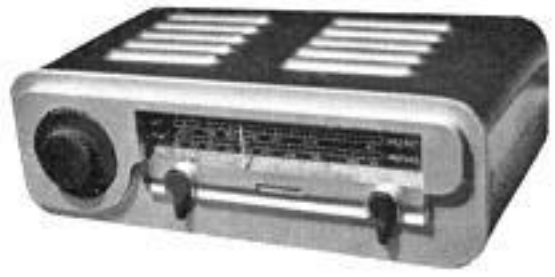

QUAD / a closer approach

A. G. WATLING VISITS THE ACOUSTICAL MANUFACTURING COMPANY AT HUNTINGTON

ANYONE who has designed and built a high quality amplifier will know how many snags can arise when he tries to build a second one exactly the same. The prospect of doing this day after day by the hundred should put anyone off being a hi-fi manufacturer! This thought kept occurring to me as we toured Acoustical's factory, seeing the Quad II and its control unit grow from metal, components and wiring forms, then passing on to tests which would condemn to failure most of our home-made triumphs. Accompanied by Peter and John Walker, answering with good humour our incessant questions, we soon began to appreciate the philosophy behind Quad equipment and the slogan "the closest approach to the original sound".

A discussion in the office before going on to the shop floor ranged over such subjects as efficiency of loudspeakers versus low frequency response (always topical), the need for careful specifications, non-standard repairs (I felt that one!), and a generally-voiced opinion that the standards of sound reproduction offered to the public were declining from the best available ten years ago. This latter remark should be qualified a little: the "best available" has probably been improved upon, but the supporting equipment to feed hi-fi to the Masses—and the general quality of signal available—falls too far short of what we *can* do.

The transistor invasion was discussed frankly, and to answer the ever-present question "When do Quads go solid-state?", the photograph on page 985 of the March *Hi-Fi News* shows that this has already happened. The 50-watt transistor amplifier is designed to replace exactly the Quad power amplifier in specification and performance where higher powers are required. The BBC is using them

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for 600-ohm line bridging amplifiers, for example, but they are not intended for the domestic market or for driving electrostatics unless you are interested in destructive testing at high power! Three times the maximum power, in fact, for twice the price. It has transformer output to meet specifications from 1-ohm to 600-ohms and 100 V-line requirements. Such attention to professional needs underlines the Quad attitude to design. "Both amplifiers," said Peter Walker, "are probably twenty times better than they need be."

Professional requirements take a high percentage of amplifier production. Radio Sweden, for example, uses over 1,000 Quad II power amplifiers. Rediffusion uses them as 20 W amplifiers for distribution. There are eleven different models of the basic amplifier to cope with various outputs and inputs. The basic amplifier has changed little since it was developed in 1945 (before the term 'Ultra-linear' became the vogue). The distributed-load design and the 'see-saw' phase-splitter have become audio history, as has the term 'Unconditional Stability'. Enthusiasts may remember the original amplifiers in the line, the Q.A. 12 and Q.A. 12 P. The Q.A. for 'Quality Amplifier' started the idea that a simple trade name would be more easily remembered than a type numbered 15374 Z. Thus Q.U.A.D. appeared, and later lost its full stops. QUality Amplifier, Domestic; no prizes are offered for alternative translations, but fascinating names suggest themselves for some equipment heard at Audio Fairs!

The control Unit, apart from going stereo, has changed quite a bit. The original mono version (78 r.p.m. characteristic) was a straightforward ECC 35 two-stage preamplifier with feedback volume control, a passive tone control network, and the then unique variable-slope filter. This was at a time when disc reproduction by better pickups and the HF response of Quad Corner Ribbon were drawing attention to tracing distortion—a case of the wider-open window again. Plug-in equalisers to meet a wide range of pickup requirements came next, with push-button selection of recording characteristics and input function. With doubling-up for stereo and increased sensitivity to cope with modern magnetic pickups, the control unit has become a complex item.

We saw the wiring, always much admired in Quad equipment, being expertly and *very* quickly completed. The final testing of such a unit poses a problem if the manufacturer is to be confident that his specification is to be met in service. Think of the permutations of tone controls, filter, volume and function settings that confront you, with a check for noise and distortion into the bargain. Quad have solved this with what I consider a fiendishly clever Chinese test-box. The control unit is plugged into it, and compared with a master unit which is carefully calibrated beforehand. A square-wave is fed to both inputs, one output is inverted and both outputs are combined on an oscilloscope. Thus, if both units are identical the result is a straight line. Any combination of settings can be quickly checked, and a non-electrostatic type speaker emits any strange noises that occur: *Quad erat demonstrandum* (!).

The power amplifier undergoes a similarly stringent test at spot frequencies for output, distortion, sensitivity and background. Valves are discarded, if suspect, with quite alarming nonchalance. If any of us, as amateurs, showed the same respect for specifications I'm sure our stock of valves would vanish overnight. That box marked 'Probably O.K.' would have to go for a start.

