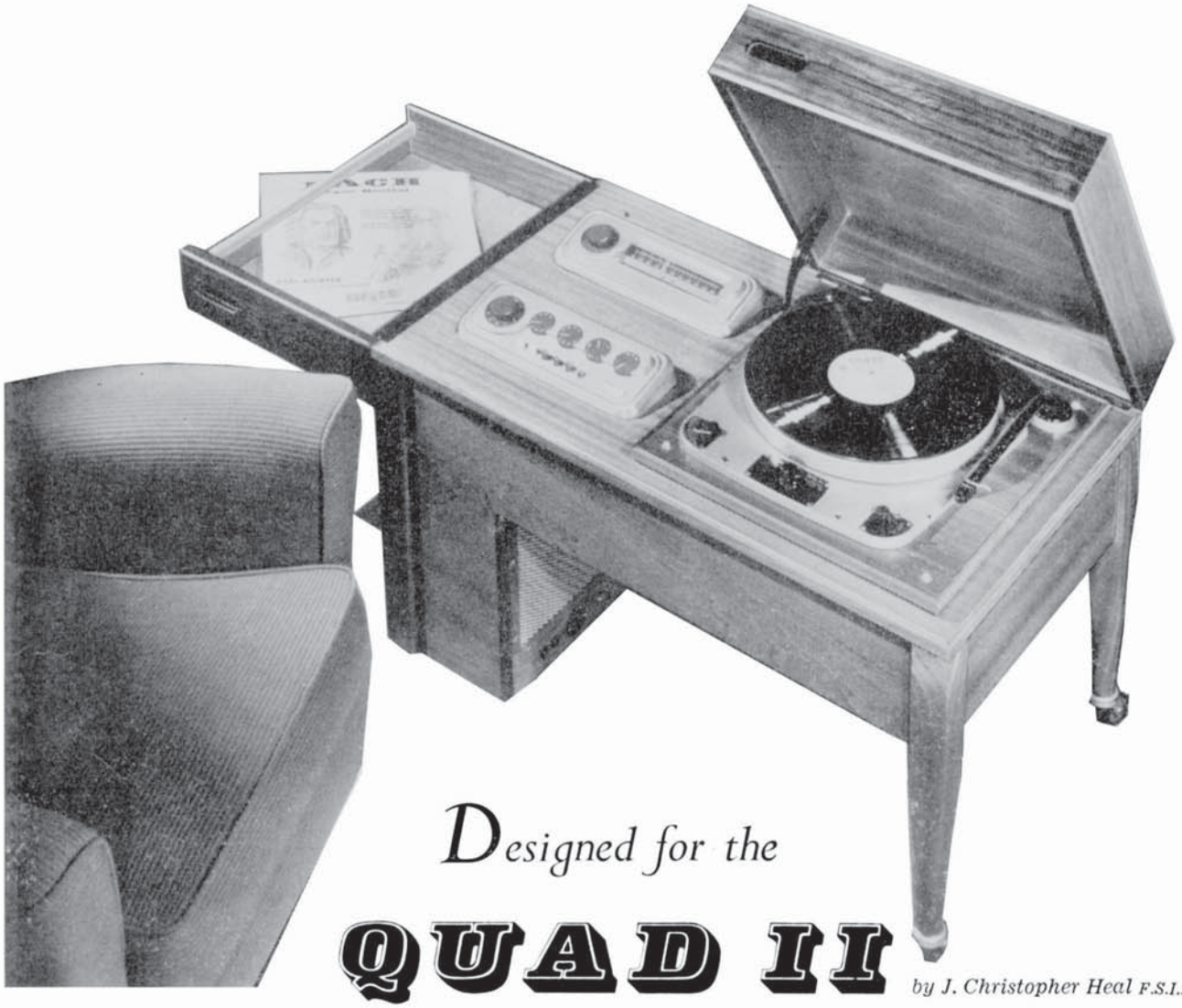
INCORPORATING TAPE RECORDERS

Hi-Fi News

AUGUST 1956 Vol. 1 No. 3 Price 1/6

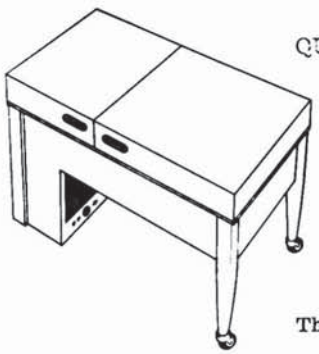
★ DETAILS & MAP OF EXTENDED FM PLAN—Page 100 ★



Designed for the

QUAD II

by J. Christopher Heal F.S.I.A.



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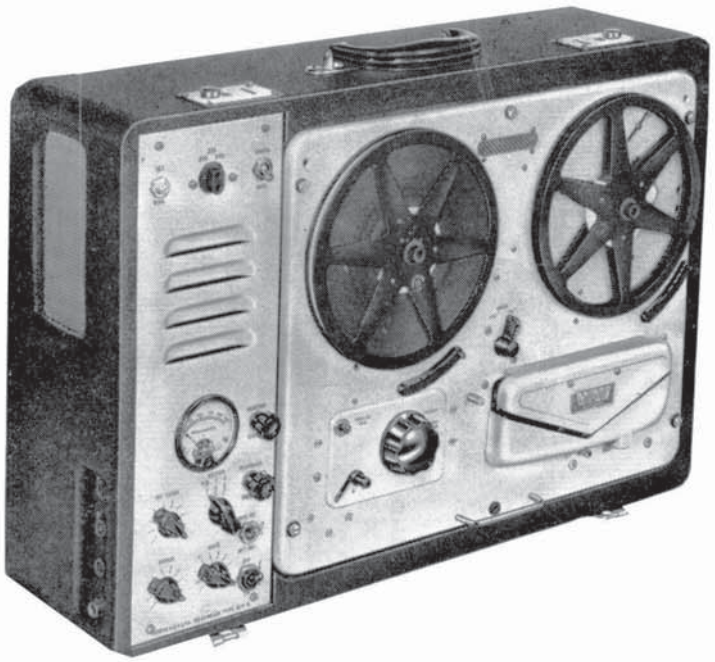

MONITOR HEAD MODEL

★ This is mainly made for the Wearite type B2 deck and has the following additional features.

★ The recording may be monitored by means of the additional head and head amplifier and its volume level and quality compared to the pre-recorded signal by throwing a switch. It is also possible to add a signal such as a commentary to already recorded tape.

★ Switching facilities provide for feeding back the monitored signal and re-recording to provide an echo the time constant of which is controlled by the speed of the tape and the distance apart of the monitor and record heads.

★ The tone of the echo can be varied as required.

★ A continuous loop unit is also available, handling between 2 and 600 ft. of tape for repeating announcements, etc.

★ The total hum and noise at 7½ in. per second, 50-12,000 c.p.s. unweighted is better than 50 dbs.

★ The meter fitted for reading signal level will also read bias voltage to enable a level response to be obtained under all circumstances. A control is provided for bias adjustment to compensate low mains or ageing valves.

★ A lower bias lifts the treble response and increases distortion. A high bias attenuates the treble and reduces distortion. The normal setting is inscribed for each instrument.

★ The distortion of the recording amplifier under recording conditions is too low to be accurately measured and is negligible.

★ A heavy mu-metal shielded microphone transformer is built in for 15-30 ohms balanced and screened line, and requires only 7 micro-volts approximately to fully load. This is equivalent to 20 ft. from a ribbon microphone and the cable may be extended 440 yds. without appreciable loss.

★ The 0.5 megohm input is fully loaded by 18 millivolts and is suitable for crystal P.U.'s, microphone or radio inputs.

★ A power plug is provided for a radio feeder unit, etc. Variable bass and treble controls are fitted for control of the playback signal.

★ The power output is 3.5 watts heavily damped by negative feedback and an oval internal speaker is built in for monitoring purposes.

★ The playback amplifier may be used as a microphone or gramophone amplifier separately or whilst recording is being made.

★ The unit may be left running on record or playback, even with 1,750 ft. reels, with the lid closed.

Price £84 0s. 0d., complete with Wearite 2A deck.

Price £99 0s. 0d., complete with Wearite B2 deck.

POWER SUPPLY UNIT for operation with Tape Recorder or similar equipment on 12V. car battery.

This D.C. to A.C. supply unit has been specially manufactured to provide 1% accurate 50 cycle A.C. power for 50 c/s synchronous motors and amplifiers sensitive to mains noise. The output from the 50 cycle is well filtered to reduce harmonics and give approximately the same degree of quietness as normal 50 cycle mains.

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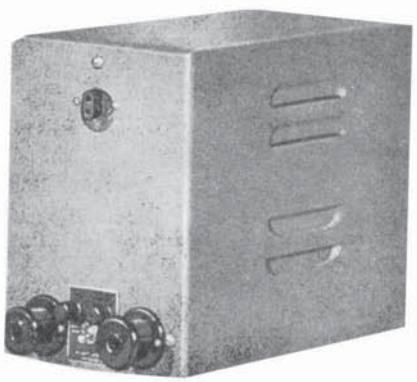
The unit is fitted in an 18 gauge steel case to give screening, but it should not be placed close to tape heads in case the field causes slight hum.

The case measures 9 in. x 6 in. x 9 in.



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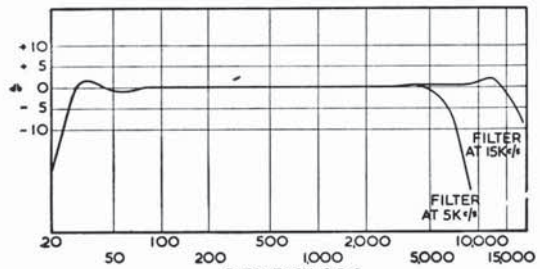
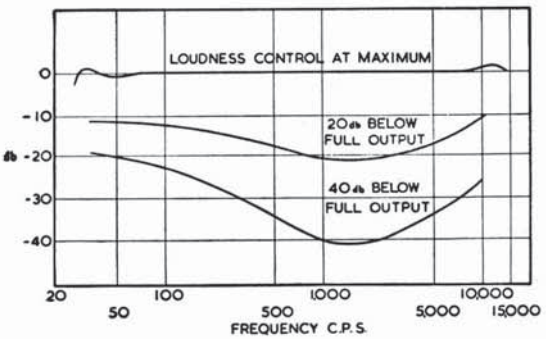


LOUDNESS CONTROL



The introduction of the TRIXONIC 800 has been withheld until there was no doubt that it was indeed the most outstanding contribution to high fidelity reproduction in its class. All the most desired features for fastidious ears are incorporated, features which would normally only be available in elaborate and costly equipment.

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OUTPUT IMPEDANCES 3, 8 and 15 ohms

FREQUENCY RESPONSE 30 c/s to 15,000 c.p.s. within ± 1·5 db. at 6 watts output, controls level

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Overall figures include output and pre-amp. stages

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HUM AND NOISE LEVEL Better than — 60 db.

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PICKUP EQUALISATION A wide range of pickups is covered by a unique rotating-plug equaliser in the pre-amp. stage. Sensitivity covers all types of magnetic, crystal, moving-coil, variable reluctance, etc.

HT/LT supply is available for feeding Radio Tuner Unit, etc.

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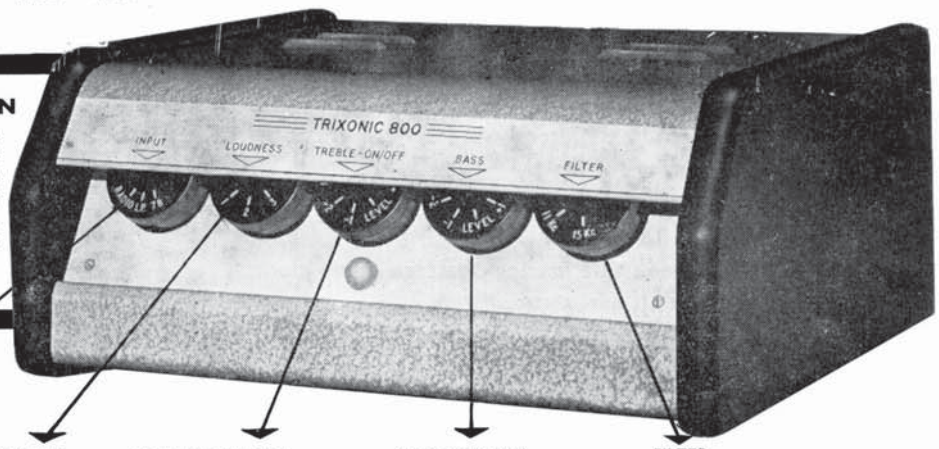
means that perfect full range reproduction can be had without recourse to increased volume, so that bass and treble frequencies are preserved absolutely intact. This means quiet listening without loss.



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78 „ 6mV.
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TREBLE CONTROL
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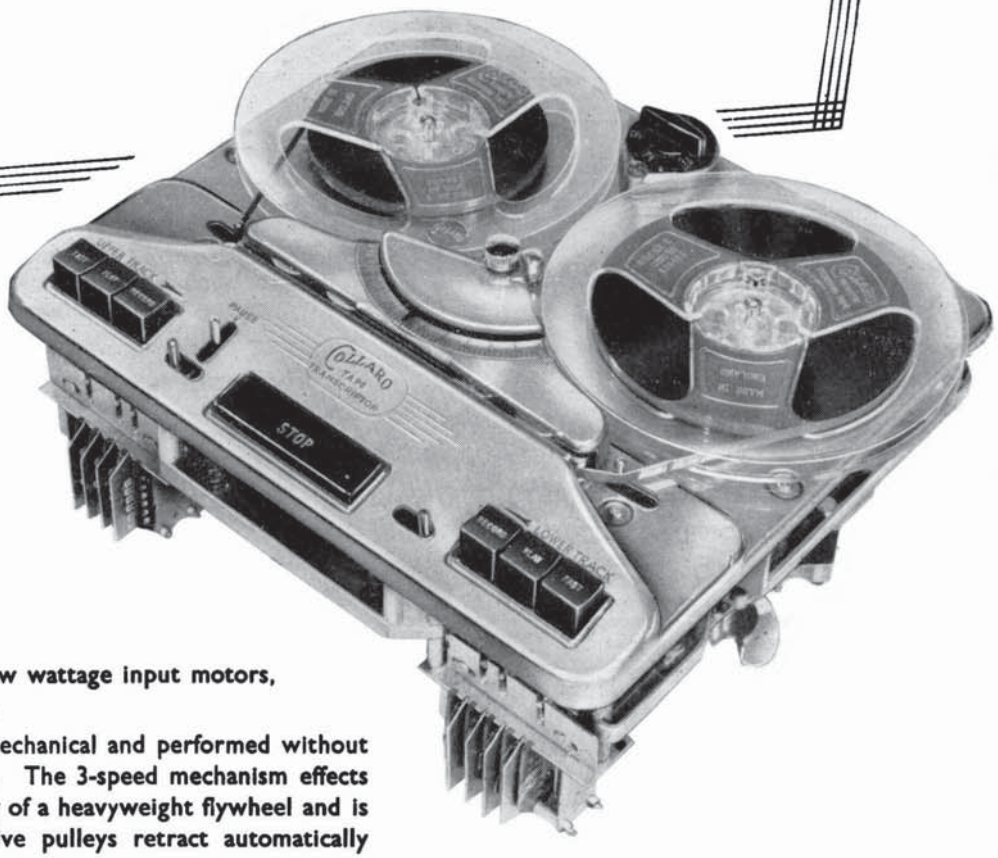
Make sure you see the NEW COLLARO TAPE TRANSCRIPTOR at the RADIO SHOW



This new High Fidelity Tape Deck has been designed on Transcription Quality Principles for live recording, recording from F.M. Broadcasts, etc., and reproducing pre-recorded tapes.

A twin-track model fitted with four heads, it runs at speeds of 3¾, 7½ and 15 inches per second. It has low wattage input motors, and the tape tensioning is automatic.

The operation and the braking are mechanical and performed without the aid of rubber belts or solenoids. The 3-speed mechanism effects the final drive through the periphery of a heavyweight flywheel and is instantaneously reversible. The drive pulleys retract automatically when the machine is switched off.

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Hi-Fi News

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EDITORIAL

AS we go to press, with the London Radio Show at Earls Court in its final stages of preparation, it is timely to write a few words on this big annual event, and to draw the attention of our many new readers to the fact that numerous manufacturers of bona-fide Hi-Fi equipment will be among the exhibitors.

The Radio Show began in a very small way nearly 30 years ago, and in its early days it was the hunting ground for those enthusiasts who wished, to see, hear, handle, and approve the components and the equipment with which they could build up "the best" in terms of wireless receivers. It has long since developed into the showground at which manufacturers can show their best, in terms of complete sets of all types. In the last ten years the main emphasis of the show has swung, naturally, to television. Last year, for the first time, a new line of interest appeared —the FM receiver. And in recent years, too, the demonstration rooms have offered thousands of people their first opportunity to hear really high quality (Hi-Fi) sound reproduction from equipment built specially for that job.

This year, without any doubt, Hi-Fi will enjoy a much larger representation than ever before ; and so the visitor to Earls Court will do well to study his catalogue, and to note the various demonstrations that will be staged.

But here a word of advice may not be out of place for the reader who is in search of genuine Hi-Fi sound reproduction. Let him study the catalogue : let him hear all that the demonstrations have to offer : let him note down what he fancies : let him collect as much literature and technical data as he can : then let him browse through the details of what pleases him, and ponder, and study them carefully. Hi-Fi results can only come from good equipment, specially tailored for the job. Elegant cabinets and sleek rows of knobs, coupled with changers, tape decks, and impressive FM wavebands and magic eyes need not be—and quite likely will not be—the answer, however fine the product for the job it has been designed to do.

If Hi-Fi equipment is wanted, then there is no better place to look for it than in the lists of the makers who know what is essential, and who have specialised in its production.

★ ★ ★

POSTSCRIPT

WE do earnestly advise readers to place a firm order with their suppliers for HI-FI NEWS if they wish to be sure of obtaining copies. Limited supplies will be held at this editorial office, but in fairness to overseas readers, who suffer the disadvantage of postal delays, these supplies are primarily earmarked as "back numbers" for posting abroad.

CONTENTS

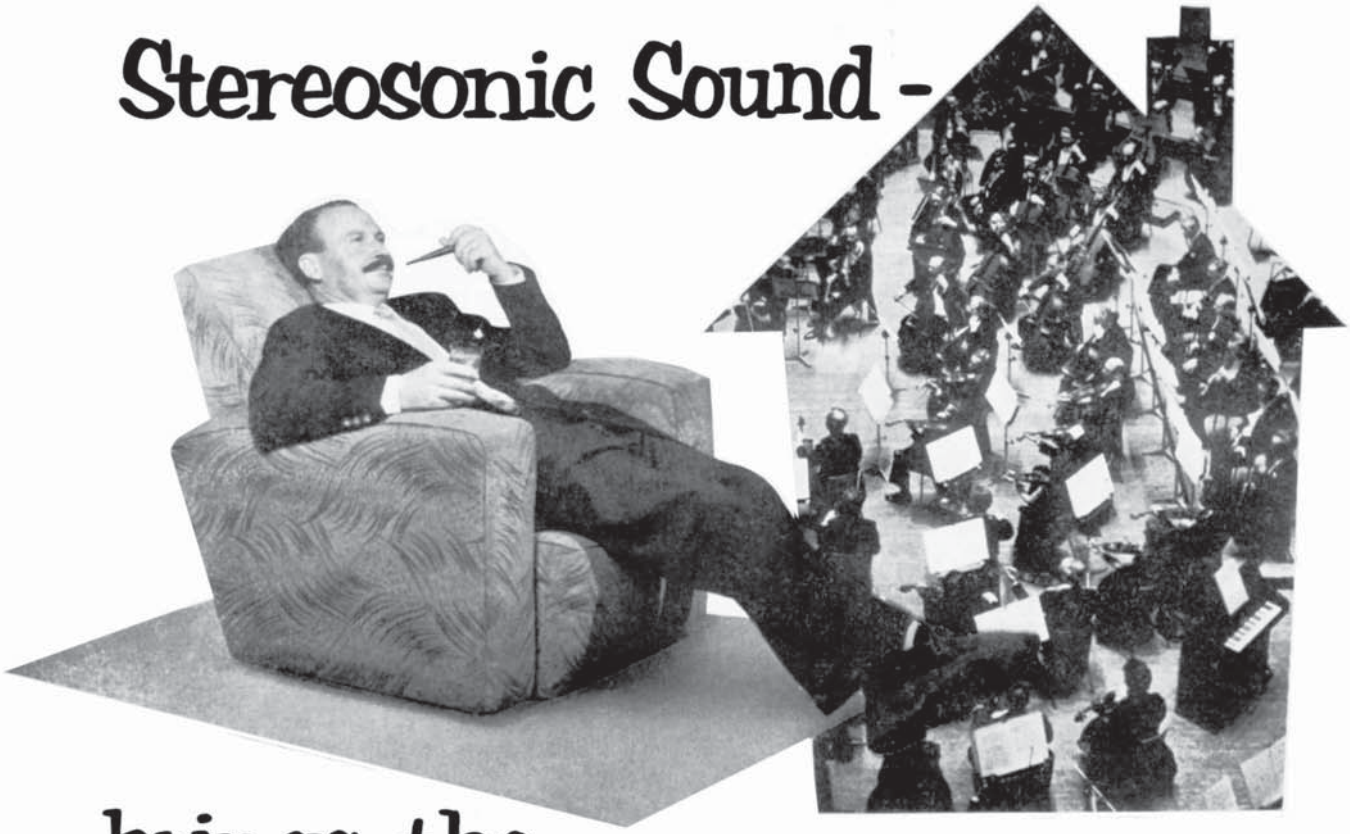
COVER PICTURE

WHE Mullard "five-ten" and twenty watt amplifiers have not only provided home constructors all over the world with a first-class basis for their Hi-Fi equipment, but several manufacturers have adopted the design for their products. On our cover this month we introduce Mr. W. A. Ferguson who designed them. The photograph was taken in the Valve Measurements and Applications Laboratory of Mullard Ltd., where these now-famous amplifiers were developed, and Mr. Ferguson is seen taking measurements on a prototype amplifier and pre-amplifier with the aid of a dual trace oscilloscope.

