler

$$L = \frac{2 \times 10^{-7} a^2 n^2}{3a + 9b + 10c} \text{ (in., turns, hys)}$$

(Proc. I.R.E. v16 N10 P1398 Oct. 1928) which I used is said to be accurate to ± 1% when the terms of the denominator are equal, and since this was the necessary condition in the maximization process, this accuracy should apply, so that an allowance (increase) of 1% in the indicated (or calculated) number of turns should be quite sufficient. For the coils which I have wound so far I have found this to be the case.

"One minor point concerns the Q figure which was simply calculated for 1000 cps. but, on the basis of DC resistance only, we realize in practice that this idealization does not apply so that these Q's are quite approximate. It is certainly true, however, that coils wound in this fashion will have minimum DC resistance.

"As an alternative method of using the curves, one can start from the allowable DC resistance of the coil, such R/10 for approx. 1 db insertion loss in the low pass section, or R/20 for about 0.5 db insertion loss. Thus in your first example, one might allow 1 ohm DC resistance in the 1.1 mh inductor, and Fig. 3 can be extrapolated with the result that # 21 would result in about 0.9Ω resistance. Or for 0.5 db insertion loss, # 18 results in 0.5Ω resistance.

Yours truly,

ALBERT MEYER,

Research Engineer."

A.W.G.	Turns Possible per sq. in. of cross section	Space factor
10	85	0.9
11	106	0.9
12	131	0.9
13	160	0.9
14	209	0.9
15	251	0.9
16	319	0.9
17	399	0.9
18	519	0.9
19	631	0.9
20	794	0.9
21	987	0.9
22	1255	0.9
23	1525	0.75
24	1933	0.75

T.V. SPURS QUALITY UPGRADING OF RECEIVER TUBES

(EXTRACT FROM R.C.A. SERVICE NEWS)

The development of television, which brought forth the most complex and critical electronic equipment ever designed for home use, was recently credited with stimulating important post-war advances in the design and production of radio receiving tubes.

As a result of television's impact on the tube manufacturing industry, receiving tubes produced to-day for use in home television and radio sets in some cases surpass in performance, efficiency and versatility some of those especially designed at the close of World War II for non-entertainment applications, according to L. S. Thees, General Sales Manager of R.C.A. Tube Department.

Preparations for the commercial introduction of television showed that few existing electron tube types, designed originally for home radio applications, were fully capable of meeting the more exacting demands of television, Mr. Thees explained.

Establishment of public confidence that television was ready for the jump from laboratory to living room depended almost entirely upon the assurance of faultless performance of receivers in the home, Mr. Trees declared. As a result, the tube industry was faced suddenly with the problem of rapidly refining existing radio receiving tube types, as well as developing new ones having unprecedented performance, quality and reliability.

The upgrading of R.C.A. radio receiving tubes for more demanding television and non-entertainment applications developed into a major and continuing activity immediately following the war. The quality level was rapidly raised by application of important post-war advances in design and production techniques, and by the institution of a co-ordinated production programme involving tighter control over more critical specifications, use of more modern production equipment, and use of improved and newly developed raw materials.

Since the war R.C.A. Tube Department alone has invested millions of dollars in modern test equipment to make sure that more exacting tube specifications are met every step of the way along the production line.

Some of the advances in tube design are . . . the gold-plated grids used in certain tubes intended for applications requiring tight control of critical tube characteristics; lead-glass envelopes, which replace conventional lime-glass envelopes in a number of high-voltage tube types to provide better life performance; cathode clips and inverted-pinched cathodes, employed in certain tube types for greater resistance to vibration and to minimize microphonics; and double helical coil heaters, which provide tube types having greater freedom from hum and better overall performance for certain applications.

These introductory notes are repeated on P.45.

ON THE COVER:

RADIOTRON 5762 / 7C24 TRIODE - FORCED AIR COOLED

Radiotron 5762/7C24 is a forced-air cooled power triode designed for TV, FM, AM and industrial services. It has a maximum plate dissipation of 3 kilowatts and is rated for operation up to 220 megacycles per second.

The flanged-header grid terminal is a design feature of particular value when the 5762 is used in cathode-drive (also called grounded-grid) circuits. In such circuits this terminal, when used with a large circular connector, effectively isolates the filament circuit from the plate circuit, and provides a direct low-inductance path to the grid. As a result, neutralization is generally unnecessary in cathode-drive service.

The design of the 5762 includes three multiple-ribbon filament leads, one of which is a centre tap to facilitate the reduction of filament-lead inductance in high-frequency circuits. Within the tube the leads to the thoriated-tungsten filament are short and direct. An efficient external radiator provides for plate cooling by means of forced air. The conical grid support is structurally strong, serves to cool the grid, and effectively reduces grid-lead inductance. These various design features all contribute to the excellent performance of the 5762 in very high-frequency applications.