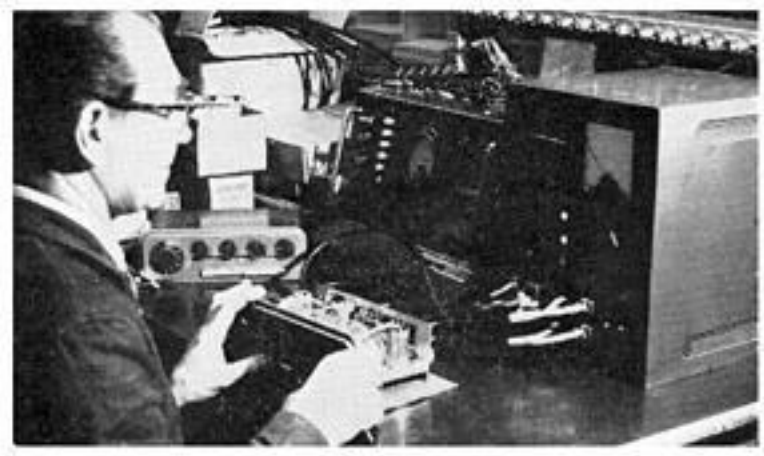
With a sidelong look at tuner assembly—an admiring one again for the neatness of RF wiring and the care taken with the tuning mechanism—we passed into the loudspeaker room. My personal Mecca, this, as I suspect it would be for a number of readers. A mouth-watering collection of electrostatic units in various stages of completion was evident. The perforated fixed plates for the bass units, with their conductive coating, were receiving their spacers. The diaphragm material? Its coating and treatment are still trade secrets, so we must keep off the subject! This is, after all, one of the reasons why Quad have kept in the forefront of ELS design since the prototype appeared in 1955.

The assembly and testing is an interesting sidelight on one of the advantages of ELS design. Since the variables are all taken care of at the drawing board stage, the assembly becomes more of a mechanical one. No ports to tune, no cabinet resonances to fiddle, and only a suspicion of damping at the rear of the unit. A sensitivity check is made by feeding a "rude noise in and seeing how much rude noise comes out"; in more explicit terms, a wobbulated square-wave input and a microphone at a fixed distance to measure the standard output. The complete loudspeaker, with its matching transformer, feed resistors and EHT supply, is listened to on programme material and oscillator against a standard in a screened enclosure.

We asked Peter Walker if he ever got requests for Jumbo-size bass units, electrostatics in boxes, and other deviations. "Yes," he said, "but we turn them all down." Once having made the decisions at various stages of the design to get what he considered optimum results, he is understandably loath to let the component parts loose for anyone else to have a go. About 2000 speakers are in professional use as quality monitors and comparison units and, like other Quad equipment, are operated in many countries. With agents in fifty countries and over 50% of all output exported, Arthur Fletcher, the Export Manager, is kept pretty busy.

Components for the electronics side which are made in the factory include air-cored filter

(*continued on page* 69)



Photos. by J. D. Thomson

Top, final assembly of complete electrostatic loudspeaker

Comprehensive test of control unit compares output with that from a calibrated master unit

Spacers are fitted to the fixed plates in the electrostatic bass unit

Test equipment used for ELS units: programme source, power amplifier, sweep source. In the background, a 'ball and biscuit' microphone monitors O/P of a bass unit

Bottom, final check of power amplifier—a test-set covers the complete specification

UNDERSTANDING HI-FI CIRCUITS CONT.

a switched high-pass filter may not be included. A typical rumble filter characteristic is shown in **fig. 3.**

Now, the tone controls and filters are incorporated in two or three stages after the first equalised preamplifier stage. In some designs the volume control is arranged to provide a progressive bass boost as it is turned down. Normally, of course, the volume control is frequency-independent, and when it is arranged to giving rising bass with decrease in setting it is called a 'loudness control'. Some amplifiers feature a loudness control which, when switched out, endows the volume control with its ordinary action, but when switched in changes the action to that of a loudness control.

It is sometimes said that a loudness control is more accurate than a volume control in controlling the level of reproduction because the human ear is not equally sensitive to loudness over the entire audio spectrum. This phenomenon has been investigated in detail by scientists, and resulting from this we have 'loudness curves' (see *Audio Diary*, page 53). These show the required relative levels of sound at various frequencies for a sensation of equal loudness. The curves demonstrate clearly that at low-level listening quite a large degree of bass boost is required to obtain the sensation of the same apparent loudness over the audio spectrum. They also show that a smaller amount of treble lift is required for optimum tonal balance at low-level listening; but few loudness controls are accurately tailored at both ends of the spectrum—bass lift being the prime effect in many instances.

Most non-American enthusiasts favour the ordinary volume control, as, if music is quiet in real life the lack of bass is accepted as normal; also, one can always perform tonal adjustments to suit any level of listening by use of the ordinary bass and treble controls. The curve in **fig. 4** shows the characteristic response of a loudness compensation circuit. This starts taking effect at about 500 c/s, giving an LF boost that increases as the volume is lowered.