SUBSCRIPTION RATES

The subscription rate to Hi-Fi News is 21/- per annum (United States of America $3.00) from Hi-Fi News, 99 Mortimer Street, London, W.1.

Stereosonic Sound -



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hearing high fidelity

——by Stanley Kelly

EVERY year, many millions of words are written in numerous technical journals giving facts and opinions pointing to the best methods for achieving at least nearly perfect reproduction of recorded sound. But, sad to relate, apart from a few specialised articles which are written for professional otologists, psychologists and medicoes, practically nothing appears for general reading on what is without doubt the most important part of the whole process of high fidelity reproduction—namely, the mechanics of hearing.

The reasons are twofold: firstly, our erudite eggheads, in their wisdom, have decreed that medicine and its associated branches shall be a closed book to the general reader, and they have therefore wrapped it up in rigmarole, ritual and fancy latin names: secondly (and I believe this is probably the reason for paragraph one above) the physical measurement of hearing, or for that matter of all the senses, is extremely difficult. These various senses are the primary means by which we receive information about the world around us. Each sense generally favours a particular kind of physical activity in the environment, such as light, smell, pressure, sound, etc. and the end product of our various sensory systems are the olfactory, gustatory, visual, etc., sensations.

Sensations of "Blueness" and "Loudness"

We each know what a sensation is, because each of us has sensations (or do we?). We can differentiate between, say, the "blueness" of a visual sensation or the "loudness" of an auditory sensation, or even the sharpness of pain caused by a pinprick; but we each know sensations individually. It is difficult, nay, almost impossible, for us to know another person's sensations, principally because without special training in psychology we cannot very easily "get inside" another's world of personal experience. Two individuals say "red" or "blue" when they see a particular object, but neither of them can be sure that the other's impression of red or blue is the same. It is this difficulty in correctly interpreting an individual's subjective response that makes the science of hearing, or of any other sensory perception almost intangible.

We have used the word "sensation" many times. What do we mean by it? We mean, basically, the stimulus that the brain receives as the result of some external excitation. It is a sobering thought that by electrically stimulating the correct nerve centres we can see a particular colour or hear a given sound or what have you, even though we are in an acoustically dead room, completely devoid of light.

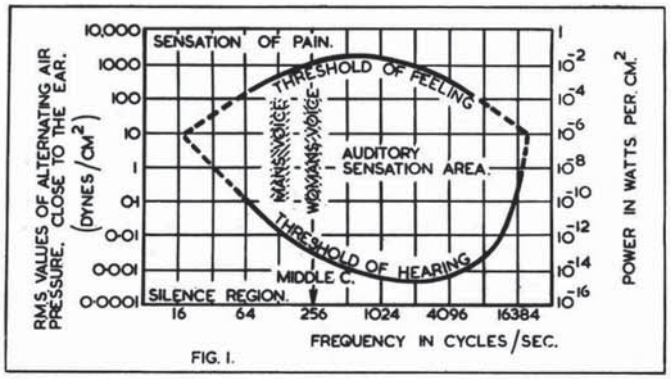

FIG. 1.

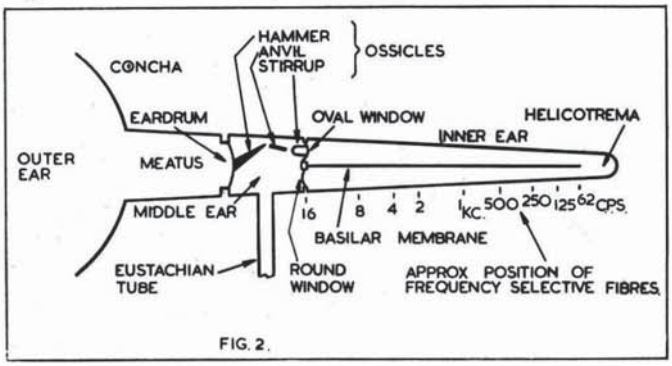

FIG. 2.

The powers involved in hearing are extremely small; the quietest sound a person can hear is about 10^{-16} watts/cm². The minuteness of this value is incredible and requires a large effort of will power to appreciate it. For instance, the ratio of this power, to that dissipated in an ordinary pocket flash lamp bulb (about 1 watt), is approximately the ratio of one-tenthousandth of an inch to the distance from the earth to the sun (93 million miles); and yet the capacity of the ear will allow sounds approximately one million times as loud to be perceived without distress.

Fig. 1 shows the working limits of an average ear in regard to frequency and "excess pressure". It will be seen that the ear is sensitive from about approximately 20 c.p.s. to 20,000 c.p.s., and from about one-thousandth of a dyne/cm² to 1,000 dynes/cm². Below the threshold of hearing all is silence, whilst above the threshold of feeling one perceives not sound, but physical pain. In the subaudible and ultrasonic regions these two points meet, and we have no knowledge of any stimulus until we feel it as a pain. From the graph we can see that, as the volume of sound is reduced, the frequency band which can be perceived is also reduced until in the ultimate we can only hear a very narrow band of frequencies round about 2,000 c.p.s.

Average Sensitivities of Ears and Eyes

We are all of us basically very efficient machines, and therefore each of our various senses is about equally sensitive, in terms of power, to its individual minimum stimulus. For instance, the eye is most sensitive in the green/yellow region, and the smallest quantity of energy which can be detected is about 10^{-16} watts, which is about the same minimum power as the ear can detect in the 3,000 c.p.s. region. The sensitivity of our olfactory organs are of about the same order. Aldous Huxley's **"Brave New World"** came very near the mark with his "feelies", "colour organs" and "smellies".

To return to hearing. In order that we may appreciate the sounds which reach our ears, they must first be converted to some other form of energy. We can therefore specify our ear as a transducer, which converts acoustic energy into nerve energy in a manner exactly analagous to a microphone converting acoustic energy into electrical energy.

The ear comprises three main compartments, **see Fig. 2.** Sound vibrations borne by the air reach the outer ear—which consists of the ear lobe or concha (from the latin word meaning a shell), the tube or meatus—and are converted by the ear drum (diaphragm) into mechanical vibrations in the middle ear, and transferred by the ossicles to the inner ear where they are again converted into nervous stimuli. We are all familiar with the outer ear, and progressively less familiar as we proceed inwards. The meatus is a short tube about one inch long, having a volume of

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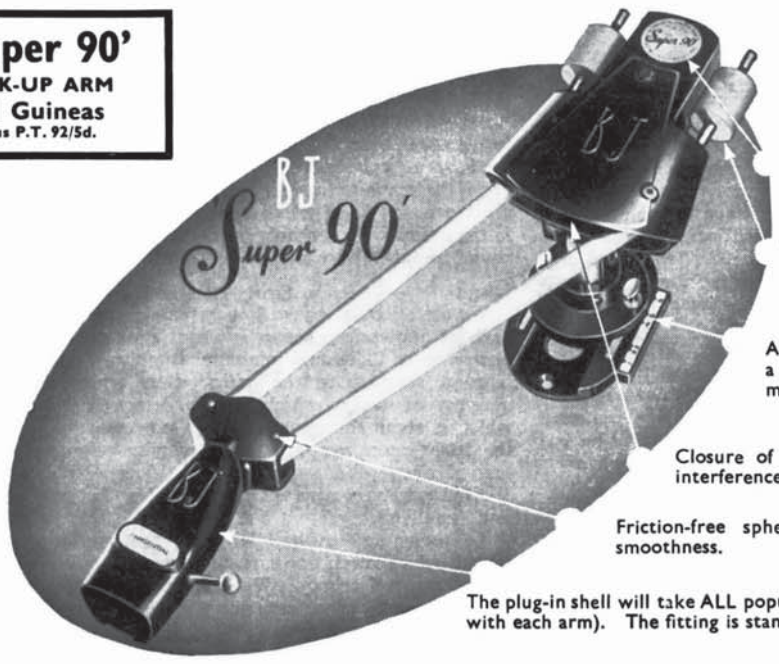

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about one c.c. It is closed at the inside end by the ear drum, and the ear drum is connected by mechanical transformer (the ossicles) to the oval window. The ossicles are known as the hammer, anvil and stirrup. They form a simple lever system **(Fig.3)** in which the force generated by the air pressure on the ear drum is amplified by about 50 times at the oval window. This amplification is obtained by the ratio of the movement of the ends of the lever, times the ratio of the area of the ear drum to the oval window; and, as in most engineering feats of nature, this transformation ratio results in optimum power transference to the inner ear.

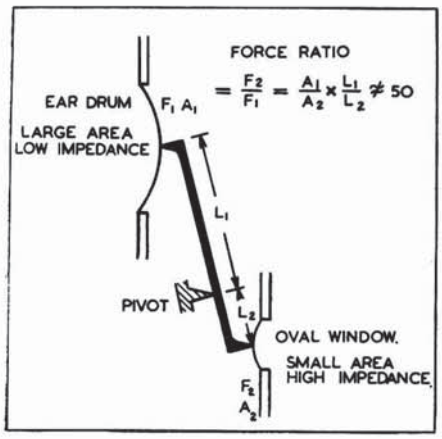

Fig. 3 shows the mechanical arrangement whereby sounds reaching the ear are amplified many times. The parts involved are hammer, anvil and stirrup.

The inner ear consists of a complicated set of small tubes and chambers embedded in solid bone. In addition to its primary function of hearing, part of it is also concerned with balance, which does not immediately concern us. The part primarily associated with hearing is known as the cochlea, from its resemblance to the shell of a snail. Its length is about 1¼ inches and it is in the form of a long cone, the diameter increasing uniformly along its length to approximately 0.2 inches. It is shown diagrammatically in **Fig. 2.** It is divided into two separate portions by the basila membrane, except for a small gap at the extreme end, known as the helicotrema.

When a sound is received by the ear, an alternating pressure is exerted on the liquid of the inner ear via the stirrup and oval window. This pressure results in a flow of liquid through the helicotrema and a consequent movement of the round window. If the pressure is positive, the oval window will move inwards, and the round window outwards, and vice versa. Situate on the basila membrane are a large number of fibres of varying length and thickness, and they function in a manner rather reminiscent of the strings of a grand piano (these are known as the organ of Corti). Each of these fibres is tuned to a particular frequency, and is connected to a separate nerve, which in turn leads to the brain. We therefore assume that each part of the cochlea will respond to a different frequency, and only those fibres having the same frequency of vibration as the incident sound wave will be excited, and will thus transmit nerve stimulus corresponding to that frequency to the brain. Thus we perceive pitch. **Fig. 2** shows the approximate frequency response of the cochlea.

As yet we have no exact explanation of how the brain interprets the sensory information from the inner ear. It is obvious that it does so, because a trained ear can easily detect whether or not a particular member of an orchestra is playing in tune.

There are only two fundamental auditory attributes which the brain can assimilate, namely pitch (frequency) and loudness (intensity). These are appreciated in accordance with Webber's "General Psychological Law of Sensation", in which he states that any change in a stimulus (visual, hearing, feeling, etc.) to produce a just perceptible increase of the sensation always bears a constant ratio to the total stimulus. In other words, if an individual can just hear a change in frequency of 1 c.p.s. in 100 c.p.s., he will be able to hear a minimum change of 10 c.p.s. at 1,000 c.p.s., 40 c.p.s. at 4,000 c.p.s., and similarly so with intensity. With normal individuals without special training, the minimum difference in frequency which can be heard is about 1 per cent, and in intensity is about 25 per cent (1db).

In previous articles we have mentioned that a complex wave can be analysed into a fundamental and its harmonics, whilst a transient sound (or a noise) consists of frequencies completely unrelated in phase and time. The ear, however, is a well-nigh perfect harmonic (and for that matter inharmonic) analyser. When complex sounds reach the ear, not only one fibre but as many fibres as are in that tone are excited and they all pass their impulses simultaneously (so far as we know at present) to the brain.

The final interpretation and analysis of the sensations is far beyond the scope of this article, but the frequency and intensity range which can be perceived by the ear can be enormously extended by practice. When I re-entered the acoustics field at the end of the war, my upper frequency limit of hearing was approximately 12,000 c.p.s. and the threshold of audibility was about +25 db on threshold. For the past five years, assuming no hangovers or colds in the head, I can consistently hear sounds at 18 Kc/s and my threshold of audibility has been reduced to +3 db on zero level: additionally, Ralph West and myself have had many arguments as to whether a speaker has been emitting a genuine 20 Kc/s note, or whether it has been just some intermodulation with white noise.

We started this article by saying that the ear was the most important part of the high fidelity system. It is unfortunately one of the most abused parts; but it is surprising how, with a little concentrated effort of listening for the high and low frequency tones and, more important, individual instruments in an ensemble, the susceptibility of the ear can be increased. I suggest that **for one record per week** the gramophile concentrates on listening to every note, mentally trying to picture the highest and the lowest frequencies, possibly giving them specific colours to help the illusion, and in a very short space of time he will probably have added nearly an octave to the range of his equipment without spending one penny on pickups, amplifiers, or loudspeakers.

Hi-Fi and Audio Shows in America

TWO exhibitions of importance are shortly to be held in America. The first of these, the "High Fidelity Show," opens for a four-day run at the New York Trades Building on September 27th. The second, the New York "Audio Fair," will be held at the New Yorker Hotel from October 4th to 7th. And, sandwiched skilfully in between them, is the "Briggs Lecture Demonstration" at the Carnegie Hall on October 3rd. On this occasion Harold J. Leak will provide the amplifiers and the audio power for the Wharfedale speakers of Gilbert Briggs. We wish them both a successful trip.

* * *

Classic Enterprise

A WELL-PRODUCED catalogue of Hi-Fi equipment has reached this office from the Classical Electric Co., Ltd., of 352/364, Lower Addiscombe Road, Croydon, Surrey. Many models of cabinets, speakers, tuners, amplifiers, and pickups are listed.

* * *

Who Was The First?

OUR feature, "Your Hi-Fi Dealer?" has only been running for three months with this number, but we have already received many interesting stories from dealers up and down the country, which we hope to publish in the near future. The more we receive, the more puzzled and interested we become—for so many dealers seem quite certain that their business has been established longer than that of anyone else. A big question therefore arises —who was the original Hi-Fi Dealer?

This must, of course, resolve itself around the still more difficult question "When did Hi-Fi start?" In other words, who was the first dealer to make, market and service equipment of a specialised nature, that would definitely have qualified as "Hi-Fi", even by the standards of the year in question? We shall be pleased to publish dates and details as they are received from any dealers who care to send them in, and we feel sure that our readers will be just as interested to read these notes and details of the progress of "Hi-Fi", in terms of retailers, covering these islands.

● Two short features, "Hi-Fi Hobby Horse", and "Do's and Don'ts" have had to be held over till next month, together with correspondence on the first of these. Apologies.—Editor.

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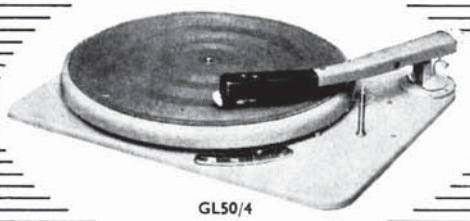

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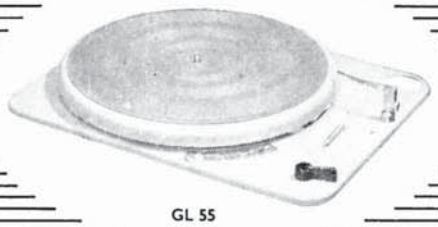

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the importance of space . . . by Cecil Watts

I REMEMBER attempting to diagnose the effect of music on a few friends, and I eventually came to the conclusion that the lower half of the audible frequency range excited their sentimental emotions, while the higher frequencies definitely disturbed the nervous system; and it seems natural that, over thousands of years, the evolution of all musical instruments, and even the human voice, has produced a nicely balanced content of low and high vibrations designed to have the greatest effect on our senses—some perhaps to soothe, others to excite or even to irritate; and these, surely, are the qualities we seek when constructing a Hi-fidelity sound reproducer, and which we cannot obtain from a Radiogram.

Hi-Fi is not, as imagined by some, just an electronic toy to be played with for the amazement of the thing, but a means to an end—which, believe it or not, can very differently affect every one of us according to our comprehension, mood, or even health. Who has not felt uplifted inwardly after hearing a good choir in a Cathedral, which of course is designed for the express purpose of enlarging and enriching the sound of the human voice? By stretching the imagination, we can even imagine a similar effect on the primitive senses of our early forebears, some few millions of years ago, when their voices were raised in a cave.

This comprehension of the effect of space on musical sounds can only be gained by experiencing many original performances in their appropriate settings, and these play an important part in our enjoyment of the music. Great efforts are made, by both the recording companies and the B.B.C., to provide the most suitable acoustic conditions possible for every type of music; but it is only after hearing, say, a Violoncello recital in the Wigmore Hall that it is realised that the same instrument in the Festival Hall can produce an entirely different quality.

The better our sound reproducers become, the more important it is to us to know where the performance originated. I often wonder why the B.B.C. do not publish this information for all their concerts.

"Distance" Controls

I believe that when the perfect reproducer is evolved our present volume control will be labelled "distance," and our own intelligence will determine the setting to provide a natural level of reproduction. Today, when listening to radio, such a setting requires continual adjustment, because for general reception conditions the announcer's voice is usually transmitted at the same level as that of a full orchestra, while quite frequently several microphones are employed on the same source which, while they might improve the definition of individual instruments, confuse the background and make it difficult to recapture the true character of the Studio or Concert Hall.

The old conception that "Hi-Fi" means having the entire orchestra in our drawing room in full blast, is dying out. Instead, it is realised that, with improved signals from l.p. records and F.M. radio, a sense of space can be created at the position of the speaker, with the performance taking place in it. Critical adjustment of volume and tone controls allows a comfortable listening "distance" to be selected, comparable to the best seats at the actual performance.

Of course, such an ideal can only be obtained by taking care to avoid all directional effects from the speaker units, which are being placed upwards, downwards, sideways, or backwards in an effort to avoid the "blow torch" effect at the higher frequencies. Further precautions are also required in the control of air column resonances in speaker enclosures. One of the best damping media I have recently struck is the new plastic sponge sheet, about an inch thick. When cut into wedge shaped pieces, which are cemented by their bases around the enclosure walls, this provides an almost anechoic air column without materially affecting the volume or path length.

It may be that quite a lot of bass response has previously been provided by such a resonance which, when controlled, may give the impression of lack of bass. Do not be too hasty in thinking of alterations, for a true and full bass is the exception rather than the rule on many broadcasts and recordings—so use a recommended record for testing.

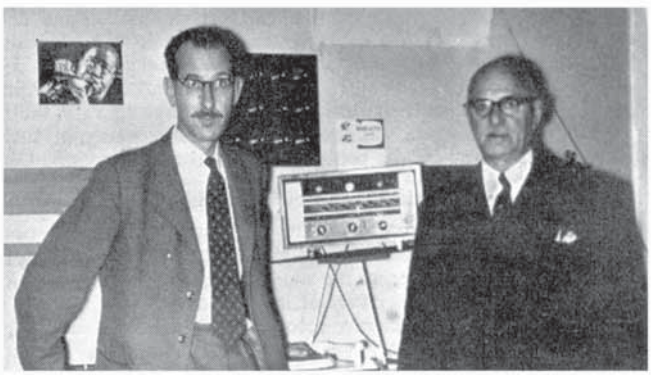
Remember also that if you have recently added a high frequency unit to your system, a corresponding extension of the range at the lower end is usually required to maintain correct balance. Any previous resonance in the bass end may have disguised the lack of this.

It is easy to calculate this balance, assuming 800 c.p.s. to be the middle of the audible scale. A natural balanced range is obtained by providing an even number of octaves below and above this frequency thus:—

6 octave range = 100-6,400 cycles per sec.
8 octave range = 50-12,000 cycles per sec.
10 octave range = 25-24,000 cycles per sec.

Without a balanced bass range an artificial closeness will always be present, and you may require a larger enclosure, a speaker unit with lower cone resonance, or both, to balance correctly the extended high frequency range.

your Hi-Fi Dealer . . . ?