The 5762 can deliver a synchronizing-level power output of 4 kilowatts in broad-band television service at 220 Mc; a carrier power output of 3.7 kilowatts in plate-modulated telephony service using conventional grid-drive circuits at frequencies up to 30 Mc; and a power output of 7 kilowatts in class C telegraphy service using cathode-drive circuits at frequencies up to 30 Mc, or 5.5 kilowatts at 110 Mc.

The 5762/7C24 supersedes the 7C24.

For full application data, see P.45.

New RCA Releases

MULTIPLIER PHOTOTUBE RCA - 6372

Multiplier Phototube RCA-6372. The 6372 is a multiplier phototube of the 10-stage type especially suitable for scintillating-counting applications involving low-level, large-area light sources. It utilizes a semicylindrically shaped, semitransparent photocathode having an area of $12\frac{3}{8}$ square inches on the bulb wall. Because of this large area, the 6372 is extremely useful in certain scintillation-counting applications such as the detection of alpha particles with a phosphor.

The spectral response of the 6372 covers the range from about 3000 to 6200 angstroms, maximum response occurring at approximately 4000 angstroms.

IMAGE ORTHICON FOR COLOR CAMERAS

Image Orthicon for Colour Cameras. RCA-6474/1854 is designed for use in colour cameras utilizing the method of simultaneous pickup of the studio or outdoor scene to be televised.

The 6474 has exceptional sensitivity combined with a spectral response approaching that of the eye, and good resolution capability. With a colour camera employing a suitably designed optical system and utilizing efficient colour filters, commercially acceptable colour pictures can be obtained with about 350 foot-candles of incident incandescent illumination on the scene and a lens stop of f: 5.6.

The photocathode utilized in the 6474 is characterized by a relatively wide spectral response having high blue sensitivity, high green sensitivity, good red sensitivity, and practically no infra-red sensitivity. This spectral characteristic enables the tube to translate colours very accurately when operated in a colour camera having appropriate colour filters and optical arrangements.

Featuring a signal-to-noise ratio and contrast range commensurate with the requirements of colour reproduction, the 6474 is capable of producing a picture having accurate detail and natural tone value.

MAGNETRON RCA - 4J50

Magnetron RCA-4J50. The 4J50 is a 3-centimeter "package" magnetron of the internal-resonant type in which the permanent magnet is integral with the tube.

Intended for service as a pulsed oscillator at a fixed frequency of 9375 ± 30 megacycles per second in applications such as radar, the 4J50 operates with high efficiency at pulse durations up to 6 microseconds. It has a maximum peak input power rating of 635 kilowatts. When operated at a peak anode current of 27.5 amperes, corresponding to a peak anode voltage in the order of 23,000 volts, the 4J50 is capable of giving a peak power output of approximately 240 kilowatts.

The design of the 4J50 incorporates an axial cathode mount which has excellent structural rigidity and conserves space, and an output wave-guide flange which can be coupled to a standard JAN RG-51/U wave-guide by means of a modified JAN UG-52/U choke flange.

The input and output structures are designed to prevent electrical breakdown at atmospheric pressures of 600 mm of mercury or greater. However, the output wave-guide flange and the mounting flange are made so that the 4J50 can be used in applications requiring a pressure seal.

RCA-6SN7-GTA TWIN TRIODE

RCA-6SN7-GTA Twin Triode. The 6SN7-GTA is a medium-mu twin triode of the glass octal type. It is designed for use as combined vertical oscillator and vertical deflection amplifier, and as horizontal deflection oscillator in television receivers. It is also suitable for use as a phase inverter, multivibrator, or resistance-coupled amplifier in radio equipment.

RCA - 6DC6

RCA-6DC6 is a semiremote cutoff pentode of the 7-pin miniature type designed for use particularly in the gain-controlled picture I.F. stages of colour television receivers. It is also useful as an R.F. amplifier in the tuners of v.h.f. television receivers. The semiremote-cutoff characteristic of the 6DC6 minimizes cross-modulation effects in the picture I.F. stages. Also featured in the 6DC6 is a high value of transconductance which contributes to high gain per stage.

RCA - 12BY7

RCA-12BY7 is a pentode of the 9-pin miniature type used as a video amplifier in television receivers utilizing series-heater strings.

EXPANDED SUPPLEMENT TO "RADIOTRON DESIGNERS' HANDBOOK"

An expanded supplement giving corrections to the latest Australian Impression and additional references for the whole handbook bringing these up to date, as at June, 1954, is now available from stock. A total of 28 pages with blue Rexine cover is being made available as a service to our readers at the nominal price of 1/- plus 3d. postage in Australia.

Editor .. .. D. Cunliffe-Jones

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