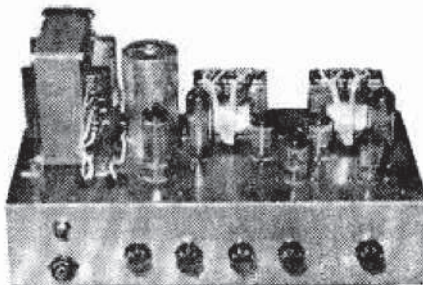


The "7-20"

stereo amplifier



by M. L. Michaelis

A NEW DESIGN USING THE ECLL800 AUDIO VALVE

THE most modern trend in high power stereophonic amplifiers is presented in this design. For clubs, schools, dances, parties and similar functions, for open-air use and even for the musical specialist at home some 8 to 10W power output on *each* channel is required.

Push pull operation is virtually essential for any high-power amplifier, as it affords the only really economical method of obtaining sufficient reduction of distortion and tolerable power efficiency. The principle objection to high-power push-pull output stages was formerly the relatively large number of valves required. In place of the single output valve of a single-ended amplifier, a pair of power valves was required, and, furthermore, a phase-splitter valve.

A basically new valve has now appeared on the market which is likely to revolutionise valve-operated audio power amplifiers.

Unidrive Push-Pull Output Valve ECLL800

The ECLL800 is, as its type designation implies, a combination of a phase-splitter triode and two power pentodes within a single envelope. It thus contains all the requirements for a push-pull output stage in the form of a single valve which is of the same physical size as a conventional EL84 pentode, and uses the same noval base. Furthermore, a set of Class B operating conditions is possible, under which the ECLL800 takes exactly the same h.t. drain as an EL84. The ECLL800 thus offers many very interesting opportunities for amateur experiments.

The present stereophonic amplifier design shows this valve under normal optimum operating conditions as recommended by the makers (Class AB).

The designation "Unidrive" for the ECLL800 means that the input drive signal required is that from a conventional single-ended voltage amplifier, e.g. from the anode circuit of one section of an EGC83, or from the anode circuit of an EF86. The ECLL800 contains its own phase-splitter, and this is in fact itself a completely new design and not a mere inclusion of a conventional voltage amplifier triode within the same glass bulb.

The tubular cathode of one pentode section is extended upwards beyond the end of the pentode

anode. The protruding section is positioned symmetrically inside a re-entrant half-cylindrical anode. Midway between the extended cathode and this anode, on both sides, are situated flat metal plates with a large rectangular cut-out to allow the electron clouds to pass through. These "rectangular iris windows" are joined together and to the control grid of one pentode system, and connected externally to pin 2 of the noval base. This combination electrode, conventionally termed "triode grid plus pentode No. 1 control grid", is the input electrode of the ECLL800, requiring a single-ended drive signal of 8V r.m.s. for 8.5W push-pull output at 5 per cent distortion.

With the adoption of the usual negative feedback arrangements, as employed in our present design too, the total distortion of the *entire amplifier* is less than 1 per cent at 8W output *per channel*.

The rectangular iris grid of the phase-splitter triode is designed such that the triode has a gain of exactly unity when an anode load of 150k Ω is employed (R64, R65 in our design). The signal at the triode anode (pin 1) is then of the same amplitude but opposite phase, as the input signal, and can be coupled externally to pin 6, the control grid of the other pentode section.

All three cathodes and both suppressor grids are commoned together to pin 7 of the base, and the screens of the two pentodes are commoned to pin 9. Pins 3 and 8 are the two pentode anode connections going to the two ends of the centre-tapped primary of a push-pull output transformer, the common h.t. supply being fed in, as usual, at the centre tap.

All electrodes of the three valve sections are thus accommodated on seven pins, the remaining two being used for the heater, in the normal position, pins 4 and 5. The total heater consumption of an ECLL800 is only 0.6A at 6.3V, which is astonishingly low for a complete push-pull output stage.