No. 3 **Beaver Radio, Liverpool**

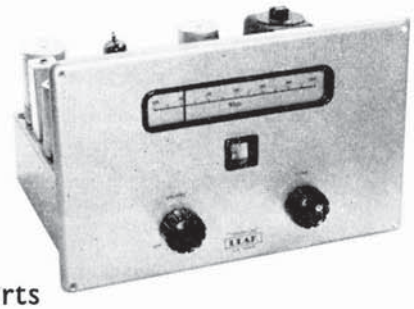
WALTER BEAVER, of Beaver Radio, 60/62, Whitechapel, Liverpool, is the Hi-Fi member of a family business which also includes his brother, Harvey Beaver, and his father, Percy Beaver, who founded it. This was in 1918, when he returned from the First World War. The shop was then in Dale Street, but when the Mersey Tunnel project became reality, it was found that the tunnel approach was to run right through the shop (and others), so they had to move!

In those days Home Construction was all the rage, and there were some 12 wireless shops in Whitechapel, which was Liverpool's "radio centre." As more and more factory-produced sets appeared on the market, the number of traders dwindled; and today the Whitechapel total has fallen to 3, of which Beaver Radio is one. Walter Beaver was in radar with the R.A.F. during the Second World War, and when he returned to civil life in 1946 he set to work to expand the business on the radio side. There was a fair audio interest in Liverpool, but people mostly came in to buy components for building up their own "Williamson" amplifiers, etc. It was in 1953 when Walter Beaver branched out into discs. He opened up the basement, fitted five listening booths, and he now carries a stock of every l.p. disc in the catalogue! As one result of this live move, he has even added the regular custom of several West-End Londoners to his steadily growing mail order business.

H.-Fi, to Walter Beaver, is part and parcel of the record business. All his booths are fitted with high quality speakers, and a switching system enables the listener to hear the music through a selection of apparatus, as chosen. His pick-ups are fitted with diamonds, which are inspected regularly, and changed every six months whether they need it or not. Only trained assistants are allowed to handle and play the discs, and the players are outside the booths, well away from the listeners' hands!

"When my customers hear their discs played," says Walter Beaver, "they automatically hear Hi-Fi results. This is as it should be; and it is the finest method of introduction to Hi-Fi that I know."

F. M. TUNERS



by
R. S. Roberts

★ *In part 2 the author discussed Frequency Stability, and this month he describes two further methods which are used to minimise the effects of temperature change on the oscillator frequency stability. The first of these is Automatic Frequency Control (A.F.C) and the second is Crystal Control.*

EXAMINATION of Fig. 6 will show that, when the signal is in correct tune, the **mean** output voltage from the demodulator is zero, and remains at this value whether the signal is modulated or not. If the signal is not accurately tuned (either due to mistuning in the first place or subsequent frequency drift), the mean ouput voltage will not be zero, but will be positive or negative by an amount depending on how far off correct tune the signal may be. It will be noted that the polarity of this voltage determines the "sense" of the tuning error, that is, it will be positive (for example) when the oscillator tunes higher than it should be, and negative if the oscillator tunes low. This "off-tune" voltage may be smoothed and used as a control voltage to vary the frequency of the receiver oscillator, the variation being in such a direction as to reduce the control voltage to zero.

Automatic Frequency Control (A.F.C.)

Several methods exist for using a control voltage to obtain A.F.C. but the usual method is to use a "Reactance Valve". This is a valve, connected across the oscillator circuit in such a manner as to exhibit the characteristics of inductance or capacitance. The amount of reactance thrown across the oscillator is determined by the g_m of the reactance valve and this, in turn, may be varied by using the control voltage as a bias.

Fig. 7 shows a typical circuit arrangement for A.F.C. The control voltage is applied to the grid of the valve via R, and the valve throws across the oscillator circuit a capacitance with a value of g_m RC. Several variations of these circuits are possible, and space is not available to detail all the possible combinations of reactance valve, oscillator and control voltage.

A.F.C. can be a great aid to accurate tuning. It is only necessary to tune near enough to the required station for a control voltage to be developed; the oscillator tuning is then controlled and brought into correct tune. Any tendency for the oscillator tuning to drift (within reason) is immediately corrected. At least one make of tuner can hold the tuning correct even though the tuning control is shifted some 400 kc/s from its correct position.

Tuners employing A.F.C. have to be very carefully designed. It will be realised that, with A.F.C. in operation, a small error in tuning will always exist whilst control is being exercised. Thus, for the best performance, the basic frequency stability of the oscillator must be quite good. A.F.C. is no substitute for bad design.

Although use of the reactance valve is probably the most popular system of A.F.C. at present, it is not the only possible system. Several other methods exist; for example, the oscillator inductance may be wound on a Ferrite core and the permeability of the core varied by causing the control voltage to change a polarising current. New components have been developed whereby a changing capacitance may result from a changing D.C. potential. There is no doubt that, in the very near future, we can expect to see circuit developments that will change the character of A.F.C. systems very substantially.

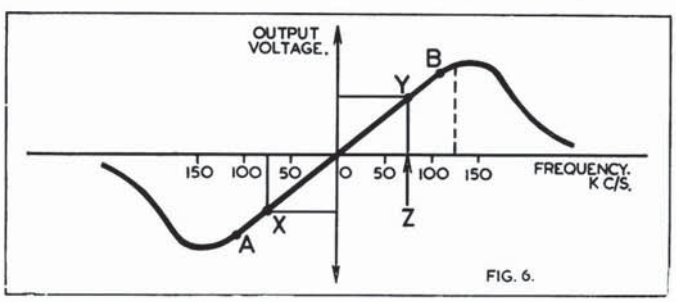


FIG. 6.

Crystal Control

Another form of oscillator circuit uses a Quartz crystal instead of the more conventional tuned-circuit system. A suitably cut quartz plate can oscillate in a mechanical sense due to its mass and elasticity, and it can be maintained in oscillation by suitable connection to a valve. The frequency of oscillation is determined by the mechanical properties of the crystal, and is but little affected by any changes in the valve or associated circuit. The resulting frequency stability is of a very high order, and can be independent of temperature variation over a very wide range.

In the F.M. service area, three crystals are required, being cut to frequencies suitable for the three programmes. At least one tuner uses this system, programme selection being by means of a switch that selects the appropriate crystal.

This method of generating the oscillator voltage is probably the most satisfactory from the point of view of frequency stability. Its disadvantages are (1) that the expense involved in the three crystals is fairly high, and (2) no tuning is possible hence, in the unlikely event of the station frequencies changing, or moving the receiver to a new area, the crystals will require to be changed. Its great advantage is that the receiver is in accurate tune from the instant of switching on the receiver—and it stays in tune.

The I.F. Amplifier

The anode circuit of the mixer includes the i.f. transformer, the purpose of which is to extract the intermediate frequency for subsequent amplification before demodulation.

The i.f. amplifier involves some special precautions, although circuit techniques are much the same as might be used for lower frequencies. The bandwidth is much wider than usual; it will be remembered that the overall bandwidth may be in the region of 400-450 kc/s. Alignment of the i.f. amplifier must be carefully carried out if distortion is to be avoided.

The ideal response curve is shown in **Fig. 8a.** The amplification over the passband is uniform and phase distortion does not occur. It will be remembered that, in F.M., the passband is fully occupied with important side frequencies, each of which must be amplified without amplitude or phase distortion. It is not possible to realise the ideal curve of **Fig. 8a.** The nearest we can get to it with a double-tuned i.f. transformer will be somewhat like the

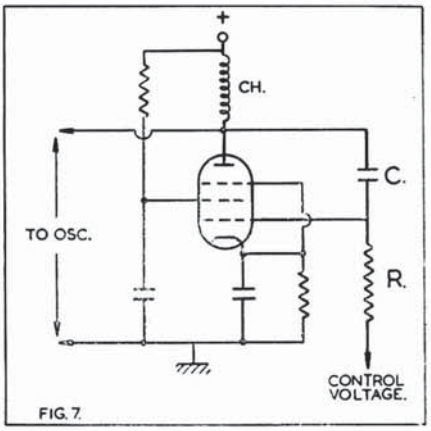
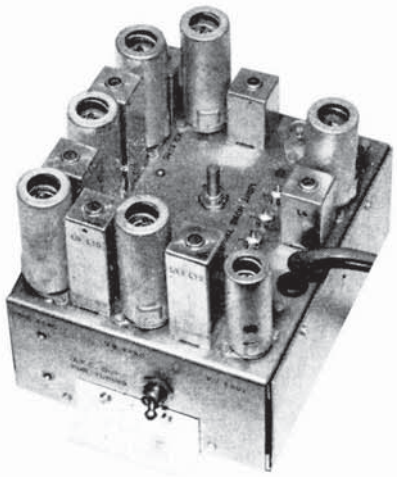


FIG. 7.



★

The Dynatron pre-tuned FM unit is a good example of reliability and simplicity. Unless one wants "Police", "Fire" and "Ambulance" traffic, three switch positions are enough!

★

solid-line curve shown in **Fig. 8b.** A triple-tuned transformer offers further improvement, as shown in **Fig. 8c,** and some manufacturers use these three-circuit transformers.

Slight misalignment can produce a response curve such as that shown dotted in **Fig. 8b.** It will be clear that the upper and lower side frequencies are not amplified uniformly (the phase response of the two sidebands will also be quite different), and the resulting distortion can be quite severe.

The final amplifier valve in the i.f. chain is often operated as an amplitude limiter. It has been pointed out that all traces of amplitude modulation must be removed and, with some forms of demodulator, this can be done in the demodulation process. With other demodulator circuits, the A.M. is removed in a stage (or stages) ahead of the demodulator.

The Limiter Stage

A typical limiter stage is shown in **Fig. 9a.** By operating an r.f. pentode with low anode and screen voltages, together with a high value grid resistor, it is possible to produce a grid voltage/anode current characteristic of the form shown in **Fig. 9b.** It is seen that, after the input voltage reaches a certain level, further increases in signal level will produce no increase in output.

A very important point to note is that the limiter relies on being driven hard for correct operation. If the signal level is low, so that the valve is operating on the slope of its characteristic, no A.M. suppression can take place.

A further feature of the limiter is that the grid assumes a negative potential, of a magnitude depending on the level of the input signal. The grid can thus provide (through a suitable decoupling resistor) a source of A.G.C. voltage.

The Demodulator

It is in this stage that the F.M. receiver differs fundamentally from the A.M. receiver. To demodulate, the F.M. signal requires that a varying frequency shall produce a sympathetic output voltage variation.

Another important difference between A.M. and F.M. receivers is that a very large number of possible demodulator systems are available for F.M., compared with the relative three or four systems to choose from for A.M. Nevertheless, most F.M. receivers use either the Foster-Seeley or Ratio Detector.

Fig. 10 shows the essentials of a Foster-Seeley "frequency discriminator". A detailed description of its operation is not possible in this limited space but, in brief, it functions as follows:—Each diode receives two voltages; one from the primary via C is common to the two diodes, the other voltage being derived from the secondary. The secondary voltages are 180° out of phase with each other, and each is 90° out of phase with the primary—one leading and the other lagging. Thus each diode receives two voltages; that from the primary and the other from the secondary, the two with a phase relationship of 90° when the signal is not modulated. Each diode voltage is, therefore, equal and is the vector sum of the primary and secondary voltage. The diode currents are equal and the output voltage is zero.

When the frequency changes, the phase of the secondary voltages will change—that at one end of the secondary increasing and the other end reducing. The primary voltage will not change appreciably, hence the net voltage on each diode **will** change, one increasing and the other decreasing. The diode currents will differ giving rise to an output voltage.

A change of frequency in the opposite direction will reverse the above situation, and give rise to an output voltage of opposite polarity. Thus a frequency deviation about the mean value will give rise to the generation of an A.C. voltage output. **Fig. 6** showed the actual shape of the output voltage/frequency curve.

Ratio Detectors

A very popular demodulator is a Seeley modification of the original Foster-Seeley discriminator, termed the "Ratio Detector". It has somewhat less output than the Foster-Seeley, but suppression of amplitude modulation is an attractive feature of the circuit, not possessed by the Foster-Seeley.

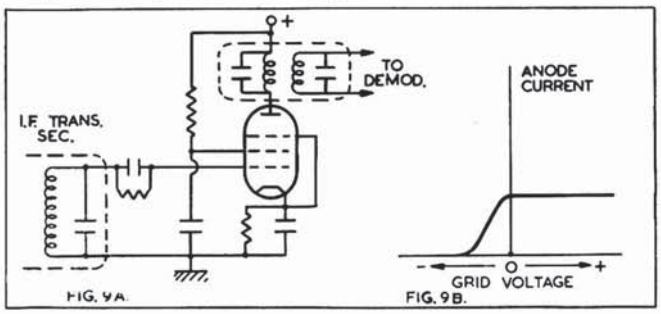


FIG. 9A. FIG. 9B.

Fig. 11 shows the Ratio Detector in its original form. It is similar to the Foster-Seeley in that it is a phase discriminator operating on the same general principles. One diode is reversed, however, resulting in the diode currents being in series, and the voltages developed across the load resistors R_1 and R_2 being in series. The capacitor C_1 is large in value, and becomes charged to a voltage dependent on the signal level. The potential between A and B is thus held constant, but during modulation the diode potentials will vary, and the resulting a.f. output is taken off at point X.

A useful feature of the circuit is that the time constant of the C_1 R_1 R_2 combination is long, and point A is at a negative D.C. potential. The magnitude of this voltage depends on the signal level and thus provides a useful source of A.G.C. bias. Many variations of the ratio detector have been developed, and have resulted in some circuit simplification.

Fig. 12 shows an "unbalanced" version of the ratio detector which is very popular. C_1 is of the order 5-8μF and the load resistor R_1 is carefully chosen to give the best compromise

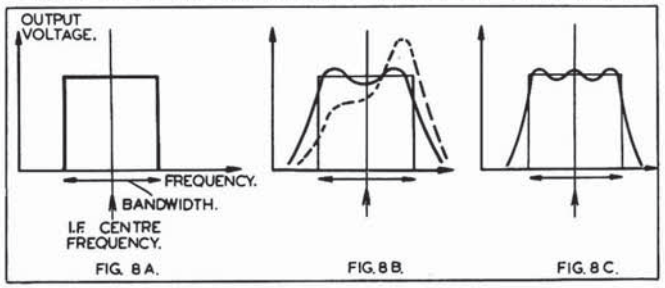


FIG. 8A. FIG. 8B. FIG. 8C.

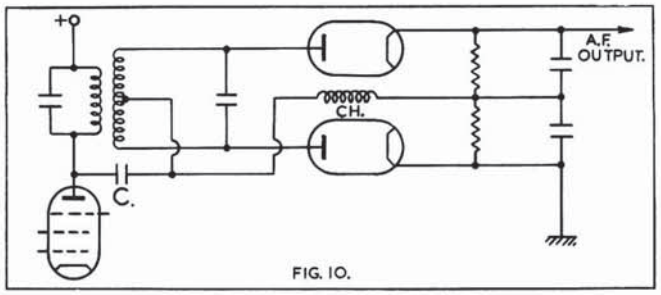


FIG. 10.

★

The Jason FM Tuner

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between obtaining a high output voltage and good A.M. suppression. A high value of R_1 gives a large output, but then stray capacitances become significant and spoil the suppression.

At least one tuner uses what is termed a "Counter" system of demodulation. In this method, the i.f. signal is "clipped" and

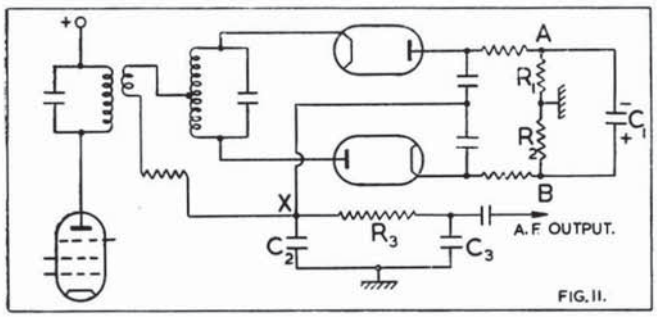


FIG. 11.

converted into pulses, and the pulses are caused to charge a capacitor. The charge on the capacitor depends on the number of pulses it receives per second and this, in turn, depends on the frequency. Thus, during modulation, the potential on the capacitor will vary at audio frequency. Amplitude limitation is carried out, of course, in the clipping process.

As mentioned earlier, a large number of demodulator systems for F.M. are possible, and in the future we can expect to find quite a number of methods exploited. Already, a new valve has been developed in the U.S. especially for use as a "Locked Oscillator" demodulator, and it promises to take the place of the popular ratio detector—particularly in U.S. television receivers which have an F.M. sound channel.

De-Emphasis

It will be remembered that the transmitted F.M. signal is predistorted in a manner (termed "pre-emphasis") that raises the level

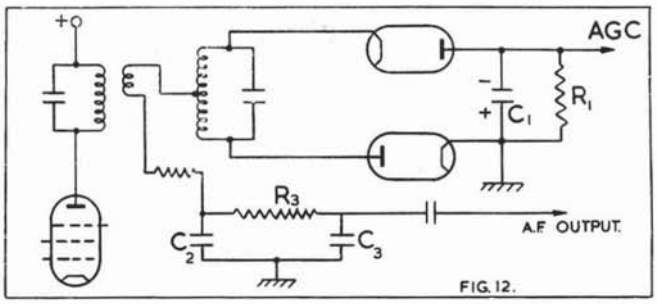
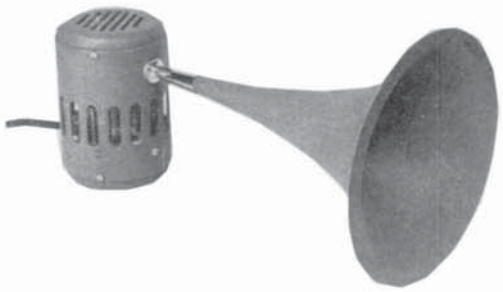


FIG. 12.

of the higher audio frequencies. The rate of rise is determined by a top-lift circuit with a time-constant of 50μ secs.

Before the a.f. output from the tuner is fit to be passed on to the amplifier, it is necessary to restore the response to a flat characteristic. This is simply carried out by passing the a.f. signal through a "de-emphasis" or top cut circuit with a time-constant of 50μ secs. Such a circuit is represented by R_3 and C_3 in **Figs. 11 and 12.** (C_2 in each of these circuits is an r.f. by-pass capacitor.) The values are not critical providing the time-constant is of the right order; typical values might be 500pF for C_3 and 100 kΩ for R_3. In some tuners, a screened output lead is used for connection to the amplifier, and the capacitance of this lead may form part of the total shunt capacitance with C_3.



★ *The Plessey Ionophone Tweeter*

THE SPEAKER IN YOUR HOME

by Ralph West

PART 3—Reproducing the Higher Frequencies

IN the first of these articles we came to the conclusion that a frequency range of 20 c.p.s. to 20,000 c.p.s. would satisfy the most exacting requirement ever likely to be encountered. Our reasoning was based on the existence of harmonics and overtones, present in all musical sounds. There is another very good reason why we need to be interested in the very high frequencies —and the magic word is "transients." Stated simply, transients are all the little noises that start suddenly and/or stop suddenly. Sometimes they accompany musical sounds, like the scrape of the bow on the double bass, and the wind noise of the flute; sometimes they precede, like the chiff of some organ pipes and the sob of the oboe; sometimes they are just noises, like the spoken "T," handclaps, maraccas, and castanets.

Such odd noises, not recurring regularly, theoretically require a frequency range from zero to nearly infinity for perfect reproduction! This we have to curtail, but it does show that as wide a response as possible must be aimed at. The high frequency response generally has the most noticeable effect on transients and, for that reason, should extend a little beyond the highest audible frequency; and, very important, it should fall off gradually not suddenly. Insufficient high note response makes handclaps (in a large auditorium) sound as though gloves are being worn. A wider response, but dying away too abruptly at the top end, would make the handclaps seem to come from an empty bathroom, becoming a shrill hiss with a very large enthusiastic crowd. Summing up, transient response pretty well equals "clarity."

The main requirement is now easily seen—lightness of moving parts, easily started, easily stopped, easily moved to and fro rapidly. The most obvious way of reducing mass is to reduce size, but this generally means reducing the power handling capacity. One way out of this dilemma is to use a small speaker, but to

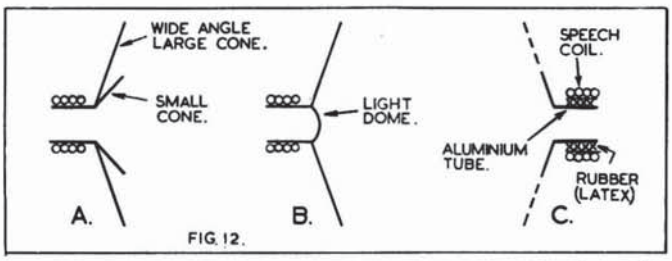


FIG. 12.

give it only a small proportion of the total power to handle. This is our familiar tweeter, and it may vary in size from something under 2in. in diameter to 4in. or 5in. Fortunately the size of cone needed diminishes as frequency rises, so that by cutting down the cone, and leaving the speech coil and magnet system untouched, the H.F. response is improved without running into power limitation problems.