We have already seen that it would be bad policy to locate the volume control in front of the first stage. In the interests of optimum signal/noise performance it is often positioned between the output of the first stage and the input of the second stage of the control unit. Sometimes it comes after the second stage, and in some amplifiers right at the output of the control unit. These positions are illustrated at **(a)**, **(b)** and **(c)** respectively in **fig. 5.**

If the volume control is positioned very late in the control unit, the designer has to take extra special care to ensure that the 'uncontrolled' stages will not be overloaded and thus run into distortion when the normal contrast of the programme applies a signal of high level at the input. With a single 'uncontrolled' stage, for instance, there is little risk of the programme contrast causing overloading, but where two or more stages are employed *before* the volume control, the signal level at the input of the final stage could be extremely high on loud passages of programme material.

For microphone amplifiers and equipment where there is likely to be a wide range of input signal levels, the volume control is often best placed directly after the first stage, but for ordinary hi-fi reproduction a cascaded amplifier system can be designed that will handle the dynamic range of the programme material without excessive noise at low level and excessive distortion at high level.

In any event, some of the stages of the control unit are not designed themselves to provide gain. The tone control stage, for example, may use a valve simply to counter the losses of the variable filter circuits of the tone control system, thereby contributing very little or nothing to the overall gain of the control unit.

Fig. 6 gives a block diagram of the various stages of the control unit, showing the volume control as the main output control, feeding the main or power amplifier. The first stage has already been dealt with in past articles of this series. Next month we shall start looking at the circuits associated with the tone, volume and loudness controls, and with the filters.

STEREO ANNIVERSARY CONTINUED

Uniontown Motel, some 40 miles outside Pittsburgh. The terrain in the Pittsburgh-Uniontown area is moderately rolling and, therefore, provides an obstacle to any VHF signal, mono or stereo. To evaluate all the performance requirements thoroughly, hundreds of test-tape recordings were made of each system under analysis. These tests were made under all kinds of reception conditions and with various types of receiving apparatus.

Finally, a decision was reached by the Commission—one which caught a large portion of the interested public and a small percentage of the industry by surprise. In April 1961 the FCC announced that the stereo broadcast system which should be used by broadcasters would be a combination of systems proposed by the *General Electric* and *Zenith* Companies. Briefly, the FCC specs called for a subcarrier modulation comprising the *difference* between the left and right channels and a main modulation derived from the *sum* of the left and right channels. Additionally, the adopted system would have a pilot carrier at 19 Kc/s which would synchronise the adapter (see **fig. 3**).

Following the FCC announcement there was rapid action in both the audio and broadcasting industries. Manufacturers became engaged in intense competition to produce the first multiplex adapters and stereo tuners, though initially these products were only available in certain parts of the country.

Two months after the FCC announcement the first *regular* FM multiplex stereo transmissions went on the air. WGFM, owned and operated by the General Electric Co., and WEFM, the Zenith FM station in Chicago, were naturally among the first stations to be using the approved stereo radio system. At the time the New York Audio Show opened in early Fall, three New York area stations (including WLIR, WQXR and WDHA) were broadcasting in stereo. By late October of 1961 the number of FM stereo stations on the air, nationwide, had increased to 15.

More than 275 FM stations currently broadcast in stereo, placing 90% of the U.S. population within range of one or more stations. The GE-Zenith System of stereo broadcasting has now spread to Canada (17 stations), Japan (32 stations) and many Continental European Broadcasters have adopted the system for their transmissions. Even Manx Radio, in the Isle of Man, is broadcasting in stereo, though on a limited basis. The FCC, always interested in advancing a good thing, is currently studying proposals on stereophonic sound for television.

QUAD VISIT CONTINUED

coils, chokes, and the intricate output transformer. There is a sizeable tool-room where prototype metalwork and specials can be made, and a well-watered paint room where we saw the familiar dark metallic grey finish being applied. The Production Manager (James Watson) has a very wide field of work to keep in mind.

Before we left we paid a quick visit to John Collinson and his team in the 'boffin' department. Working in the sort of organised chaos that seems a bit more familiar to us than the production line, he was deep in printed circuits, multiplex decoders and decibels. The discussion there could have gone on a great deal longer, putting the audio world to rights, but we had come to the end of our visit.

Although I'm sure the Walkers would detest the phrase, the Quad 'image' is quite a definite one: A great respect for design and specification, a relationship with the customer which treats him as an intelligent being, and an obviously happy staff. What is more, they listen to music and know what it should sound like. They cater, in fact, for the people who "buy a loudspeaker to listen to Beethoven"—not the other way round.

Thank you, Quad, for a most interesting day.

HINTS AND TIPS

BY HARRY LEEMING

FILM CANS

The small aluminium cans which come with 35 mm film casette refills are very handy for screening PU matching units, attenuators, etc. Most photographic dealers have large numbers of these surplus, and will gladly let you have a few free of charge.

ARMS AND CARTRIDGES

It should be noted that the position of the fixing holes on cartridges of different makes is by no means identical, and that this can cause a serious tracking error (resulting in distortion, especially near the centre of a record) if it is not allowed for. When fitting a cartridge to an arm, the tracking should be measured near the centre of the record, and the head shell re-drilled, or the pickup arm adjusted in some other way if the error exceeds two degrees.

(continued on page 89)