Curvature Compensation

The control characteristic of the rectangular irises on the triode has been made such that its residual curvature (non-linearity) is compensatory to that of the pentodes, so that the overall linearity of the ECLL800 is better than for any of its

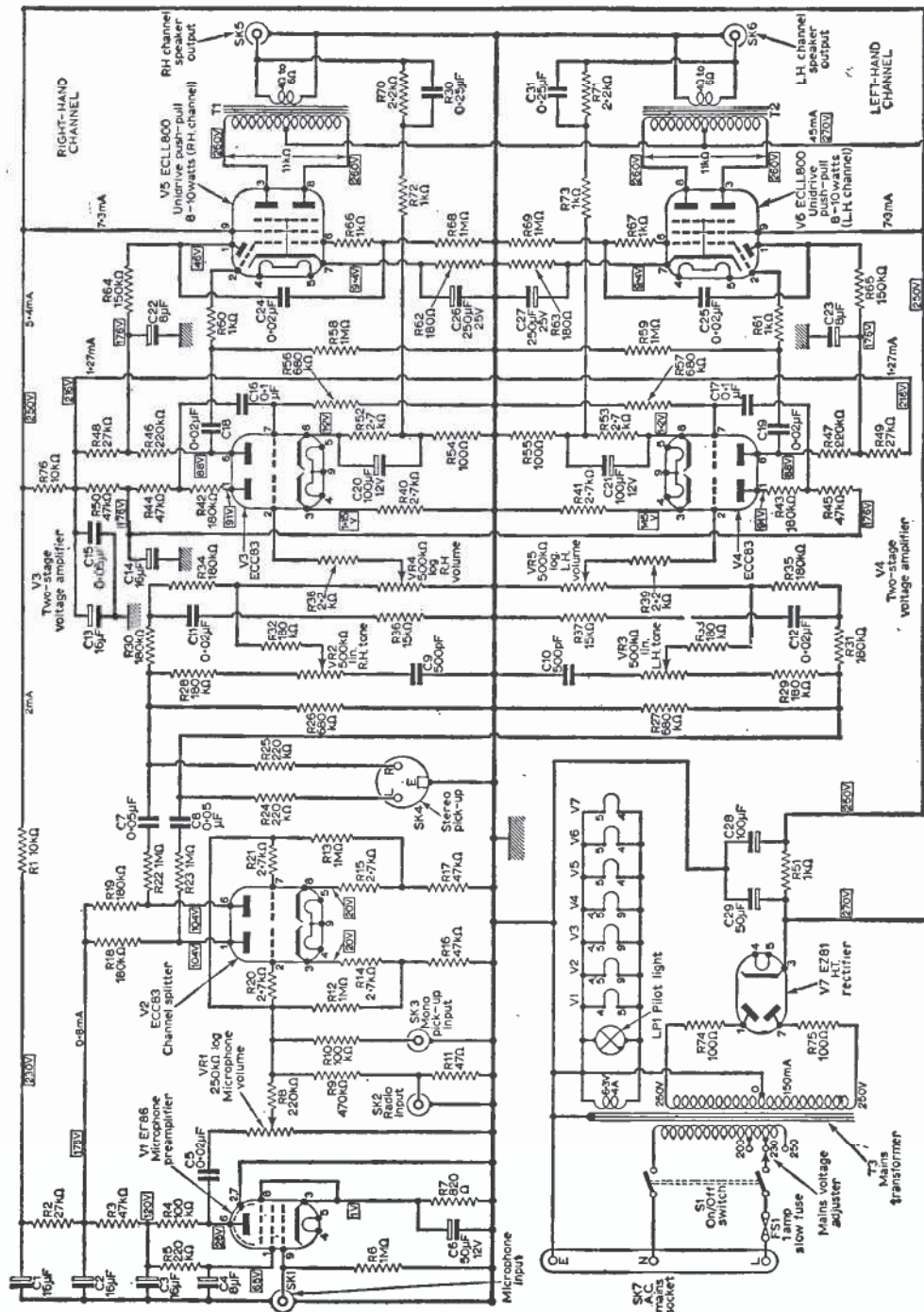


Fig. 1: The circuit. Numbers in circles indicate positive voltages w.r.t. chassis, as measured for prototype, using 20kΩ/V meter and with all volume controls at zero setting (no signal). Values shown against arrows on h.t. feeds are as calculated from above mentioned voltage readings.

sections alone. This is the first deliberate exploitation of this method of compensating distortion known to the author in commercial production practice. Certainly it is in general simpler and more economical to use negative feedback for improving linearity, in the familiar manner, yet the adoption of "compensatory control characteristics" for two or more stages in an amplifier chain offers, in principle, the possibility of driving the amplifier well beyond the linear part of the characteristics of individual stages, without undue overall distortion.

In combination with conventional negative feedback, this leads to greatly improved conversion efficiency of h.t. input power to audio output power. The ECLL800 probably represents nowhere near the ultimate of what may be achievable with such techniques, and valve manufacturers will doubtless bring out new types along these lines in the future.