It is usually necessary to prevent low frequency signals from reaching such speakers, as large cone movements lead to serious distortion (intermodulation, etc.) and possibly damage. Crossover units are designed to do just this, and at the same time they prevent the H.F. energy being "wasted" in the bass speaker. A simpler way, sometimes definitely better, is to feed the tweeter via a condenser of suitable value, so that both speakers receive the H.F. signals. It should be a paper type, not an electrolytic, and its value will usually lie between 2μF and 10 μF, depending on the speaker impedance and the range of frequencies to be fed to it. Neither the series condenser nor the crossover circuit cuts **all** signals below a certain frequency. The "cutting" is very gradual, even with the more elaborate half-section crossover, so that something may be heard even two octaves below the nominal crossover frequency. The amount of signal reaching the speaker is, however, quite small and does no harm. To produce a really sharp cutoff would be both expensive and undesirable.

The tweeter speaker is sometimes mounted coaxially inside the hollow of the accompanying bass speaker cone, but when it is separate the control of H.F. sound dispersion is easier.

The use of aluminium instead of copper for the speech coil is another obvious way of reducing weight. In the past, the difficulty of soldering aluminium sometimes led to unreliability, but this drawback has been quite forgotten for some time now.

Several years ago, Voigt added a small auxiliary cone to the familiar assembly, as shown in **Fig. 12A.** At low frequencies the whole system moves as one piece, and the extra mass has negligible effect. At high frequencies the larger wide-angle cone flexes, because it is flexible by virtue of its shallowness. This leaves only the speech coil and small cone vibrating. The scheme is very successful and is still in use by at least two manufacturers for high-quality speakers.

Another scheme, sometimes seen, is to close the speech tube with a very light aluminium dome (beryllium would be better!) as in **Fig. 12B.** This again assures that the main cone flexes near the centre leaving only the speech coil and dome moving at high frequencies.

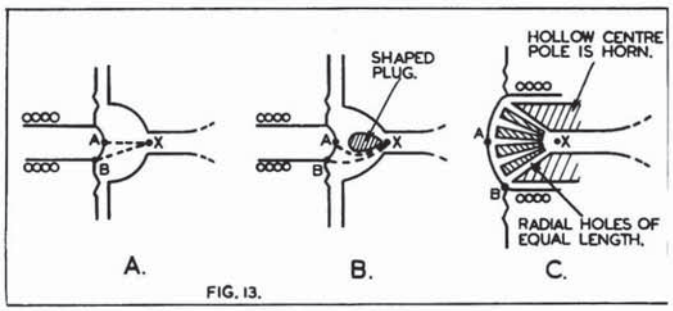
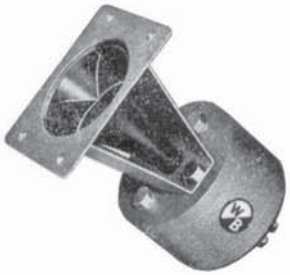


FIG. 13.

A very ingenious idea, devised by Barker, is seen in **Fig. 12C.** The speech coil winding is separated from the speech tube by a thin resilient layer. At low frequencies the assembly behaves normally, except that the aluminium speech tube (acting like a short circuited loop) gives excellent damping, so that there is virtually no bass resonance. At high frequencies, the magnetic coupling between coil and tube is sufficient to induce speech currents into the tube, causing it to move while the speech coil moves but little. The effective mass of moving parts is thus considerably reduced.

If the speaker is made **very** small indeed, its **very** high frequency response is improved, but the lowest frequency it can handle is raised, possibly to 5,000 c.p.s. If a 3-speaker assembly is contemplated, bass—middle—top, this is all right, but if only two



W. B. Tweeter Unit

units are to be used, this will require a bass speaker with a **good** response up to 5,000 c.p.s.—which is difficult! If the tiny speaker is horn loaded, it will operate down to a frequency determined by the shape and size of the horn. Down to 500 c.p.s. only needs a horn about 15in. long. The moving parts of such a unit (called a pressure unit) are very light indeed, since there is only the speech coil and dome to move. A simple shape like **Fig. 13A** would be very disappointing, except at the lower end of its range.

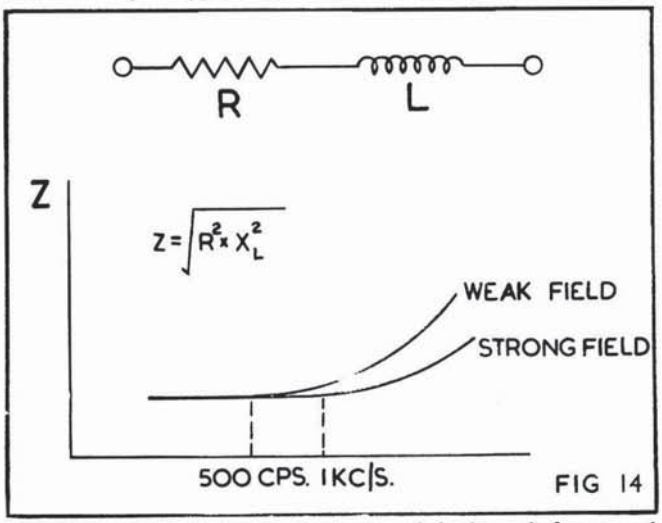


FIG 14

Sound from A reaches X, the beginning of the horn, before sound from B. Their effects do not add simply, in fact, they would cancel at the frequency where the time difference between the A and B signals equals ½ a cycle.

A big improvement occurs by fitting a shaped plug shown in **Fig. 13B,** which makes the AX path equal to the BX path. The problem is even more subtle than this, because an allowance must also be made for the time it takes for the sound to travel from A to B in the diaphragm. Another reason for loss of top is the fact that the cavity acts as a low-pass filter, i.e., the air in the cavity compresses, and less sound pressure acts at the beginning of the horn proper. The perfect solution is shown in **Fig. 13C,** where not only are the AX and BX paths equalised, but all the others in between, **and** the cavity, is completely filled in. Horn

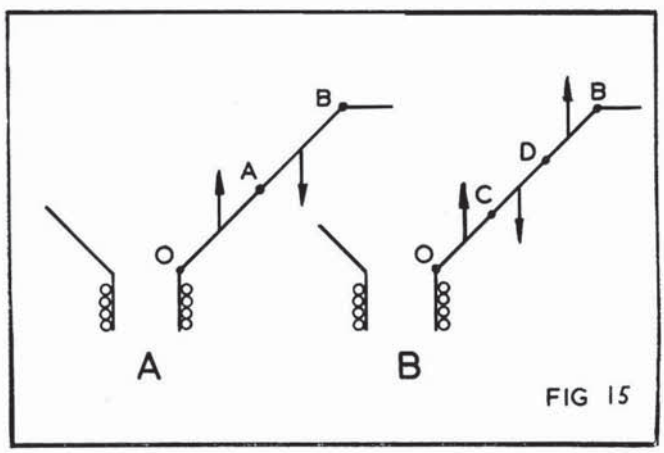
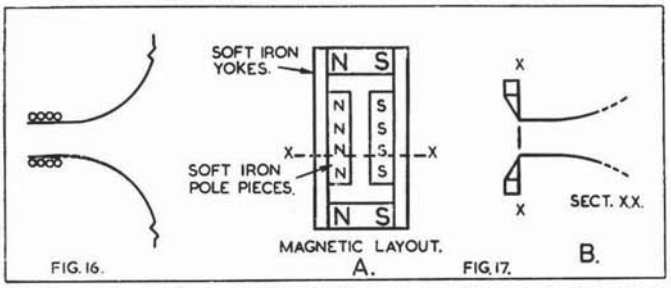


FIG 15



loud speakers (large and small) are usually markedly more efficient than all other types.

Without modifying the cone at all, a marked increase of high frequency output can be obtained by increasing the magnetic field, more strictly, the flux density. The speech coil, as any other coil, has inductance and this is augmented by its magnetic surroundings, the centre pole and outer pole. This causes a rise in its impedance at high frequencies (see **Fig. 14).** Thus, feeding it at constant voltage, which all modern amplifiers do, it receives less and less power as the frequency rises, and so gives less top than it could do. A simple experiment will make this very real to the reader. Place a 50Ω or 100Ω resistor in **series** with the speaker: turn up the volume control a little—and the extra top is most surprising. In this instance the high resistance controls the current, not the speaker. While this may increase the H.F. response, it will reduce the total power and spoil the bass, for the amplifier can no longer damp the speaker; so it is **not** a method of improving the H.F. response at the present time. The only way is to fit a larger magnet so that the pole tips are nearly saturated, then their contribution to the speech coil inductance is nil, and the speaker impedance does not rise very much within the audible range. The other advantage of a powerful magnetic field is increase in efficiency, which is a good thing anyway. The only snags being cost and weight!

Crossover Units

Now, a large coned speaker can, and usually does, produce high frequencies; unfortunately the tendency is to reproduce some frequencies too efficiently and others hardly at all—i.e., an irregular response with objectionable peaks. This may give an immediate impression of plenty of top, but further listening tires the ear because of its harshness. Musicians and our womenfolk will probably take an instant dislike to the reproduction. It is this objectionable top response that often makes it necessary to use a crossover with a two-speaker system, instead of simple circuits. It is thus wise to use a bass speaker which has either a very smooth top, or none at all; failing that, cross over at a low enough frequency to make sure its output is sufficiently attenuated at the various peaks for their efforts to be inaudible.

The reason for such behaviour is explained in **Fig. 15,** where the movements of the various parts of the cone are illustrated. It takes time for the sound to travel from the centre to the outside of the cone, so that the movement of the outer cone regions lags behind, and could easily be going in the opposite direction to the central region. Case A shown will produce little output, depending on the relative amplitudes of motion of the OA and AB regions. Case B will give a peak, far more serious, because it can be heard!

"Holes" in the reproduction are not very noticeable as a rule, but this phenomenon produces both peaks and troughs in the response curve, and is known as cone break up! The first peak is about 1½ times the frequency of the first dip. For very large speakers, these results may set in below 1,000 c.p.s.; for an 8in. at 1-2 kc/s (about 4 kc/s for a metal cone, as sound travels faster in aluminium than in paper); and for small tweeters, above 10 kc/s, where it is too high to matter. If the cone, by virtue of its shape and material, absorbs some high frequency energy and only passes on a little, the AB region will vibrate with much less energy than the OA region. The result will be less cancellation and a shallower dip in the response curve. Likewise the peaks will be reduced and a smoother, sweeter high frequency response results. In contrast, cone break-up is at its worst when enough

THE SPEAKER IN YOUR HOME (*cont.*)

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Kelly R.L.S.I. Ribbon Tweeter

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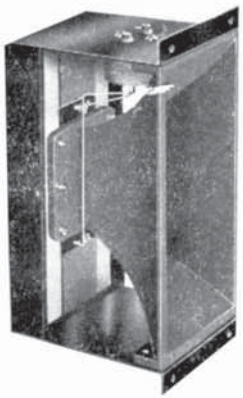


energy is reflected back from the edge of the cone to boost up the movements of the outer cone regions.

Very careful choice of surround material and design is needed to provide the correct degree of damping, as too much is as bad as too little. Discontinuities, such as indentations and weighting patches added to the cone, also help by altering the time taken for the sound to travel from the centre to the edge, in some directions. The elliptical cone also possesses this desirable departure from complete symmetry. The ideal is a shrinking area of vibrating cone as the frequency is raised, so that the whole moving area, at any frequency, is in phase or in step. Various "tricks" are resorted to to achieve this end; the cone may be graduated in hardness by doping certain parts, or by shaping it as in **Fig. 16,** so that the cone becomes progressively stiffer towards the centre, and the vibrating area shrinks to the centre as the operating frequency rises. Amular rings are sometimes moulded into the cone to restrict the vibrating area at high frequencies.

Ribbon Tweeters

The ribbon speaker, shown in **Fig. 17,** bypasses most of the problems already mentioned. It works on the same principle as the moving coil speaker, but has no extra pieces added on to the actual driving part. Its moving parts therefore weigh but a tiny fraction of those of the smallest moving coil unit. The aluminium ribbon used will be much thinner than one thousandth of an inch, and seemingly very fragile. If a very powerful field is used, its efficiency is raised, and less heat it produced—anyway, it is very efficiently air cooled! Another problem bypassed is breakup—it can't. Since its whole surface is driven uniformally, it must move as one piece. It is usually horn-loaded so that it can operate down to low enough frequencies to use with typical bass units. Theoretically, if the horn shape is correct, its response curve must be flat! In practice, perfection is never quite reached, one reason is most probably due to slight difference in the air leaks between the ribbon edges and the pole tips, causing the ribbon to tilt. With careful design it is possible, under ordinary manufacturing conditions, to produce a far smoother high frequency response than could ever be produced by a moving coil unit having the same lower frequency limit. It is very much more difficult though to get such a high flux density (and corresponding efficiency) in the relatively wide gap of the ribbon unit. It is possible to use the radiation from both sides of the ribbon, but one side is usually closed to prevent the ribbon being sucked adrift when sliding the unit out of its box! As it has such a low resistance (and impedance) a small step-down transformer is fitted to it so that it can present the usual 15Ω to the amplifier (it only has to handle high frequencies).

The electrostatic speaker, preferably in push-pull form, also bypasses these problems since its diaphragm is extremely light—so light in fact that further reduction in weight would have no measurable effect in the audible range. Like the ribbon, it too is driven all over its surface, and so just can't break up. Unlike the ribbon, its size and shape is not limited, so that its area can be large enough to radiate low enough frequencies without horn loading, and it can be made curved so as to give any desired spread of sound.

Basically the speaker is a condenser, and its impedance would fall as the frequency rose, so that if fed with a constant signal voltage, the acoustic output would rise considerably with rising frequency. To offset this effect it is generally run in series with a resistance. This also reduces the impedance variation, which in turn helps the matching. The electrostatic, on the whole, should give the smoothest response of any tweeter type since its moving parts are so simple and there are no "acoustic appendages" whatsoever.

The Ionophone has the lightest moving parts of any speaker in existence and ever likely to be, so that its transient response (and H.F. response) is expected to be above reproach. Like the ribbon it needs a horn in order operate down to a convenient frequency. The speaker and its immediate circuity must be screened, otherwise radio and TV interference would result. This presents no particular difficulty because radio receivers, TVs and tape recorders all contain R.F. oscillators, and very little trouble results from them. Both the electrostatic and the Ionophone require auxiliary electrical supplies—a high voltage at virtually zero current, and a few R.F. watts respectively, but the slight extra cost and complexity of wires is a small price to pay.

Despite all these remarks about the relative virtues of the various H.F. speaker designs, good specimens of the various types would be difficult to identify by ear when heard as complete speaker combinations, and when using good average signals. With exceptionally good signals, say 15in. per sec. tape, or B.B.C.'s F.M. at its best, there might be slight differences discernible—but there would not be complete agreement as to which was the best!

A Frequency Cut At Wrotham

LISTENERS with sharp ears have noticed a change in the quality of the F.M. transmissions in the London area and have written in to comment on this fact, asking for an explanation. The answer is that, early in July, the B.B.C. cut the transmitted frequency range from the Wrotham station at 10 Kc/s, because of trouble which was being experienced with the higher frequencies. This cut will continue until further notice—which means, in effect, until the engineers have got to the root of the trouble and found the cure. Normally, Wrotham transmits a virtually unlimited frequency range, and is a particularly favoured station in this respect, because the transmission lines were specially equalised by the G.P.O. in the early days of experimental transmissions.

A generation of spurious frequencies in the higher frequency range occurred at the transmitter, and the cause of this distortion has so far not been solved, hence the present cut. The fault is not due to pre-emphasis as has been suggested.

* * *

The 1957 London Audio Fair

PRELIMINARY arrangements for the 2nd London Audio Fair have just been announced by the Organising Committee. As a result of the great success and the large attendance of the 1956 Fair, it has been decided to plan for an exhibition on a larger scale next year, and this will be held at the Waldorf Hotel, Aldwych, over a four-day period. The dates are April 12th to 15th inclusive (Friday to Monday).

The Fair will comprise demonstration rooms on two floors of the hotel, and a static exhibition on the ground floor. The increased space available will enable exhibitors to plan more elaborately for their static displays, and the demonstration rooms will also be larger. From the point of view of the visitor this should mean a correspondingly greater degree of comfort and convenience. Further, the addition of another day to the duration of the Fair will make it possible to set aside special times of opening for Trade and Overseas buyers.

THE B.B.C. PLAN

REQUESTS for a general picture of the B.B.C. plans for F.M. coverage of the United Kingdom continue to come in from all quarters, so we take this opportunity for summarising what is already in being, or in preparation, and for announcing the latest news of the second stage of the scheme. On the facing pages is a new map, prepared by the B.B.C., which shows the areas to be covered by stage 1 (10 transmitters) and with amendments to show stage 2 (6 transmitters). At the foot of column four is a table showing all the frequencies involved, with the exception of those for the "Light" and "Third" programmes from the projected station at Corwen, N. Wales, which is scheduled to come into operation late in 1957.

Stations already in operation are: Wrotham, Kent; Pontop Pike, near Newcastle; Divis, Northern Ireland; Meldrum, Aberdeenshire; Penmon, Anglesey (temporary); North Hessary Tor.

North Hessary Tor, South Devon, was brought into service on 7th August and now transmits the West of England Home Service on 92.5 Mc/s, the Light Programme on 88.1 Mc/s, and the Third Programme on 90.3 Mc/s, each with an effective radiated power of 60 kW. The transmissions are horizontally polarised. This new station is on the same site as the B.B.C.'s North Hessary Tor Television Station.

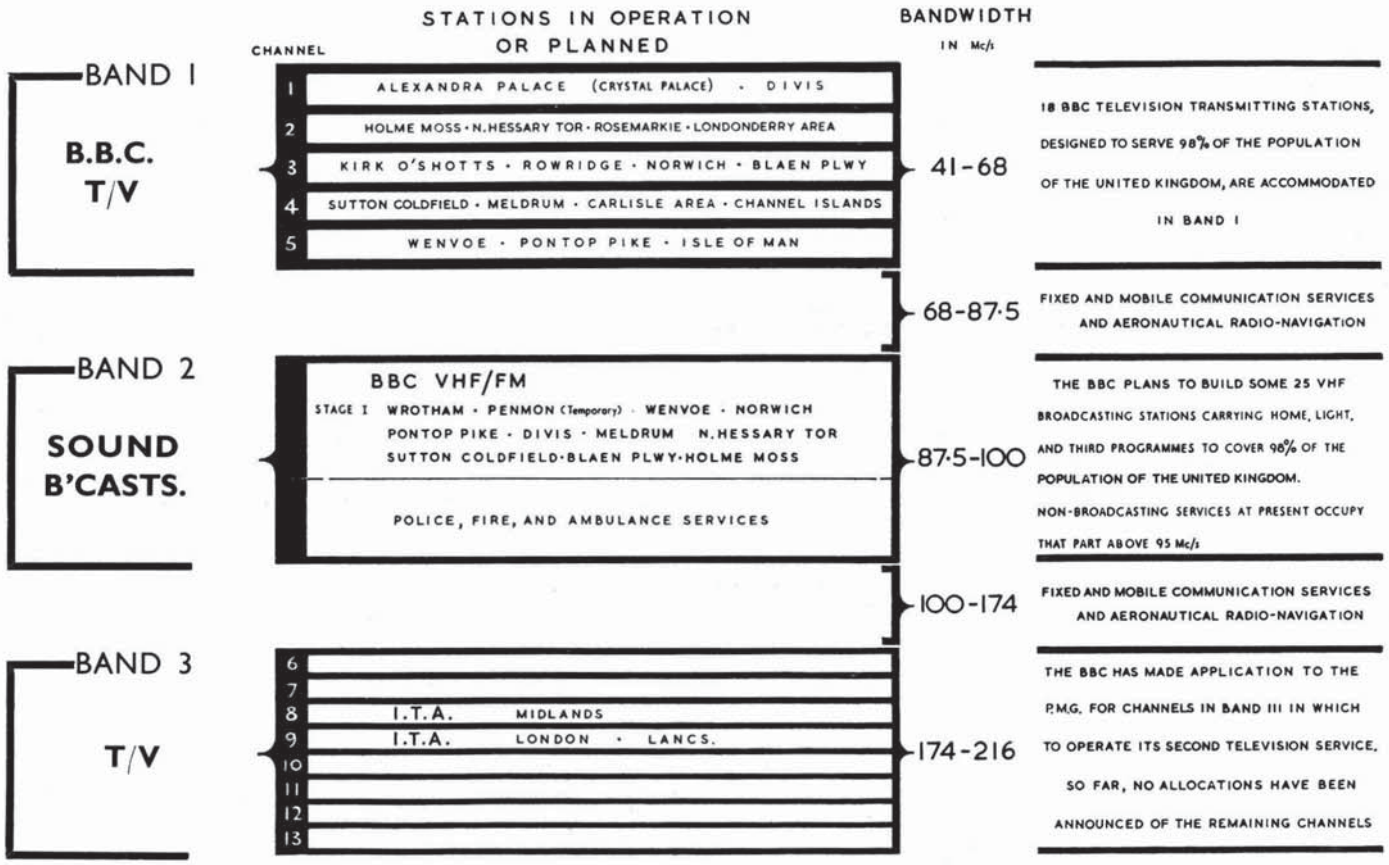
The area in which satisfactory reception is expected includes almost the whole of Devon and Cornwall, thus bringing the V.H.F. service within reach of well over 1 million more people. This new service provides a valuable reinforcement to the existing long-wave and medium-wave transmissions. The greatly improved reception, with its complete freedom from foreign station interference and better quality of reproduction that the V.H.F. system of broadcasting makes possible, will enable listeners in South-west England who have provided themselves with V.H.F. receivers and suitable aerials to get the fullest enjoyment from the three B.B.C. sound programmes.

As noted in our last number, the F.M. service will be further extended in the West Country when the additional transmitters are ready later this summer at Wenvoe, near Cardiff. This will provide good reception in North Devon, Somerset, and parts of Dorset, Wiltshire and Gloucestershire. The effective radiated power will be 120 kW. for each transmitter.

Norwich, Norfolk, will come into service towards the end of this year, with an effective radiated power of 120 kW from each of its three transmitters. Its coverage will be the whole of East Anglia, joining the service areas of London and Sutton Coldfield in the south and west and extending northwards to Boston and Skegness.

Sutton Coldfield, near Birmingham, will also be on the air late in 1956, with each of its three transmitters radiating an effective power 120 kW. It will serve an area extending as far as Chester and Gainsborough in the north, Oxford in the south, and Welshpool in the west, and linking up with the service area of Norwich in the east. This area includes the Nottingham district, where reception of the Midland Home Service on the medium wavelength is unsatisfactory.

TELEVISION AND VHF/FM SOUND BROADCASTING WAVEBANDS (U.K.)



FOR F.M.

SIX NEW STATIONS ARE ANNOUNCED FOR 1957-1958

Holme Moss, near Manchester, should start up at about the same time (late 1956), and with the same power as Sutton Coldfield. Its service area will be bounded on the north by a line running roughly from Barrow to Bridlington, and on the south by a line from Rhyl to Cleethorpes.

Blaen Plwy, near Cardigan, begins to operate as a temporary low power station, late in 1956, but is scheduled to go on to full power of 60 kW per transmitter early in 1957. It will cover the Cardigan Bay area.

The Next Six Stations

Rowridge, Isle of Wight, will be the first of the six new stations to come into service, and will be on the air early in 1957. It will cover the south coastal area roughly from Weymouth to Brighton, and including the eastern half of Dorsetshire, the Isle of Wight, most of Hampshire, West Sussex and the southern part of Wiltshire.

Kirk O'Shotts should be ready late in 1957, and will serve central Scotland, bounded in the north by a line running roughly from Rothesay in the West through Aberfeldy to Brechin and Montrose in the east, and in the south by a line running roughly from Ayr in the west to St. Abb's Head in the east.

Sandale, near Carlisle, is also expected to be ready by late 1957. Its frequencies are given as Light, 88.1 Mc/s; Third, 90.3 Mc/s; North, 92.5 Mc/s; and Scottish, 94.7 Mc/s. Its service area will be North-west England and South-west Scotland, including the counties of Cumberland, most of Westmorland and the southern half of Kirkcudbright and Dumfries.

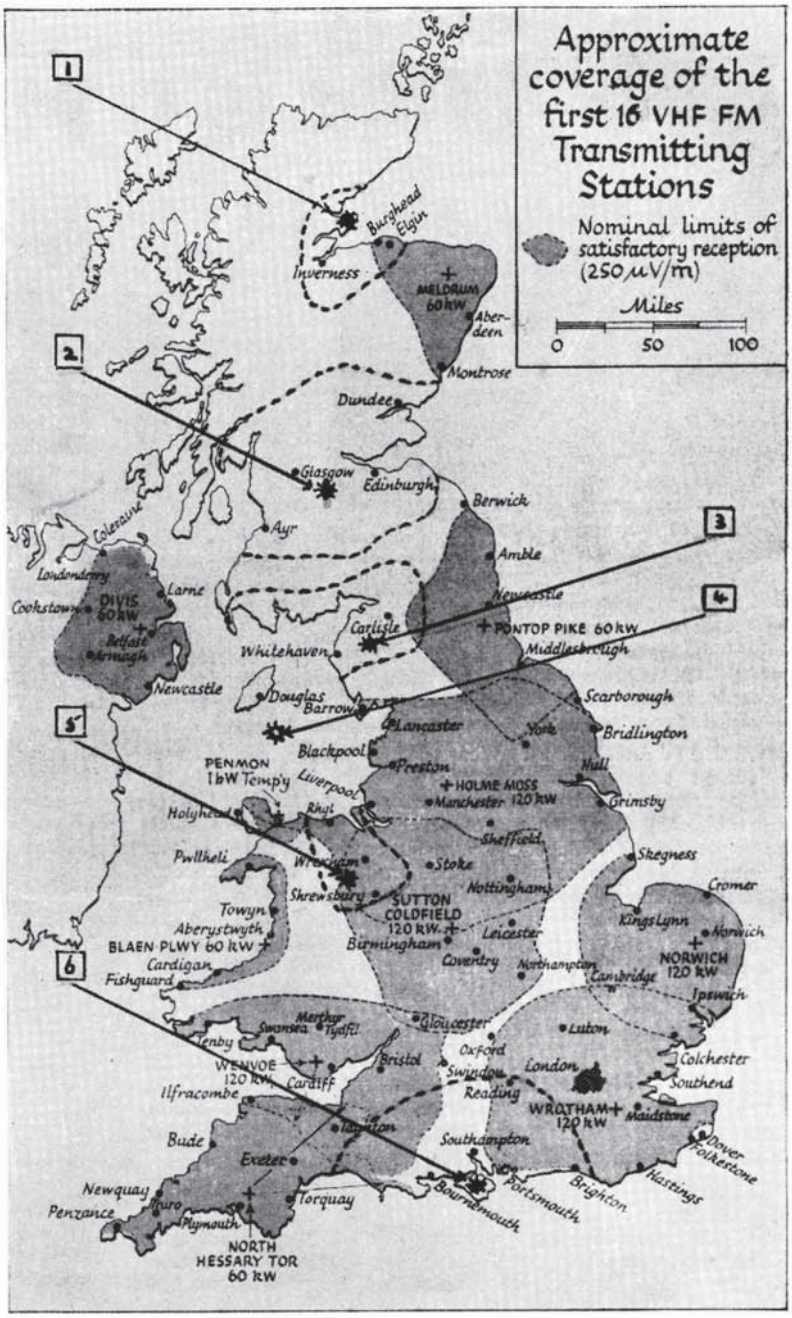
Anglesey, which will replace the temporary Penmon station now in operation, is scheduled to take over on full power in 1958. It will cover the coastal area including Caernarvon, Bethesda, Bangor and Conway, and at least the eastern half of Anglesey.

Corwen, North Wales, is dated for service in the latter part of 1957, and will serve Wrexham and the whole of Flintshire, most of Denbighshire, and parts of Merioneth and Montgomery.

Rosemarkie, Moray Firth, will complete the second stage of the plan when it comes into operation in 1958. It will cover most of Moray, joining up in the east with the area covered by the existing station at Meldrum. The whole of Nairn. The northern part of Inverness-shire including the Burgh of Inverness and the northern part of Loch Ness. The eastern part of Ross and Cromarty including Dingwell, Strathpeffer, Invergordon and Tain, and the coast of Sutherland including Helmsdale in the north.

No details are yet available of the effective radiated powers of the transmitters involved in the above six new stations, but all will use horizontal polarisation.

The original plan of the B.B.C. was to provide V.H.F. coverage, by F.M. transmissions, for approximately 98% of the population of the United Kingdom, taking in the Home, Light, and Third programmes. It was thought that this might be achieved by the erection of some 25 stations, of which the above two stages of the plan account for 16. It may well be, however, that the experience gained by practice will show that fewer than nine additional stations will be needed.

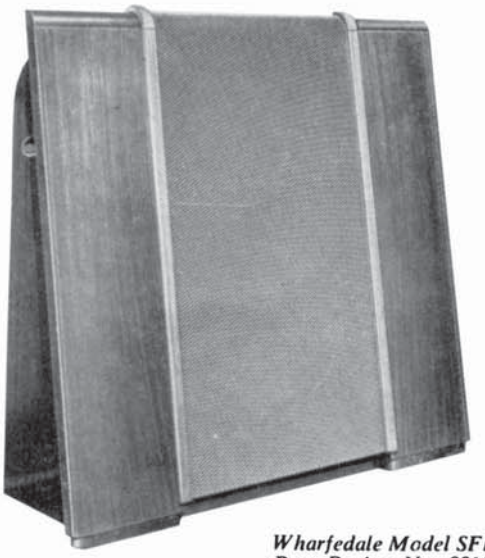


● *On the map, above, are the first* 10 *FM stations, marked* +, *with approximate limits of good reception (field strength* 250μV/m) *shown by shaded areas. The next* 6 *stations, marked* *, *are numbered* 1 *to* 6. *The frequencies are tabulated below. Dotted lines enclose the areas of good reception. The site of the new Anglesey station is not yet fixed.*

B.B.C. FM STATION AND FREQUENCIES

Station		Light	Third	Home	
		Frequencies in Mc/s.			
Wrotham		89.1	91.3	93.5	
Pontop Pike		88.5	90.7	92.9	
Divis		90.1	92.3	94.5	
Meldrum		88.7	90.9	93.1	
North Hessary Tor		88.1	90.3	92.5	
Sutton Coldfield		88.3	90.5	92.7	
Norwich		89.7	91.9	94.1	
Blaen Plwy		88.7	90.9	93.1	
Holme Moss		89.3	91.5	93.7	
Wenvoe		89.9	92.1	94.3	
	The six new stations as numbered on map				
Rosemarkie	**(1)**	89.3	91.5	93.7	
Kirk o' Shotts	**(2)**	89.9	92.1	94.3	
Sandale	**(3)**	88.1	90.3	92.5	**(North)**
				94.7	**(Scottish)**
Anglesey	**(4)**	89.6	91.8	94.0	
Corwen	**(5)**	—	—	94.9	
Rowridge	**(6)**	88.5	90.7	92.9	

SOME DETAILS



Wharfedale Model SFB/3
Reg. Design No. 881557

A 3-Speaker System by Wharfedale

GILBERT BRIGGS, of Wharfedale Wireless Works, Ltd., springs a surprise this month by the introduction of an entirely new 3-speaker system. It incorporates the W12/CS, 10-inch bronze/CSB, and Super 3, of which the 12- and 10-inch units are in parallel. The Super 3 is also in parallel via a 4 Mfd condenser. A high efficiency is claimed, suitable for full domestic volume from any good 5-watt amplifier. The baffle is sand-filled.

The reproducer is described as "free standing and easily moved"; it can be positioned for best results, and then moved against the wall when not in use. There is a choice of 4 finishes, in walnut, mahogany, oak and maple veneers. The price is £37 10s. complete.

The Connoisseur Amplifier

The Connoisseur HQ20 Amplifier and Preamplifier. Manufactured by A. R. Sugden & Co. (Engineers) Ltd., Well Green Lane, Brighouse, Yorkshire.

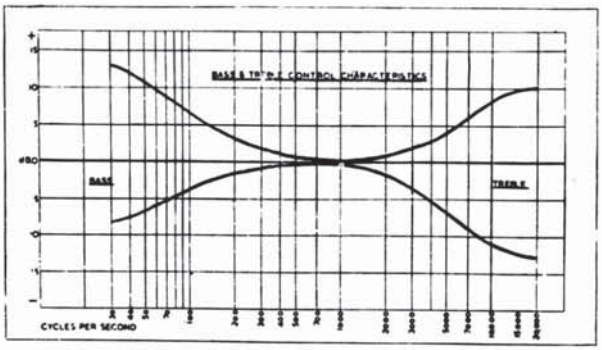
Summary: The principal features include a high power output to allow the reproduction of peak passages without overload; variable loudspeaker damping factor; cathode follower output stage to the power amplifier; inbuilt high-pass filter; input for tape; separate cathode follower stage allowing for recordings on tape from records or radio, with independent monitoring; compensation for disc recordings; comprehensive filtering system. The Power amplifier is a four stage unit consisting of a low noise non-microphonic miniature pentode Type EF 86, which is triode strapped and directly coupled to a high-gain miniature twin triode Type ECC 83. This valve is both a phase splitter and a driver amplifier for two EL 34 high slope pentodes operating under distributed load conditions. Loops of positive and negative feedback are applied from the secondary of the "C" core output transformer to the cathode circuit of the input valve, the amount of positive feedback being adjustable to give a variation in damping factor. A full wave heavy duty rectifier Type GZ 32 provides power for the amplifier and associated equipment.

Technical data (Maker's figures)

Output, Nominal rating 20 watts throughout the range 30/20,000 c/s. **Distortion,** Total harmonic content less than 0.1% at 20 watts 1,000 c/s. **Noise Level,** 88 dbs below rated ouput. **Damping Factor,** Variable from positive to negative values. **Frequency Response,** Within 0.5 db 10-50,000 c/s. **Load Impedance,** 15 ohms (normal). **Input Voltage,** 350 mV for 20 watts. **Input Impedance,** 220 K/ohms. Spare Power, 430 v/25 mA, 6.3 v/2.5 A for pre-amplifier and auxiliaries. **Power Consumption,** 120 watts excluding pre-amplifier and auxiliaries. **A.C. Voltage Input Required,** 200 - 220 - 240 or 100 - 110 - 120 volts 50 - 60 c/s. **Dimensions,** 12in. × 8½in. × 7½in. high. **Valves,** 1-EF 86, 1-ECC 83, 2-EL 34,, 1-GZ 32.

The Control Unit

The Control Unit is a low noise, low distortion tone control pre-amplifier. The first stage employs a non-microphonic low noise miniature pentode, Type EF 86, and uses frequency selective negative feedback to give correct compensation for most types of disc recordings. Feedback also operates on the radio position to give an appropriate flat response. The tape input socket is switchable to level response for use with tape, or, alternatively, to any of the record characteristics to allow the use of a second pickup in this position. The second and third stages use a high gain miniature twin triode Type ECC 83, the first half of which contains within a negative feedback loop the treble control and the inbuilt high-pass filter. Integral with the second half, and also using negative feedback, is the bass control and the resistor-capacitor network

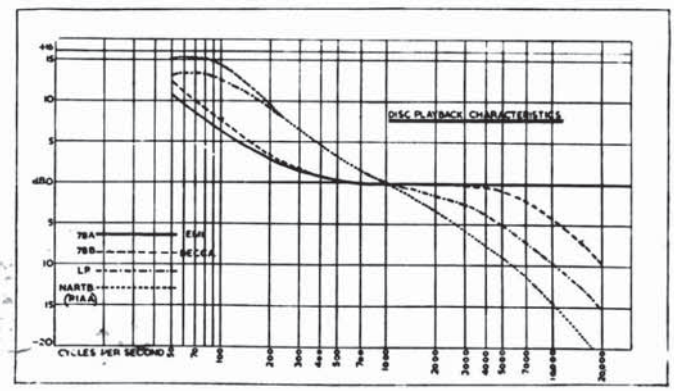


● *Connoisseur Bass and Treble control curves.*

which forms the low-pass filter. The fourth and fifth stages are the two halves of an ECC 83, operating as cathode followers. The input to the first cathode follower is regulated by the volume control and the output from the cathode is fed via the connecting cable to the power amplifier. The second cathode follower receives the full input and the voltage developed across the low impedance output can be used to feed a tape recorder or other auxiliary equipment without the loss of top response, even when a long connecting cable is used.

Technical data (Maker's figures)

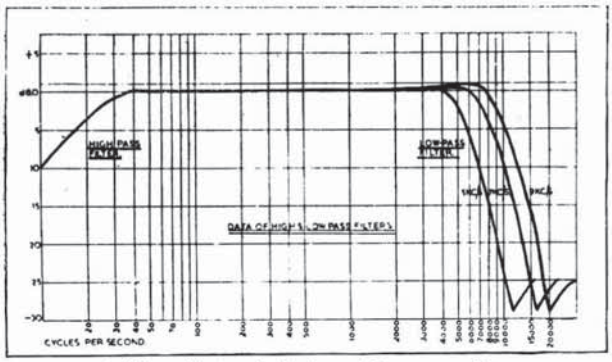
Nominal Input Sensitivity: Pickup, 15 mV. (impedance 200 k/ohms). Radio, 120 mV. (impedance 600 k/ohms). Tape, 15 mV. (impedance 200 k/ohms).



● *Disc playback characteristics of the unit.*

OF NEW EQUIPMENT

Controls Selector, for Radio (Flat response). 78A (EMI, 78 recordings). 78B (Decca, 78 recordings). L.P. (Long-playing records). N.A.R.T.B. (American 78 and a close approximation to the R.I.A.A. curve). Tape and Radio. **Treble,** Lift and cut continuously variable. **Low Pass Filter,** Switchable to roll off at 5 K/c-7 K/c-9 K/c and out. **Bass,** Lift and cut continuously variable. **Volume,** Linear operation. **High Pass Filter,** Inbuilt to give attenuation below 30 c/s. **Output,** 0.6 volts from cathode follower. **Output (Tape),** 0.6 volts from cathode follower into 200 k/ohms. **Power Requirements,** 430 v. D.C./5 mA. 6.3 v. A.C./ 1.1A. **Dimensions,** 11½in. × 4in. × 4¼in. deep. **Valves,** 1-EF 86, 2-ECC 83 or equivalent 12 AX7.



● *The effects of high and low pass filters.*

The units are supplied complete with all plugs and sockets. The chassis are of cast aluminium, with aluminium covers. The control unit is of stoved silver-grey, hammer enamel finish, with the escutcheon plate of engraved brass, finished in black and silver. The prices of the two units are: amplifier, £31·10·0 and pre-amplifier £16·0·0.

* * *

Lowther Transistor Pre-Amplifier

THE Lowther Manufacturing Co., will shortly market the first of a series of new transistor pre-amplifier units. This first model has been designed to operate as an intermediate stage between the control unit and low impedance units, such as moving coil pick-ups and microphones and variable reluctance pick-ups. Its gain is 100 to 1 (40 db): input, 3 mV; input resistance 5 ohms to 2,000 ohms; output resistance approximately 2,000 ohms. The front end frequency response is flat from 25 c.p.s. to 20 Kc/s, and the noise is below that of all background levels.

A sample of this unit is being submitted for review in "Hi-Fi News." In the meantime, those interested may write for further details to the Lowther Manufacturing Co., Lowther House, St. Marks Road, Bromley, Kent.

* * *

New Elizabethan Tape Recorder

HARD on the heels of the announcement of the Collaro Tape Transcriptor comes news of the first complete tape recorder to embody it. This is the "Elizabethan de luxe," manufactured by E.A.P. (Tape Recorders), Ltd., 9, Field Place, St. John Street, London, E.C.1. A sample has arrived for test, and a report will be published shortly. In the meantime, here are a few details, together with the maker's specification. It is unnecessary to discuss the deck, because this has already been dealt with (page 74, July). E.A.P. have mounted it in a portable case, measuring 17in. x 14in. x 9in., and the weight is 40lb. It is supplied complete, with a spool of E.M.I. Long-play tape (1,800ft.), take-up spool, moving coil microphone, plugs for extra speaker, and gram/radio connecting lead. Price 65 gns. A table model is also available, in ebony and sycamore veneers, for 69 gns.

There are three socket connections, for Radio/Gram, Microphone, and Monitor. A gram/volume control (combined with the on/off switch), and a master volume control, enable the microphone input to be mixed with the input from either gram or radio.

Specification (maker's figures): Amplifier input voltages for 3½ watts undistorted output, mic—2 mV, gram—200 mV. Outputs: internal monitor speaker (9in. x 4in. elliptical), switched speaker sockets, 3 Ohms, monitor and Hi-Fi output socket, 1 volt at 20,000 Ohms. Frequency response, at 15 i.p.s. 50 to 14,000 c.p.s. at 7½ i.p.s. 50 to 10,000 c.p.s. with 3 db, guaranteed (but top limits more usually 16,000 and 12,000 c.p.s. respectively). Amplifier bass boosted for discs to approx. 20 db. Tone control pre-set equalisation on "Record," variable top cut and boost on Playback. Magic eye indicator. Power supplies needed, 200-250 volts, A.C., consumption 100 watts.

* * *

Champion Hi-Fi Equipment

THE Champion Electric Corporation (London Office, 8, Eccleston Street, S.W.1) have just announced details of three Hi-Fi units. Model 853a—a pre-amplifier control unit; Model 853—a power amplifier; and Model 854—a pre-amplifier combined with FM tuner. Both 854 and 853a can be used with the amplifier, and the units 853 and 854 are of identical dimensions and in matching cabinets. They are priced at 22 gns. and 33 gns. (tax paid) respectively. The price of the separate control unit (853a) is still to be announced.