Functions of the "7-20" Stereo Amplifier

This amplifier is designed for universal stereo and monaural (conventional) applications. V2 is here a channel-splitter, for feeding ordinary monaural inputs evenly onto both channels, the amplifier then functioning as 20W power output system for such signals.

The fact that half of this power is fed to each of two speakers or speaker systems, which can be placed some distance apart (ideally in opposite corners of the room, or opposite wings of a stage, for stereo use), enables an impressive projection of the sound into the room to be achieved, even for monaural inputs from ordinary pickups, tape decks or radio tuners. The use of such an amplifier system, employing two channels, is thus definitely worth while even for such signals. The sound appears to stand in the room, and *not* "come out of a hole", as otherwise with single speaker systems. Moreover, the intensity of sound is greater for the same power, and subjective quality and brilliance are improved.

It is, of course, essential to use speakers able to handle 10W peak power. It is not safe to use smaller speakers, even if one keeps the general volume turned low, because transients could still drive the amplifier momentarily to full power and rupture the cone and voice-coil system of a small speaker. Examples of suitable speakers are the WB Stentorian units HF 1016, in any of the makers cabinets or well designed amateur-built cabinets. For outdoor use, suitable horn speakers may be employed.

The Pre-amplifier

The pre-amplifier system included in the "7-20" stereo amplifier is quite comprehensive since the public address and entertainment applications require the frequent use of an announcer's or soloist's microphone.

High gain reserves are incorporated, which can be brought into use by internal variation of certain component values (as discussed below), to any extent such as to trim the complete amplifier to simultaneous optimum performance at all inputs for a particular microphone, tape deck, stereo pickup, etc.

The channel-splitter, V2, allows *simultaneous* monaural and stereophonic operation without

mutual interference. Such requirements arise, for example, if a public stereophonic concert (or an educational stereophonic concert in a school) is being given in a hall, with the two speakers in the wings of the stage, and a commentator wishes to inject explanations or announcements into the amplifier via a microphone. He may do so without any switching whatsoever, and whilst a stereo recording is actually playing, his voice will come equally over both channels, and will thus appear to originate from mid-stage, where he will, in fact, probably be situated.

Controls

The arrangement of controls has been designed with such applications in mind. Thus each main channel has been given two controls, a volume control and a treble tone control. Balance controls and other ganged arrangements have been discarded, as they bring added complexity and confusion. It was decided to dispense with a manual bass control too, in order to keep the number of controls down to a very minimum. A treble control is much more important than a bass control, and it is generally satisfactory to run the amplifier with some 15dB fixed bass boost for musical purposes and associated commentaries, as has here been done. Details of varying the degree of fixed bass boost are given below, as well as for the introduction of manual bass controls if required—there is still ample room for such on the chassis.

These considerations led to the use of just four simple controls for the main amplifier, with the addition of a fifth, VR1, the microphone volume control. The commentator can "mix himself in" on to a playing stereo or monaural recording at any desired relative intensity from zero to full power.

Monaural Inputs

The microphone input at SK1 may, of course, be used for any other weak signal input requiring greater amplification than a pick-up, e.g. a conventional monaural tape deck. V3 and V4 anode circuits (pin 1) can be adjusted (see below) such that inputs of 1mV or less at SK1 suffice to fully load the amplifier. VR1 is operative only for inputs at SK1. Inputs at SK2 and SK3, as well as stereo inputs at SK4, are controlled only by the four main amplifier controls, which, of course, also control SK1 inputs once again.

The radio input at SK2 is intended to be fed from the extension speaker sockets of a radio (low impedance). R11 is inserted to make this input insensitive to hum pick-up, so that long unscreened twin flex leads can be employed. If the insertion of the appropriate plug in the extension speaker sockets of the radio disconnects the internal speaker, the value of R11 must be reduced to the speaker impedance of the radio receiver, and must be of sufficient power rating to absorb the entire output power of the radio set. This demand can be satisfied by leaving R11 as shown, and wiring the necessary additional parallel resistor in or near the plug fitting SK2, if desired.