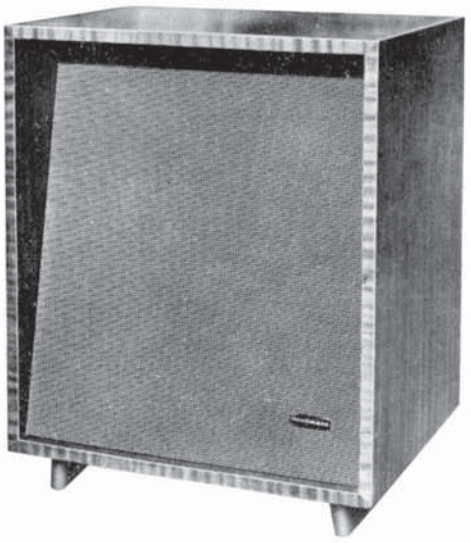
* * *

Philips Stylus Microscope

A MOST useful device is announced by Philips Electrical, Ltd., and which our contributor, Cecil Watts, intends to praise in high terms next month. It is a powerful microscope (x 100 magnification) for the examination of styli for wear and tear, and is fitted with a neat clamp for holding the specimens. Its official title is an unfortunate one—the "Needle Tester"; and equally unfortunate is the present official decision to restrict its sale to dealers.

The idea, however, is as excellent as the product is useful. And this could be a big and overdue step in the direction of longer record life.

A New Enclosure by Goodmans



● *The above illustration is of the new "Viscount" speaker cabinet recently announced by Goodmans Industries, Ltd., Wembley, Middlesex. It is the first of several new products which will soon be available from this Company, for new High Fidelity speakers, including two named, respectively, "Trebax" and "Midax," are to be released at the Radio Show this month. The prices of these units are not yet announced.*

TWO-SPEAKER SYSTEM

COMPRISING SUPER 3 TWEETER & BRONZE REFLEX

Illustrated on the right is an attractive combination of the new Super 3 Tweeter and the Bronze Reflex Cabinet. This small and compact two-speaker system gives a well-balanced, wide range response. The total cost, including 10" Bronze/CSB and Super 3 units, would come to £30. 1s. 2d., purchase tax on the two speaker units included, made up as follows:-

	£	s.	d	
Bronze Reflex Cabinet	14.	0.	0	
Super 3 Cabinet (10/15 ohms)	3.	10.	0	inc. V.C. and Capacitor
10" Bronze/CSB	5.	11.	3	inc. Tax
Super 3	6.	19.	11	inc. Tax
	£30.	1.	2	

Size of main cabinet 28"x 14"x 12¼"

Owing to the limited space occupied by this Two-speaker System it is ideal for stereophonic reproduction. The non-directional properties of the Super 3, which has open mounting, also help enormously in obtaining natural results.

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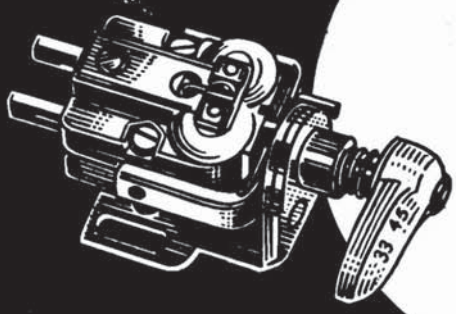

JANUARY, 1955	**This latest Goldring No. 500 is a complete answer** P. WILSON, M.A., "The Gramophone"
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JUNE, 1955	**Rated best Cartridge—best buy** *Special Report on 26 Hi-Fi Pick-Ups by a leading Testing Organization, U.S.A.*
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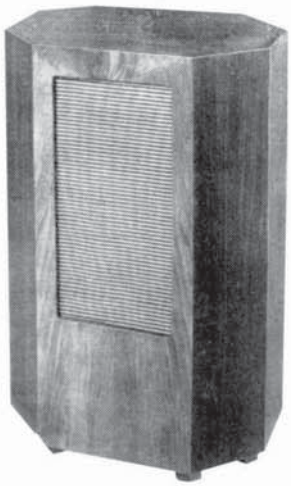
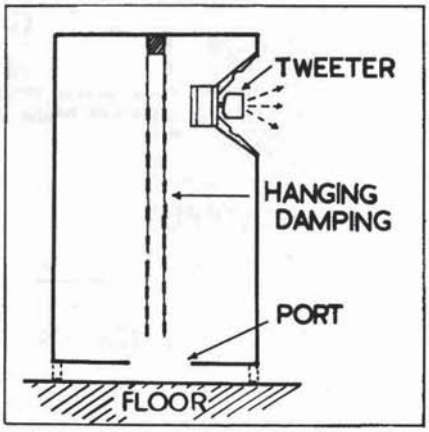
EQUIPMENT REVIEWED

G.E.C. Metal Cone Speaker With H.F. Unit





Design: The basic design is a conventional reflex loaded speaker, but several important features are incorporated which materially improve its performance. The bass port is in the centre of the bottom, and the space between it and the floor constitutes an external "tunnel." This enables the overall volume to be reduced without raising the resonant frequency or having to use an abnormally small port area. Slight alteration of leg height will tune the reflex (e.g., increasing the height will **raise** the frequency of resonance).

The octagonal shape reduces the areas of cabinet wall that are parallel to and facing each other, reducing the internal modes of (air) resonance in the 300-600 c.p.s. region. The damping material hangs in "midstream", instead of the more common position on the walls. This makes it operative over a very much wider frequency range, in fact, down to a few hundred c.p.s. while remaining as good at the top end (see "Hi-Fi Year Book" 1956, page 101).

The driving unit has three very interesting properties. Firstly, the speech coil former is an aluminium tube which, acting as a short-circuited turn, provides excellent damping at the low frequencies with quite a modest magnet system. As expected, the bass resonance is scarcely detectable. Secondly, the top response is exceptionally smooth, partly due to the speech coil design and partly due to indentations in the aluminium cone which "spoil" its symmetry (see diagram, and see note on cone breakup on page 98 in this issue). Thirdly, the performance is very stable with respect to time, temperature, and humidity, making it a useful laboratory tool, for which work it was originally evolved.

Above 3 Kc/s the top response is inadequate (except on the axis) for the best signals available, and to augment it a miniature moving coil speaker (15Ω) has been designed to screw into the centre pole in place of the familiar plastic "bung." This unit, being very small, has all the requisite properties for giving a good HF response, smooth, and widely distributed. It is normally fed via a 10 μF condenser as there is no need to cut the top to the main unit. This unit can of course be used for any HF application.

To match the rather awkward 4Ω of the metal cone speaker to current amplifiers, there is available an auto-transformer having negligible loss over the whole audio range. This will match one, two, or three 4Ω speakers to 15Ω.

For larger inputs than a nominal 12w, two units can be used in one octagonal cabinet. One tweeter is usually enough.

The 8in. metal cone speaker costs £6 13s. 7d. (plus £2 11s. 5d. P.T.), the tweeter £3 19s. 6d. (No P.T.), the autotransformer £2 17s. 6d. (No P.T.), and the octagonal cabinet £17 10s. (No P.T.). However, for those who wish to build their own, full constructional details for the cabinet are normally included with the 8in. speaker.

Listening: Without the tweeter operating, it proved itself a very pleasant little speaker, the smooth top response being adequate for most programme material. The bass response was very good indeed, smooth, and maintained to a surprisingly low frequency considering the cabinet size. No bass lift was necessary. For large orchestral items the cabinet was turned round to face the corner and slight top lift given. The result was quite impressive.

With the HF unit in circuit, the performance moved into another class and was capable of doing justice to the best signal inputs available. Used facing into the room, it gave the precisely located source suitable for solo items, and the HF distribution all over the room was even, as would be expected from so small a source size. Used the other way round, no top lift was needed, and the results were very satisfying. Continued listening produced no tiring, and a white noise check corroborated the evidence for a very smooth response over the whole spectrum. The small size of the cabinet (20in. x 14½in. x 30in. high), is useful, and its shape is pleasantly proportioned and is not likely to clash with many schemes of decoration.

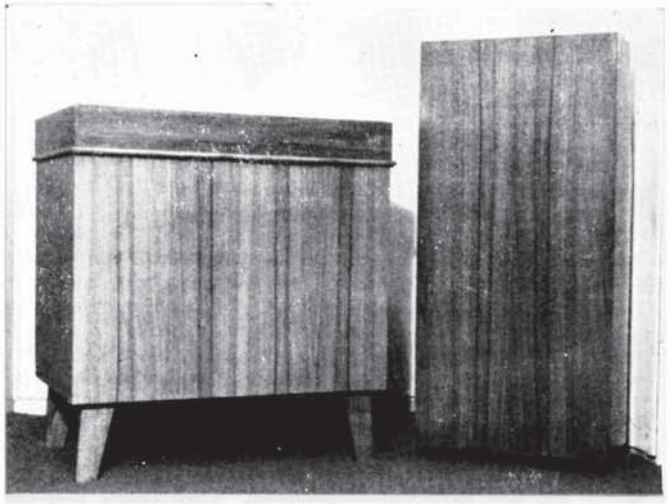
★ ★ ★

Connoisseur Super Lightweight Pickup

ALL knowledgeable Yorkshiremen will tell you that for many years the name of Sugden is synonymous with good engineering and honest workmanship, and the Connoisseur Turntable has long been the standard by which other units are judged. In point of fact, the turntable at present used for these reviews has been in continuous operation, six hours per day, five days per week, since 1951! and on present showing it appears to be good for another five years of trouble-free service. With this background, we were extremely interested to put Mr. Sugden's latest product through its paces, and in general we have not been disappointed.

The design of the cartridges and tone arm is simple and effective, and the finish cannot be criticised. The tone arm itself is a simple tube suspended on a single point, thus ensuring an absolute minimum of lateral and vertical friction. It is counterbalanced and the playing weight can be adjusted between 4 and 8 grams; in the writer's opinion, this should be adjusted to the upper limit of 8 grams. No provision is made for earthing the tone arm, but in view of the very low hum level this may not be considered necessary.

The model submitted for review has heads fitted with diamond styli, and the finish of these points did justice to the rest of the apparatus. The 78 r.p.m. stylus was 0.00235 inch diameter, and the l.p. was 0.00095 inch diameter. These are well within the production tolerances normally required. They appear to be



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The connoisseur will appreciate the tonal value and reproduction capacity which is equivalent to professional standards, for, make no mistake, the Elizabethan de Luxe is undoubtedly a machine for the real lover of fine sounds in speech or music.

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The Connoisseur Lightweight Pickup

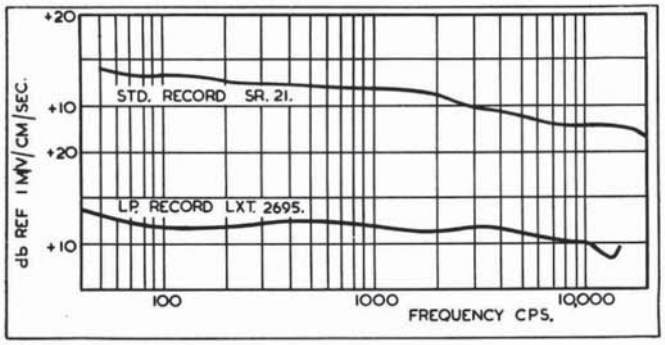
truly spherical within the limits of our apparatus (magnification x 500), and the polish was excellent.

Magnetic pickups are tending to fall into two distinct classes, according to the particular arguments their designer subscribes to. One group using the cantilever stylus tends towards the variable reluctance type of pickup, whilst the other concentrates the whole of the effective armature mass in a vertical plane pivoting it at the end remote from the stylus. Both types have their advantages and disadvantages. The Connoisseur Super Lightweight is based on this latter design and appears to have been carried towards the ultimate as far as practical. Because the whole of the moving armature is concentrated in the magnetic field, the efficiency is extremely high, and is in fact the most efficient pickup (in terms of electrical power output/mechanical power input) we have yet investigated. Because of this high efficiency, the electrical impedance for a given voltage output can be correspondingly reduced, and this contributes in no small measure to a high signal to noise ratio and exceptionally low hum pickup: on the sample we measured, about 20 microvolts, at any position over the turntable.

The armature itself is a small tube of magnetic material, about 1/32 inch in diameter, just over ¼in. long, and with its wall only a few thou. thick. It is supported at the remote end in such a manner that there is no possibility of forward motion. It is not generally realised that if there is appreciable motion of the armature in the direction of the groove, considerable distortion can take place on music passages, which is not apparent when measured on a sinusoidal groove, and with the increasing use of wide range equipment this particular form of insidious distortion can be most distressing.

The low effective lateral mass of the armature system results in the high frequency resonance being outside the recorded band on both 78 and microgroove test discs, and in the samples measured was of the order of 25 Kc/s. As this value was obtained by speeding up a normal record it is not strictly accurate but gives a reasonable indication as to its probable whereabouts.

The frequency response shown in the accompanying graph is extremely smooth and resonance free. A tendency towards third harmonic distortion was noted on the 8 Kc/s and 9 Kc/s bands of the SR21 test record. This tendency appeared cyclically once per revolution. Careful examination showed that the record was not exactly flat, lifting about 0.02 inch on one side. As the stylus started "climbing the hill" the distortion became apparent, whilst over the rest of the circle distortion was inappreciable.



● *These curves were measured from heads with diamond styli submitted for review. They show a corrected response for constant velocity. The load in each case was* 10 *megohms* + 100*pF. SR*21 *record for* 78 *head* : *LXT*2695 *for l.p.*

Increasing the playing weight from the normal five grams to eight grams completely eliminated this tendency. It is thought that this is caused by the vertical compliance being a little below optimum, especially when it is realised that the effective vertical dynamic mass of this type of structure will be approximately three times that of the lateral dynamic mass. However, exact analysis of the high frequency vibrational modes of even simple structures such as this is extremely difficult, and one should therefore not be tempted to prognosticate. The low frequency compliance was 3.5 x 10^{-6} cm/dyne, and this should result in adequate tracking capabilities with playing weights down to three to four grams.

We also found it necessary to increase the downward pressure to track the outer band of the JH 138 intermodulation test record. This again, we think, points to insufficiency of vertical compliance.

Needle chatter was not obtrusive in the least, and we were extremely gratified to find an Allen screw wrench thoughtfully provided for fixing the set screw on the counterbalance weight.

To summarise, this is a soundly constructed and beautifully finished piece of equipment. The frequency response is beyond suspicion, and the performance is more than adequate for all normal requirements.

Manufacturer's Specification: Connoisseur Super Lightweight Mk. 2.

Type: Plug in Magnetic. **Stylus,** tip radii (1) Green, for modern 78 r.p.m. 0.0025in. (2) Yellow, for older 78 r.p.m. 0.003in. (3) Red, for microgroove 0.001in. **Normal tracking pressure,** 4 to 6 grams for microgroove, and 7 to 8 grams for 78 r.p.m. **Lateral compliance,** not quoted. **Effective mass at Stylus tip,** not quoted. **Armature mass,** 4 to 5 milligrams. **Output,** average, l.p. 15 mV (90 mV with T6 transformer); 78 r.p.m. 25 mV (150 mV with T6). **Coil impedance,** 400 ohms. **Recommended load resistance,** optional resistive, to suit equipment. **Frequency response,** 25-20,000 c.p.s. ± 2db. **Price,** arm with one head (Diamond) £8 15s. 0d. (plus £3 14s. 10d. tax in U.K.), and (Sapphire), £5 13s. 0d. (plus £2 8s. 4d. tax in U.K.).

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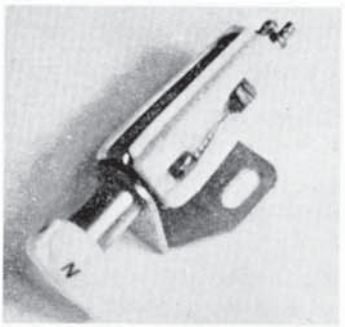


The Collaro Studio 'P' Crystal Pickup Cartridge

★

ONE definition of good engineering is "the efficient quantity production of a product equal in quality and performance to a costlier but less well-engineered design." When microgroove records first made their appearance, which necessitated different stylus dimension, a large spanner was thrown right into the middle of most design and production departments connected with the pickup industry. A few manufacturers, who had produced plug-in cartridges, were given an initial advantage in that generally the only additional pieceparts required for microgroove cartridges was a stylus point of correct radius. Fortunately, recorded velocities on microgroove records were then somewhat lower than standard 78 r.p.m., with the result that a cartridge which could satisfactorily track a 78 r.p.m. record at 15 grams would also track a microgroove at 10 grams, but the cost was one complete extra cartridge and in a very short space of time countless ideas were tried to use one cartridge only.

It didn't take very long before it was apparent that for general purpose requirements a crystal cartridge with two styli was the most satisfactory solution. In the early cartridges, the two styli

were coupled on to a common driving member, and one or other brought into operation by rotating the cartridge through 180 deg. The only disadvantage was that the free stylus resonated in the 3Kc to 5Kc region and resulted in a large "crevice" or "suck-out" in the response curve at these frequencies. It was soon realised that if sufficient mechanical decoupling could be inserted between the stylus arm and the crystal, the "suck-out" would be made virtually non-existent.

A few years ago, Messrs. Collaro placed on the British market the Ronette type turnover cartridge. By the judicious application of "lossy" plastic coupling members, the effect of the free stylus has been reduced to negligible proportions; an additional benefit of the damping so introduced is that minor resonances have also been almost completely ironed out. A further material advantage is the very effective decoupling of vertical motion of the stylus tip to the crystal, and because the remote end of the cantilever is firmly fixed to the cartridge case, motion in the direction of the record groove is impossible. The summation of all of these precautions is a considerable reduction in intermodulation distortion, especially at high modulation levels. On the cartridge tested, which incidentally was a random sample purchased over the counter, the intermodulation was of the order of 3 per cent. on the outer band of the JH138 test record, which is amongst the lowest we have ever measured.

As will be seen from the graph, the frequency response is very materially affected by the load resistance. This is indeed true of all crystal cartridges. It is our normal practice to measure into a virtual open circuit load and as a check into 1 megohm plus 100 p.f., which represents the average load conditions on domestic amplifiers. When the cartridge is so connected, the response is within the limits of the various types of recording characteristics. Alternatively, a differentiating circuit can be connected to the cartridge, which will result in a constant velocity response.

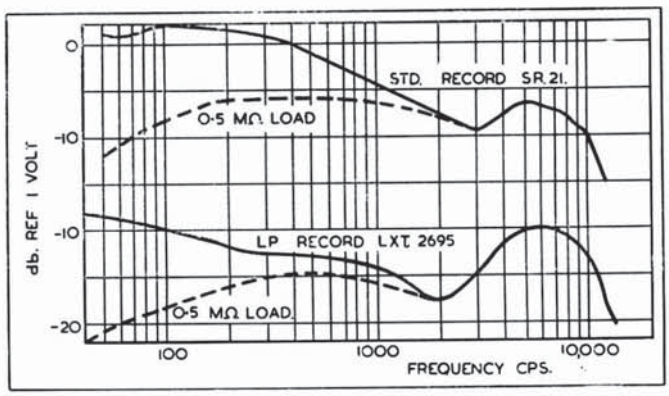
The compliance measured 2.2×10^{-6} cm/dyne, and because of the highly damped structure, was virtually non-resonant. The effective stylus mass was about 9 milligrams, but again was difficult to measure because of the above-mentioned damping.

Mechanically, the cartridge is neat, small, and extremely well finished. Stylus replacement is simple.

To summarise, this is a well made general purpose cartridge with an output more than adequate for all normal requirements. It has an extremely low distortion factor and the tracking capabilities are equal to the most heavily recorded discs we have yet obtained.

Manufacturer's Specification: "Studio P" Cartridge.

Type: Crystal turnover cartridge. **Stylus,** tip radii (1) 0.001in. for L.P. and (2) 0·00025 in. for 78 r.p.m. **Normal tracking pressure,** 7½ grams. **Horizontal displacement force,** 3 grams for 0.1 millimetres. **Effective mass at stylus tip,** 9 milligrams. **Output** (average), 150 mV per 3.16 cm/sec. for 78 r.p.m., and 50 mV per cm/sec. for L.P. **Impedance** (capacitative), 1,500 pF. **Recommended load resistance,** 12,000 ohms. **Frequency response,** after equalisation, substantially flat from 50 c.p.s. to 12,000 c.p.s. **Price,** £1 10s. (plus 11/7d. tax in U.K.).



● *These curves of the Collaro "Studio P" were measured from samples submitted for review and show an uncorrected response. Load in each case 10 megohms + 100pF. Discs used—SR21 for 78 stylus and LXT2695 for l.p.*

TAPE RECORDERS

In this section each month will be found news of tape recorders and details of stereophony.

"Reflectograph Bricks"

AN ingenious form of construction of pre-amplifier and power pack units has recently been developed by the Staffordshire firm, Rudman Darlington (Electronics), Ltd. These units, termed "bricks" on account of their self-contained nature, can be used singly, or "two-up," for single channel or twin channel work. Details and illustrations will be published in this section of **Hi-Fi News** shortly.

★

Reflectograph "Series 100" portable recorder, with variable tape speed, by Rudman and Darlington, who also make the "Brick" playback units.

★

Choosing a Tape Deck

AS mentioned at the conclusion of our introductory article last month, mechanical efficiency should be the primary consideration when choosing a tape deck, and there is a short list of points that should be studied with care before buying. First, and of absolute importance, is the matter of a rock-steady tape drive. There is no forgiveable reason why any tape deck, designed for the recording and reproduction of music, should fail in this respect. If it does, then ignore it. Good motors, of ample power; a simple, solidly built drive between motor(s) and capstan; a smooth tape take-up mechanism, with even tension and freedom from snatching; sensibly designed pressure pads; a perfectly-balanced and generously-proportioned capstan flywheel, running in good bearings—these are the essentials to look for.

Perfect braking is the next point to watch for; and brakes should be tested properly, and seen to give instantaneous "stop" from full speed winding. Unreliable brakes not only cause endless irritation when it comes to winding back, or on, to a particular point on the tape, but they will inevitably result in the spilling and braking of tape.

Simplicity of mechanical operation is every bit as important, as the two points already mentioned. There is no reason why a deck should be complicated. If it is, then the user will inevitably make mistakes, however careful and methodical he may be. Stop and start controls should be so placed and effective that their use calls for no more than the simplest and most instinctive action.

The "Foolproof" quality of a deck, in mechanical terms, is without doubt the final point which must commend it or damn it out of hand. It should be so designed that it is impossible to "Record" (and therefore "erase") without having to make some definite and deliberate action to do so; and with this in mind, the prospective purchaser should see to it that the "Record" button, or lever, or knob, cannot be operated accidentally in any circumstances.

Of considerable importance, too, is the provision of a practical device for indicating the amount of tape used, or in hand—an indicator which will, in its best form, enable the user to return to a given point. Several types of indicator have been adopted. The Wearite deck uses an illuminated, graduated strip beneath the spool. The Collaro employs a feeler bar, which rests against the spooled tape and operates a needle on a scale. In the long run, however, it seems likely that best and most useful indicator will prove to be the "counter" type, which can be set to zero at the beginning of a spool and which "counts," like a speedometer, in units, tens, and 100's as the tape travels; for with such a device, carefully installed, it is possible to return to a given syllable, or bar of music, even from a fast wind.

Choice of Speeds

Speed requirements were discussed last month. For speech, 3¾ inches per second. For minimum Hi-Fi requirements, 7½ inches per second. It is unlikely that the Hi-Fi enthusiast will have much use for the 3¾ i.p.s. speed; though on a 3-speed deck it is an added attraction. Therefore, since it is equally unlikely that a single speed deck would be entertained (except by those who merely wish to play back the E.M.I. tape records, single or twin-channel, which are all recorded at 7½ inches per second), the two speeds to consider, when a type of deck offers two speeds, are 7½ and 15 inches per second.

The technical reasons for the use of the higher speeds are beyond the scope of this brief essay. Arrangements have been made for the preparation of a series of articles on this subject by one of the most experienced authorities in this country, and the first of these articles will appear shortly. Suffice it to say here that, properly handled, and with good Hi-Fi equipment in the form of FM tuner and amplifier, and given radio transmissions of a quality that we can now expect from the B.B.C. under ideal conditions, the Hi-Fi enthusiast can make tape recordings at the 15 i.p.s. speed that will equal, if not surpass, the quality of the best l.p. discs on the market.

The Collaro Tape Transcriptor

READERS who have been waiting for definite news of the 3-speed Collaro tape deck, and who are able to visit the Radio Show at Earls Court, which opens on August 22nd, will have the opportunity for examining this new unit, and for hearing it in operation. It is probable that the Transcriptor will also be seen as part and parcel of several domestic instruments, for the Trade has been awaiting deliveries almost as keenly as the Hi-Fi enthusiasts who hope to incorporate it into their sets of equipment. It should be borne in mind that several firms have been working upon small pre-amplifier units to operate with this deck, and we hope to give details of recommended units in our next number.

* * *

M.S.S. Recording Tape.

A sample of "professional quality" tape from the M.S.S. Recording Company was received, examined, and tested with great interest. One of the immediate advantages noticed is the high degree of polish on the oxide-coated side. This is so remarkable that, when making a test splice in artificial light, it was necessary to make an audible check, via the sound head, to ensure that the two lengths were being joined the correct way round! As may be imagined, the resultant saving of wear on the sound heads must be very considerable (and the M.S.S. Co. assure us that they are planning to mark the reverse side to make editing easier). For those interested in the properties of tape we publish the following data (maker's claimed figures):

Remnant flux, 0.7 Maxwells per ¼-inch tape. **Sensitivity and Frequency Response,** permits recording with a dynamic range of at least 60 db for the C.C.I. international, replay characteristic. **Modulation Noise,** 50 db below signal level. **Background Noise,** at least 65 db below peak recording level. **Print Through,** negligible from layer to layer. **Optimum Bias** (depending upon recording head design), H.F. bias ampere turns 7 to 10 times peak audio recording ampere turns.

The tape is supplied in the following lengths: 150 ft. (5/6d.), 300 ft. (10/6d.), 600 ft. (20/-), 850 ft. (27/6d.), 1,200 ft. (35/-), 1,750 ft. (55/-) and 2,400 ft. (75/-).

STEREOPHONIC SOUND No. 2

By James Moir

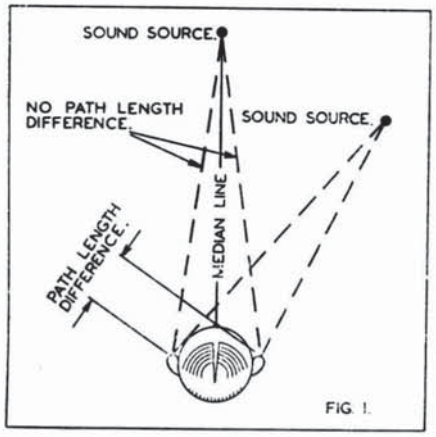
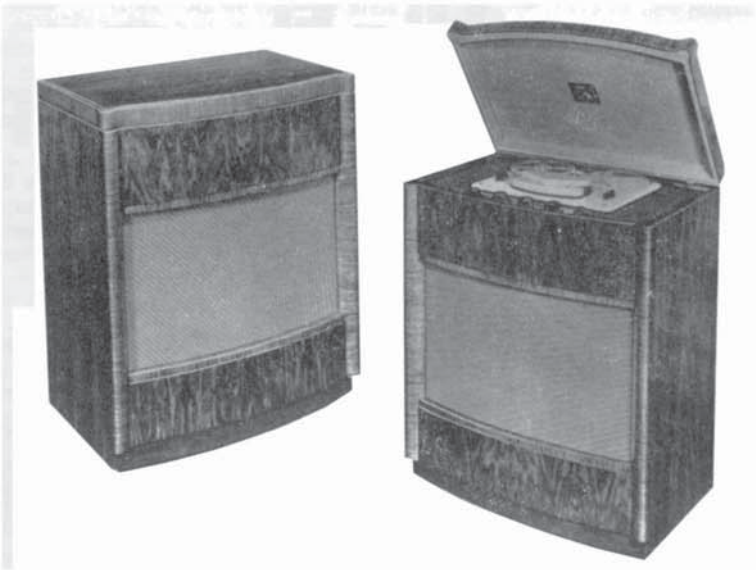


Fig. 1. *Origin of path length difference due to sound source off median line.*



H.M.V. Model 3034 Twin Channel Reproducer for sound from tape in the home.

LAST month we examined the characteristics of a stereophonic sound reproducer system and came to the conclusion that the main advantage was its ability to transmit an indication of the size and spatial position of the various sections of a large orchestra, or the relative positions of the actors in a play. At first sight this does not appear to be of overwhelming importance, but it turned out to have far-reaching implications. This month it is intended to consider what equipment is necessary to achieve a stereophonic reproducer system. It is most logically approached by reviewing what is known about the hearing systems' method of locating a sound source, for it is clearly necessary that our electrical equipment should do nothing to destroy the clues on which the hearing system bases its judgement.

Nature has provided man with two ears, either as a precaution against damage to one of them, or because two ears are necessary to fix the position of a sound source. Presumably the dangers to which early man was exposed during the night hours were just as great as the dangers he faced during daylight, and in consequence nature developed the hearing system to the point at which it has substantially the same performance as the eyes.

The Two Ears Sample The Differences

Two ears are necessary because they allow the sound field to be sampled at two points about 21 cms. apart, and from the **difference** in the sounds at the two ears the brain is enabled to calculate the direction and the distance of the sound source. It is important to note that it is the **difference** in the sounds at the two ears that provide the clues to source position, and it would therefore seem essential that our electro-acoustic system should convey to the listener's ears two **separate** sound images. If the two sound images get mixed during transmission the stereophonic effects will be lost.

After more than 30 years work by many high calibre research workers, we are still without any completely satisfactory explanation of just which differences are used by the hearing system to fix the position of the sound source, so the explanation which follows is necessarily not completely conclusive.

The brain may compare the differences in time of arrival at the two ears of some characteristic point on each sound wave. **Fig. 1** illustrates what happens when a sound wave arrives at the ears from a position directly in front, or from a position on one side of the head. If the sound source is directly in front of the head, the path from source to each ear has the same length, and the sounds arrive simultaneously at the two ears. When the sound source is round to one side of the head the sound has to travel about 21 cms farther to reach the far ear than it has to travel to reach the near ear. From the known velocity of sound in air, and the dimensions of the head, it can be calculated that there is a "time of arrival" difference of 630 microseconds (630 millionths of a second) when the sound is on one side of the head. As the sound source moves round the head, from the side to the centre, the time of arrival difference decreases from 630 microseconds to zero when the sound source is on the median line between the two ears.

The brain **may** compare the difference in loudness at the two ears, for sounds will clearly be slightly louder at the ear nearer the sound source.

The brain **may** compare the difference in the frequency characteristic of the sound arriving at the two ears. If the sound source is towards one side of the head, high frequency sounds will be increased in intensity at the near ear, for the head acts as an obstruction that reflects the sound, and it can double the intensity of the high frequency component in the near ear. At the same time the head acts as an obstacle which throws a sound shadow over the far ear, and decreases the high frequency content of the sound energy at this ear. Measurements by Weiner at Bell Telephone Laboratories have shown that at 1,000 c/s there may be a difference of 7 db, and at 7,000 c/s a difference of 18 db, in the intensity of the sound at the two ears when the sound source is 45° round one side of the head. This is illustrated by **Fig. 2.**

Though difference in time of arrival, loudness, and frequency characteristic, are thought to provide the main clues to the position of the sound source there may be others, individually of minor importance but collectively of considerable value.

Two Separate Channels Essential

Quite clearly, any good stereophonic reproducer system will have to provide two separate channels all the way from the orchestra in the studio to the ears of the listener at home. Two microphones and two amplifiers in the studio are not a particularly difficult problem, but two sound tracks on a gramophone record, two tracks on a magnetic tape, or two radio transmitters, are a sizeable complication. The gramophone record problem has been solved in two ways, though it is not thought that either will find extended public use. Blumlein of E.M.I. devised a method of simultaneously modulating a single record groove with two signals, the cutter moving from side to side for one signal and up and

down for the second signal. If two separate tunes were recorded, a change could be made by merely turning a switch.

Other workers have chosen the easier method of recording one signal over the outer half of the record surface and the other signal over the inner half. Two pickup heads mounted on a single tone arm tracked both inside and outside grooves simultaneously. In view of the importance of maintaining the time difference, separate pickups cannot be employed.

Two Magnetic Tracks, The Present Method

Two tracks on a ¼in. magnetic tape are an easier problem, for double track tape recorders have already been developed for other purposes. To adapt them for stereophonic recording only requires that the two recording heads be mounted side by side with their gaps accurately in line. When reproducing, the two reproducer heads must also have their gaps accurately in line, for this is essential if the reproducer system is not to alter the time **difference** between the sounds on the two tracks.

Two radio transmitters obviously represent a more difficult and more expensive problem, but it has been shown that the two signals may be simultaneously modulated on to one carrier, using amplitude modulation for one signal and frequency modulation for the other.

Sound film presents some difficulty but the Twentieth Century-Fox engineers have solved the problem very satisfactorily in Cinema-Scope, where four tracks are recorded on magnetic strips down the outer edges of the film.

At the reproducer end of the system the two amplifiers are not a particularly difficult problem, but the last link to the ears is really troublesome. A pair of headphones are an obvious choice, because this ensures absolute separation of the two signals, right up to the two ears. In practice few people are prepared to tolerate headphones, so some other solution is necessary if stereophonic sound is to get out of the laboratory and have widespread public use.

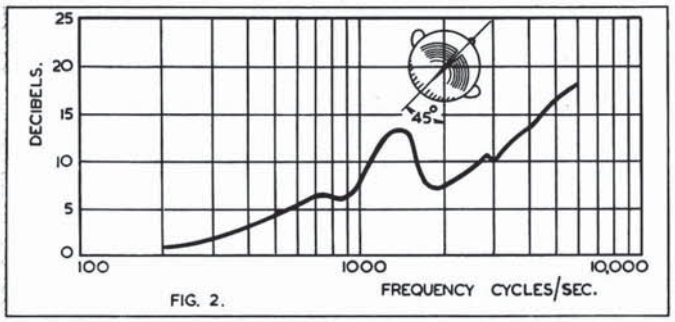


Fig. 2. *Ratio Db of sound pressure at ears for angle of 45°.*

Two speakers are convenient but they do not ensure complete separation of the two acoustic signals though, this may be assisted by appropriate positioning of the two speakers. Convenience may be considered to justify some loss in stereophonic performance, for no other alternative has been suggested for domestic use. At the moment two speakers are accepted as a practical necessity in domestic stereophonic systems, rather than in the belief that they are the ultimate choice. Experience shows that a two-channel stereophonic system, even with this limitation, can give a performance that is vastly superior to any single-channel system.

Accepting two channels, and two speakers at the reproducer end of the system, as a practical limitation it is natural to consider whether anything might be done elsewhere in the system to compensate for the deficiencies that result from lack of complete separation of the two acoustic images at the listener's ears. E.M.I., Philips and some other workers claim that a suitable choice of microphone mounting in the recording studio can give a considerable improvement, but as space is running out this point will be considered in the next article.

● Readers of James Moir's articles may be interested to note the title of his book to be published shortly by Chapman & Hall—**High Quality Sound Reproduction.**

New E.M.I. Twin-Channel Tapes.

LAST month, on page 64, we published details of the complete H.M.V. and Columbia catalogues of "Stereosonic" twin-channel tapes. As we close for press, details have arrived of new releases under both these labels, as published below. The release date is August 31st.

Columbia . . . 3rd Release

BTA	106	**Liszt.** Psalm XIII—"Lord, How Long?". Sung in English by Walter Midgley, Tenor, and the Beecham Choral Society (Chorus Master: Denis Vaughan) with the Royal Philharmonic Orchestra conducted by Sir Thomas Beecham, Bart.
BTA	107	**Glazounov.** "Raymonda"—Ballet Suite (Op. 57), played by the Philharmonia Orchestra, conducted by Lovro von Matacic.
BTA	108	**Violin Artistry, No. 2,** played by David Oistrakh (Violin) with Vladimir Yampolsky (Piano). (a) Clair de Lune (No. 3 of "Suite Bergamasque" by Debussy). (b) Jota (No. 4 of "7 Canciones Populares Espanolas" by Falla). (c) Extase by E. Ysaye, (Op. 21). (d) Valse—Scherzo, Tchaikowsky, (Op. 34).
BTA	109	**Mozart.** Concerto in E Flat Major for two pianos (K. 365), played by Clara Haskil and Geza Anda with The Philharmonia Orchestra, conducted by Alceo Galliera.
BTB	302	**Mozart Song Recital (Vol. 2).** Sung in German by Elisabeth Schwarzkopf (Soprano) with Walter Gieseking (Piano). (a) Das Traumbild (K. 530) (Hölty). (b) Das Veilchen (K. 476) (Goethe). (c) Der Zauberer (K. 472) (Weisse). (d) Im Frühlingsanfange (K. 597) (Sturm). (e) Die Zufriedenheit (K. 349) (Miller).
BTB	303	**Mozart.** Serenade in G Major (K. 525)—"Eine Kleine Nachtmusik", played by The Philharmonia Orchestra, conducted by Otto Klemperer.
BTC	503	**"Waltzing with Waldteufel" (No.1).** (a) Les Patineurs, (Op. 183). (b) Mon rêve, (Op. 151). (c) Estudiantina, (Op. 191), played by The Philharmonia Orchestra, conducted by Henry Krips.
BTD	703	**"Interlude for Rhythm".** (a) Lullaby of Birdland. (b) Alligator Crawl. (c) Spanish Affair. (d) Farewell Blues. (e) In a Sentimental Mood, played by Philip Green and his orchestra.
BTD	704	**"Music for Candlelight".** (a) Embraceable You. (b) The Touch of Your Lips. (c) The Nearness of You. (d) Stairway to the Stars. (e) Stardust, played by Norrie Paramor and his orchestra.
BTD	705	**"Music of Eric Coates"—(Vol. 1).** (a) "The Three Bears" Fantasy. (b) By the Sleepy Lagoon. (c) "Queen Elizabeth" March (from "Three Elizabeths" Suite), played by The London Symphony Orchestra, conducted by Charles Mackerras.

H.M.V. . . . 3rd Release

SAT	1009/11	**Mozart.** "The Marriage of Figaro". Sung in Italian. Acts 3 and 4. A Glyndebourne Festival opera recording, with orchestra and chorus conducted by Vittorio Gui. Cast: *Figaro,* Sesto Bruscantini; *Susanna,* Graziella Sciutti; *Bartolo,* Ian Wallace; *Marcellina,* Monica Sinclair; *Cherubino,* Rise Stevens; *Count Almaviva,* Franco Calabrese; *Don Basilio,* Hugues Cuenod; *The Countess,* Sena Jurinac; *Antonio,* Gwyn Griffiths; *Barbarina,* Jeannette Sinclair; *Don Curzio,* Daniel McCoshan.
Act 3 (First Part) Nos. 35-42 ... ... SAT 1009		
Act 3 (Conclusion) Nos. 43-50 and Act 4 (First Part) Nos. 51,52,54,55 ... ... SAT 1010		
Act 4 (Conclusion) Nos. 56-60 ... ... SAT 1011		
SBT	1251	**Saint Saens.** Concerto No. 1 in A Minor, (Op. 33), played by Mtislav Rostropovitch ('Cello) and The Philharmonia Orchestra, conducted by Sir Malcolm Sargent.
SCT	1505	**Prokofiev.** Symphony No. 7, (Op. 131), played by The Philharmonia Orchestra, conducted by Nicolai Malko.
SCT	1506	**Mozart.** Concerto No. 24 in C Minor (K. 491), played by Gina Bachauer (Piano) and The London Orchestra, conducted by Alec Sherman.
SCT	1507	**Delibes.** "La Source" (Act 2)—Ballet Music, played by The Royal Opera House Orchestra, Covent Garden, conducted by Charles Mackerras.

HI-FI BOFFINS

Personalities behind the apparatus we use

WHILE the name "Lowther" carries a fine reputation in the Hi-Fi world, Donald M. Chave, chief designer and owner of the firm, stays modestly in the background. So we thought it high time to turn our monthly spotlight on him. He entered the then "Medium-Fi" business in a very practical manner when he left school in 1929 (via Sheerness Junior Technical, and Polytechnic studies), and he designed a reproducer to provide interval music for the "Oxford Cinema" at Sheerness, in preparation for disc and film operation.

He recalls the details of that set-up with a smile; an Igranic head, with armature filed down and fitted with soft rubber and extra horseshoe magnets, and gantry arrangement to reduce downward pressure. This he coupled to a three-stage RC amplifier with a power stage of LS5B, and an LS6 push-pull output stage, with a generously constructed output transformer. LT power came from a car battery; HT from a heavy-duty Exide HT accumulator of 450 v.; Grid bias from a dry battery. All accumulators were automatically switched to D.C. mains for trickle charging when not in use.

The moving coil loudspeaker was based on, and constructed from, details published by "Wireless World" on the first dynamic speaker unit. Field ampere turns were increased; the pole piece was Swedish iron with a gap flux of 16/17,000 gauss; the diaphragm a re-entrant cone with rubber surround, and a fairly high impedance speech coil. The motor units were B.T.H. for D.C. mains.

Before the Days of Rumble!

And the results? In his own words, "a smooth response from the pick-up at about 25 grams downward pressure. True running motors (before rumble was invented). No background noise. A moving coil unit with very low resonance, good clear 'high's,' mounted on a heavy mahogany baffle—all providing very high degree of entertainment value." This equipment was later adapted with 4 turntables, with faders, etc., for disc and film combination.

Three years later the Lowther Manufacturing Company was started at Maidstone, with Donald Chave and O. P. Lowther as partners, and it got away to a flying start with the first of the now famous Dual tuners. These were followed by power amplifiers, tone control units, FM units, pick-ups and, of course, speaker drive units as the years passed.