The input at SK3 must be screened. The resistors R8, R9 and R10 effect mutual decoupling of the three monaural inputs, so that all three may be left connected even when not operative. Many

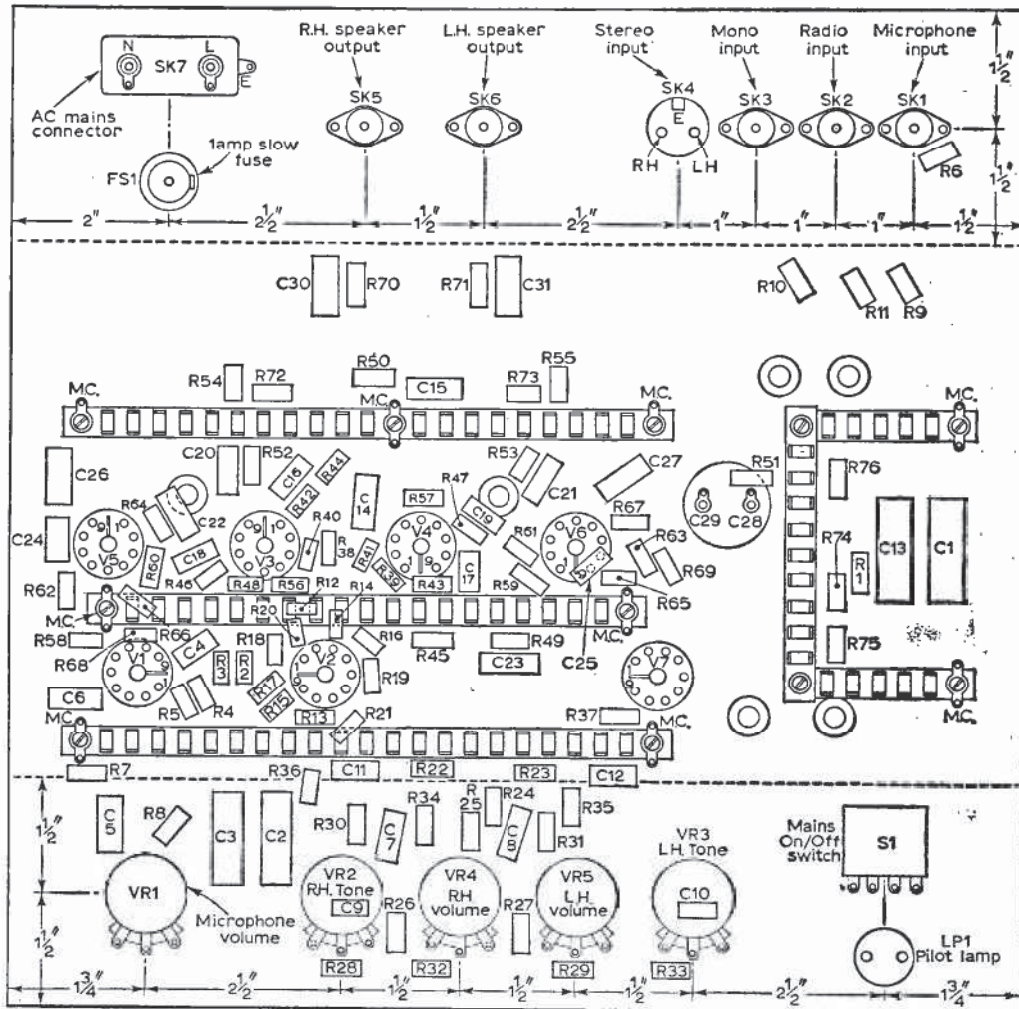


Fig. 2: Underchassis layout diagram.

pick-up units have extra contacts shorting the output when the motor is not running: R10 (and R24, R25 in the case of the stereo input SK4) thereby prevent shorting of other signals in the amplifier. At the same time, these decoupling resistors permit a wide range of fixed adjustments to the relative gains for the various inputs to be made, for optimum performance with a particular set of equipment.

Hum Removal

The principal gain reserves of the "7-20" stereo amplifier lie in the anode circuits of V3, V4 at pin 1. Gain can be increased by increasing the values of R44 and R45 and decreasing the values of R42, R43 by the same amount—and vice versa. In the extremes, the gain of the entire amplifier can be raised by a factor of five times, or reduced to zero, by these measures.

When making adjustments, it should first of all be checked whether the arrangement shown, with split anode loads, gives least hum output, or whether it is better to replace R42-R45 by a pair of 220kΩ ½W resistors, taking C16 and C17 still to the tops of R56 and R57, but splitting these resistors appropriately for the grid pin 7 feeds. The precise conditions will here depend somewhat on the exact positions of heater wiring, etc.

In general, heater wires should be run low in the chassis, hard up against the metal bottom, and other circuit wiring held well clear. If necessary, heater wires should be in the form of tightly twisted leads, one of which is earthed to chassis in passing each valveholder. It may also prove of advantage to experiment with small aluminium shields (earthed to chassis) between the rectifier (V7) valveholder and the control panel VR1 to VR4.