The company moved to its present address at Bromley in 1935, and when Mr. Lowther left in 1939, Donald Chave took over sole control. An association between Voigt Patents, Limited, and the Lowther company resulted in the development of speakers being left in the capable hands of none other than P. G. A. H. Voigt, whose domestic corner reflector speaker was used exclusively by "Lowther" until 1949.

Donald Chave spent his war years with C.I.E.M.E. (Ministry of Supply) serving on Inter-Service valve and component specification panels, etc. He returned to find the Hi-Fi world bristling with material difficulties and so decided to concentrate all the effort into permanent magnet speaker development. The results were landmarks that most Hi-Fi enthusiasts will recall—19,000 gauss P.M.1 drive unit (1946); 24,000 gauss P.M.4 drive unit (1947); 25,000 gauss P.M.4 drive unit (1955); and also (1954) one of the most famous of all acoustic developments, the T.P.1. This reproducer employs the P.M.3 drive unit, and is a system of entirely new design and conception of compound horn loading. It is still the only reproducer of its type, with a single drive unit, which for the first time controls the action of a free-edged inner cone, and pressure drives an exportential bass horn.

The first experimental tuners (AM FM) were marketed by the Lowther Company to provide reception of the "first ever" transmissions from Alexandra Palace, so as to make possible the companion of AM and FM reception on V.H.F. The present model, the FM Mk. 2 tuner, has behind it all these years of useful experience.

As for the past, it certainly seems that the Lowther Manufacturing Company has a fair claim to being "one of the first in Hi-Fi." Of his future plans, Donald Chave will not say a great deal, but has promised us a news item in time for press (see page 103). He says that development is well in hand on a number of units which will be of considerable interest to all who are keen on good sound reproduction, and adds that "Hi-Fi News" will be the first with the details!

Rhona Chave, his wife, now controls the inevitably growing office work of the company, and also concentrates her energies on the development of the export market.

★ ★ ★

E.M.I. TWIN CHANNEL TAPES—(*cont. from p. 113*)

SCT 1501/04 **"The Beggar's Opera".** (Gay, Pepusch and Austin). Sung in English. Recorded by a double cast of speakers and singers, with the Pro Ante Orchestra and Chorus, conducted by Sir Malcolm Sargent. Cast, with speakers shown first: Polly, Zena Walker and Elsie Morison; Macheath, John Neville and John Cameron; Lucy, Rachel Roberts and Monica Sinclair; Lockit, Eric Carter and Ian Wallace; Peachum, Paul Rogers and Owen Brannigan; Mrs. Peachum and Mrs. Trapes, Daphne Heard and Constance Shacklock; Filch, Robert Hardy and Alexander Young; Jenny Diver, Jane Jacobs and Anna Pollak; Beggar and Gaoler, Lawrence Hardy; Matt, Robert Hardy; Highwayman, etc., Ronald Fraser; Player and Drawer, Aubrey Morris; also Eleanore Bryan, Anne Robson, and Loretta Davett.

Overture and Act 1 (First Part) ... ... SCT 1501
Act 1 (Conclusion) and Act 2 (First Part) ... ... SCT 1502
Act 2 (Conclusion) ... ... SCT 1503
Act 3 ... ... SCT 1504

SDT 1751 **"Memories of the Ballet"** (arr. Melachrino). Faust; La Source; Casse Noisette; La Boutique Fantasque; Ballet Egyptien; Coppelia; Swan Lake; La Gioconda; Syivia; also **"Waltzing Through The Operettas".** Lilac Domino (Cuvillier); Wild Violets—You, Just You (Stolz); Merrie England—Waltz Song (German); Tom Jones—Waltz Song (German); Monsieur Beaucaire—Philomel (Messager); Veronique—Swiss Song (Messager); Vagabond King—Valse Huguette (Friml); Belle of New York—Waltz (Kerker); Conversation Piece—I'll Follow My Secret Heart (Coward), also **Woodland Revels** (Melachrino), played by The Melachrino Orchestra, conducted by George Melachrino.

E.M.I. Twin-Channel Tape Prices.

Columbia		H.M.V.	
Series BTA	£3. 3.0.	Series SAT	£3. 3.0.
,, BTB	£2. 7.6.	,, SBT	£2. 7.6.
,, BTC	£2.15.0.	,, SCT	£2.15.0.
,, BTD	£2. 2.0.	,, SDT	£2. 2.0.

Binders For "Hi-Fi News"

READERS who wish to file their copies of **Hi-Fi News** will be interested to note that binders will shortly be available. These will be in the form of loose-leaf books with stiff covers, fitted with 13 strings for the 12 monthly numbers plus index. Current copies can thus be added to the book as they are published, and when complete the volume is of permanent form. Any pair of pages can be opened flat, and the binder is firm and rigid from the first number. The price of these binders is 13/3, including package and postage.

PAMPHONIC 1003

A new 10 watt amplifier complete in a table cabinet of attractive appearance with edge-lit perspex panel illuminating the comprehensive control gradations. **27 gns.**

Q.M. RECORD SERVICE

- **All Records FACTORY FRESH.**
  How important it is to get records free from blemishes that occur where others have tried them over.
- **All LP's and 45's in GARDISK full size polythene bags.**
- **Prompt mailing of any record in current supply.**
- **All LP's and 45's POST FREE in U.K.** *except single* 45's.
- **EXPORT ORDERS Tax Free at about 4/5ths home prices.**

V.H.F. RADIO

We stock a comprehensive selection of FM tuners. Amongst the best is this Pamphonic unit with good sensitivity, freedom from drift and tuning indicator. **£17.9.0**

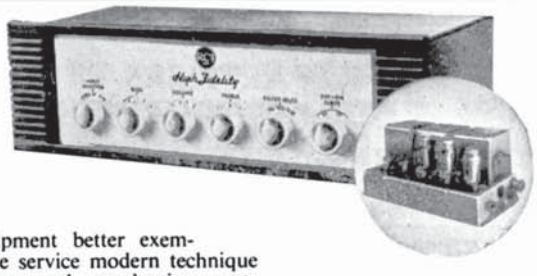
LONG PLAY TAPES

Give an increase of 50% recording time.
Emitape "99": 3in. 250 ft. 9/6, 5in. 850ft. 28/-, 5½in. 1,200ft. 35/-, 7in. 1,800ft. 50/-.
Scotch Boy 150: 5in. 900 ft. 32/-, 7in. 1,800ft. 54/-.
BASF: 5in. 850ft. 34/-, 5½in. 1,200 ft. 40/-, 7in. 1,700ft. 55/-.

DIAMOND STYLI

The merits of diamond points, especially for LP use, are increasingly recognised. For all popular pickups from stock. Acos, B.S.R., Collaro, crystal p.u.'s, £4.19.9; Decca magnetic LP, £5.1.10; Garrard GC2, £4.19.6; Goldring 500, £5.4.3.

RCA *New Orthophonic High Fidelity*



No equipment better exemplifies the service modern technique in design and production puts at the disposal of the seeker after fine quality. In appearance, in performance here is a thoroughbred. Come and hear it if you can or write for details.

RCA Pre-Amplifier Control Unit and Power Amplifier (inset) £48.

COLLARO 2010 TRANSCRIPTION MOTOR UNITS

These units combine high performance with moderate price. Well balanced motor and heavy turntable give freedom from rumble and wow, the "Studio" pickups being among the best for high fidelity reproduction.

With "P" pickup, £19. 3. 0; with "PX" pickup, £19. 10. 0.
Without pickup, £14. 18. 0.

QUALITY MART

8 Dartmouth Park Avenue, London, N.W.5. GULliver 1131

DEMONSTRATIONS
Tuesday—Saturday 9.30—6
Friday 1.30—9

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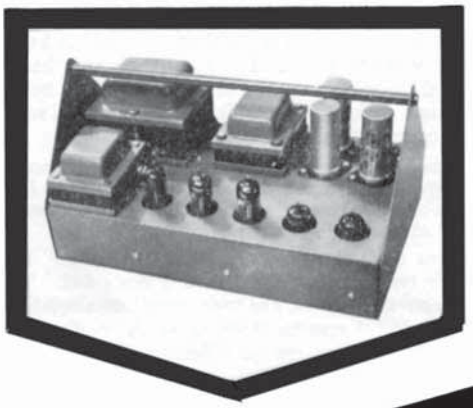
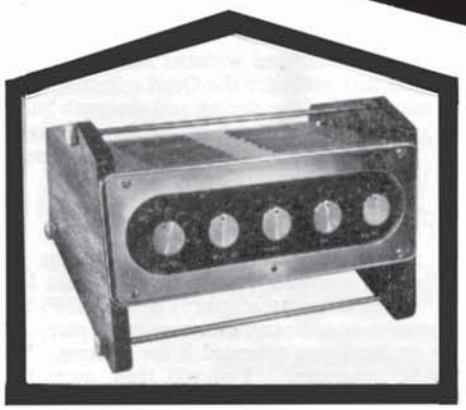


The NEW THERMIONIC TP100 AMPLIFIER and REMOTE CONTROL UNIT

TP Ltd

Ready for Autumn Listening!



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Q's and A's

A PRACTICAL FEATURE DESIGNED STRICTLY FOR BEGINNERS

JUDGING by the number of letters received, amplifiers present the biggest problem to the newcomer to Hi-Fi. On the one hand this seems strange, because there is much more thought required when buying a pickup or a speaker: on the other hand, it is understandable, because the choice of amplifiers is already wide, and it is widening rapidly.

Many of the letters include some such sentence as: "I have just seen such-and-such an amplifier (or an advertisement for it), and it seems to look pretty good, but I wonder whether it might not be better to spend the extra £5 or £6 on the so-and-so or the blank-blank. And is the one I have seen any good?". And, believe us, those letters are extremely difficult to answer individually! So, here we go:

Q. 1 *I have seen the Blank amplifier advertised, and I have been along to look at it. I must admit that it is not one of the better-known makes, but it is cheaper. What do you advise? Would it be better to spend the odd £s on another, and be sure?*

A. 1. You have the answer in the last three words. It should be realised that, with prevailing prices, the "odd £8" represents no more than four L.P. discs. Therefore, in order "to be sure", why back-pedal over such a sum? Of course, this argument can be extended until it covers the ridiculous; but it is a good point to consider when only a small sum is involved. Your amplifier is a component whose goodness, or otherwise, will very largely control the usefulness, and value-for-money, of all the other components you may want to use with it. Don't "save" unwisely when buying it.

Q. 2 *Yes, but why should the one I saw be other than good? How can I tell?*

A. 2. You can't. Not without knowing quite a lot about the subject; and that is precisely why you are advised to go in for one or other of the better known makes. With these, you are quite sure of getting what is necessary, and without having to know what to look for, or what to avoid. It stands to reason that if any amplifier is offered for sale (new) at a price substantially below that of the better known makes, there is likely to have been some saving effected in its construction.

Q. 3 *What* **should** *I look for in an amplifier? Assuming that I accept your advice that the better-known ones are going to give me all that I am likely to need, in terms of Hi-Fi results, what are the points to consider when choosing between them all?*

A. 3. These questions are still surrounded with difficuties. For example, let us name two makes. The Quad 2 costs £42. The Rogers RD Junior costs £26. Both are truly excellent amplifiers. Both will provide wonderful results, from radio, from disc, and from tape. You may well ask where the difference lies.

Q. 4 *All right, I will. What is the difference?*

A. 4. It lies largely in a matter of personal taste, and largely in the needs of the purchaser. Taking the second point first, the **Quad** has a greater power output than the **Rogers.** If you have a small room you may well be satisfied with the latter, but if you want the extra power you may settle for the Quad. Passing on to the other point, you may fall for the styling and the push-button selector controls of the Quad, or the finish of the Rogers may be just your cup of tea. And what applies with these two examples is equally applicable to all the other well-recognised makes.

Q. 5 *You still have to answer my query about points to look for. What are they, please?*

A. 5. That is a very easy one. As things are at the moment, you may only want to use your amplifier for playing discs, but look much further ahead. When bitten satisfactorily by the Hi-Fi bug, you will turn up your nose at ordinary, everyday radio reception, and will wonder how on earth you tolerated it for so long. You will then want an F.M. tuner unit. You will then, more than likely, want to play tapes. And you will probably want to record on to tapes yourself. So the basic things to look for are: input

points for disc, radio tuner, and tape (both record and replay); and since you are buying an amplifier, you want to be certain that it has enough spare power available from its power pack to drive the radio tuner when you decide to buy it.

Q. 6 *And what else? What about all those control knobs on the pre-amplifiers? How many of those are really necessary?*

A. 6. Five at a minimum: seven if you go the whole hog. The essential five are: volume, treble, bass, and selector switch (for switching from disc to radio, etc., and for selecting different types of input from different types of disc), also a filter control, by which you can cut off the higher frequencies as required. Some filters embody two controls, and some amplifiers are fitted with a "loudness" control. That makes seven.

Q. 7 *And is that all I have to look for?*

A. 7. More or less. For you can be sure that the other necessities (the details of good electrical performance) have been well and truly cared for by every reputable maker of amplifiers. You will certainly be quite safe in purchasing any amplifiers that you see advertised in the "Hi-Fi News". In other words, make up your mind to buy a good make; then decide what power requirements your room will need (and 10 watts normal output is adequate for small rooms); then decide how many of the refinements you need to satisfy your whims; and after that, let your own personal choice dictate the last word. For one thing is certain: all amplifiers costing £25 and upwards, made by makers whose names are household words in the Hi-Fi world, are basically good. Beyond that figure, and up to approximately £50, the field is yours to indulge yourself in extras, in styling, and in personal likes and dislikes. And we will deal with all these matters in future Q's and A's.

* * *

FLASH-BACK TO APRIL, 1956

● *The date was Friday, April 13th,* 1956. *The place was the Washington Hotel, Curzon Street. The event was the first London Audio Fair—and this picture was taken by our staff photographer in the brief period of inactivity before the fair opened, ten minutes later. Those who visited it will remember the crowds that followed. Seen here are the editor's secretary, Brenda Andrew, and our contributor, Stanley Kelly. We have been trying to publish a series of pictures of our contributors, but each month a pressure of other editorial matter has squeezed them out. This one has just made it, with an inch to spare. Details of the* 1957 *Fair are published elsewhere in this number.*

Connoisseur

THE MUSIC CAMERA

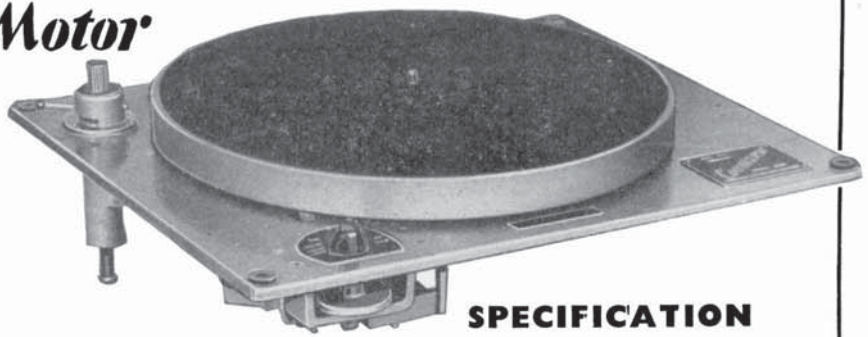
Come to think of it, music camera is a rather apt simile for the Mark II. Firstly, like a camera, it is a precision instrument. Secondly, it gives you a faithful reproduction of the original without any distortion.
The Connoisseur Mark II is a superb instrument.

- Frequency range from 20—20,000 cycles at 33⅓ r.p.m.
- 4 grams downward pressure.
- Total Armature mass 4 milligrams suspended on Nylon.
- Armature retracts if head is dropped.
- 100% coil screening minimises hum.
- Voltage output 15 mV. from L.P. disc.

THESE are the features that put the Mark II in a class of its own. When you own a Connoisseur, you never invite your friends to listen to the gramophone. You ask them to listen to an orchestra and they hear every instrument and every note.

PRICE : Pick-up complete with 1 head fitted with Diamond Armature **£8.19.0,** plus Purchase Tax **£3.16.6.** Head only, **£6.12.0,** plus Purchase Tax **£2.16.5.** Replaceable Armature System **£4.10.0,** plus Purchase Tax **£1.18.6.**
Pick-up complete with 1 head fitted with Sapphire Armature **£5.17.0,** plus Purchase Tax **£2.10.0.** Head only **£3.10.0,** plus Purchase Tax **£1.9.11.** Replaceable Armature System **£1.4.0,** plus Purchase Tax **10/4d.**

Transcription Motor



The Connoisseur 3 speed Transcription Motor is probably the finest gramophone turntable on the market to-day. It is a first-class engineering job, hand built from the highest quality materials. The 12-in. turntable is lathe turned in non-ferrous metal. The main spindle is precision ground and runs in phosphor bronze bearings. The Internal rim drive from a synchronous motor provides a mechanical speed variation of 4% on all speeds without braking action.

SPECIFICATION

Full 12-in. turntable. Synchronous motor. Mechanical speed change with 4% variation on all speeds. Input voltages 200/250 v AC 50 c/s or to order for 200/250 v AC 60 c/s or 110 v AC either 50 or 60 c/s. Price £20, plus P.T. £8.11.0

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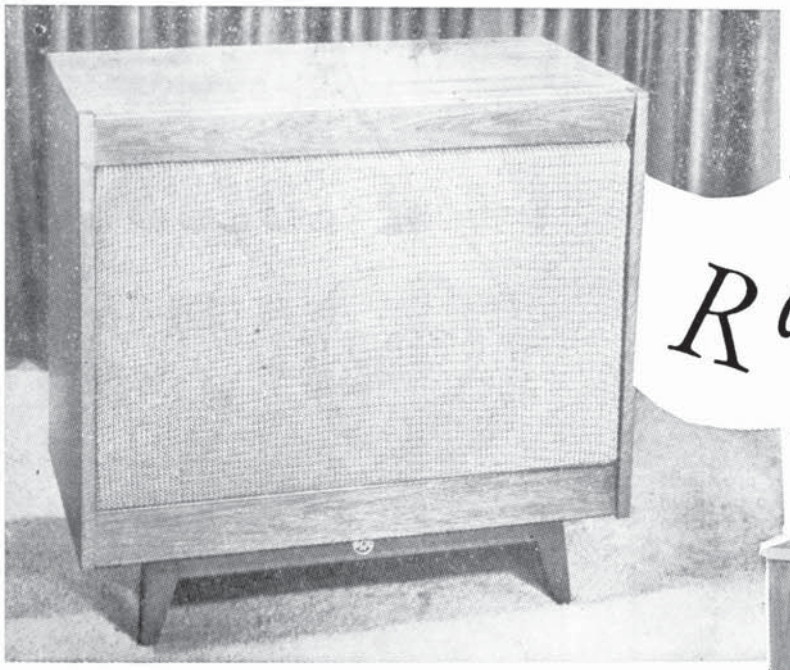
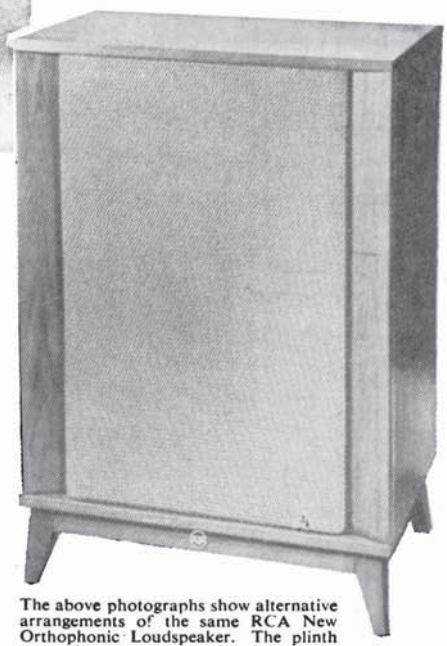


Realism



. . . is not enough!

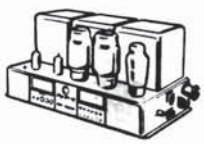
You need to be able to live with your high fidelity equipment as well as listen to it.
This RCA New Orthophonic High Fidelity speaker system uses advanced acoustical design to give a liveable size with clean aesthetic lines which will harmonise with any furnishing scheme. The system uses a ported bass reflex type enclosure including the exclusive RCA acoustic curtain damping feature. The special arrangement of the triple speaker assembly ensures even sound distribution to all parts of your room with perfectly balanced bass and treble response. This instrument with its great sensitivity captures those elusive elements of sound which make for completely natural reproduction. The RCA Loudspeaker is the latest addition to a complete range of perfectly matched High Fidelity units designed for studio quality, radio and gramophone reproduction in the home. Send for further details.

The above photographs show alternative arrangements of the same RCA New Orthophonic Loudspeaker. The plinth shown is a separate unit. Speakers can be supplied in light oak or continental dark walnut finish and without plinth if required.

F/M TUNER

TRANSCRIPTION DECK

PRE-AMPLIFIER



MAIN AMPLIFIER

RCA

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