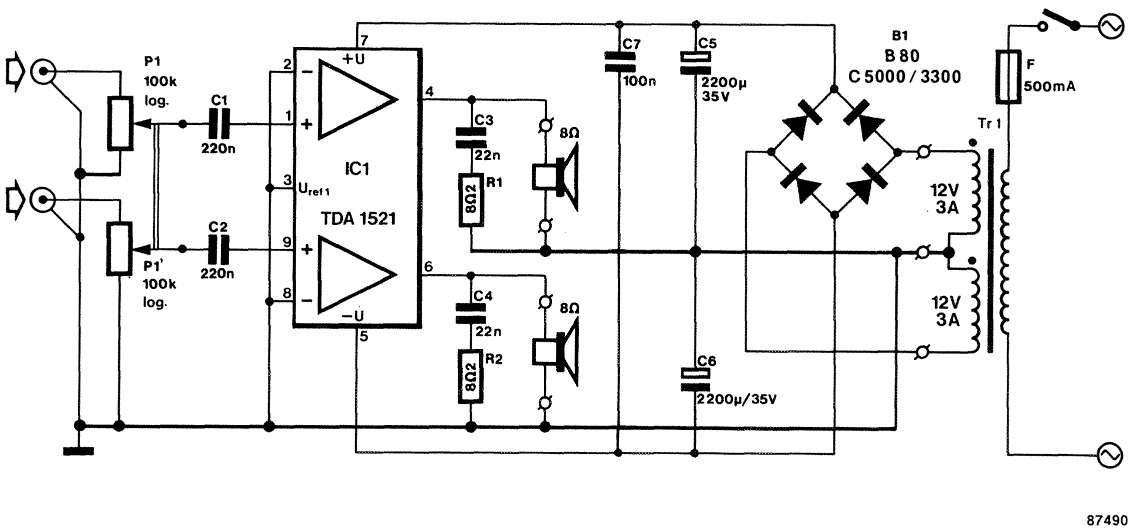
±6 V and ±9 V. Since T_2 is connected as a current source, the exact supply voltage can be set with the 2k2 preset at the wanted clipping level.
If desired, the output off-set may be zeroed by inserting a 50 kilo-ohm preset in the base circuit of T_4. This base should also be decoupled by a 1 µF, 63 V capacitor.

The current consumption of the opamp is about 35 mA and that of the buffer stages not more than 10 mA. If, therefore, ten buffer stages are used, the power supply should be capable of providing 150 mA at ±15 V.

013 INTEGRATED STEREO AMPLIFIER

The Type TDA1521 from Valvo/Mullard is an integrated HiFi stereo power amplifier designed for mains fed applications such as stereo TV. The device works optimally when fed from a ± 16 V supply, and delivers a maximum output power of 2×12 W into 8 Ω. The gain of the amplifiers is fixed internally at 30 dB with a spread of 0.2 dB to ensure optimum gain balance between the channels.
A special feature of the chip is its built-in mute circuit, which disconnects the non-inverting inputs when the supply voltage is less than ± 6 V, a level at which the amplifiers are still correctly biased. This arrangement ensures the absence of unwanted clicks and other noise when the amplifier is switched on or off. The TDA1521 is protected against output short circuits and thermal overloading. The SIL9 package should be bolted onto a heatsink with a thermal resistance of no more than 3.3 K/W ($R_L = 8\ \Omega$; $V_s = \pm\ 16$ V; $P_d = 14.6$ W; $T_a = 65$ °C). Note that the metal tab on the chip package is internally connected to pin 5.
The accompanying photograph shows that this high quality stereo amplifier has a very low component count, and is readily constructed on a piece of Veroboard.
The following technical data are stated as typical in the datasheets for the TDA1521 ($R_L = 8\ \Omega$; $V_s = \pm\ 16$ V):

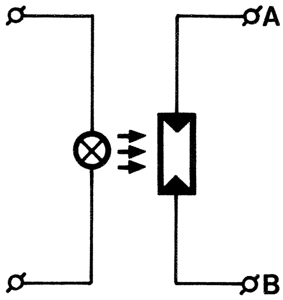
Distortion at $P_o = 12$ W:	0.5%
Quiescent current:	40 mA
Gain balance:	0.2 dB
Supply ripple rejection:	60 dB
Channel separation:	70 dB
Output offset voltage:	20 mV
3 dB power bandwidth:	20-20,000 Hz



014 LOUDSPEAKER PROTECTION I

There are many ways of protecting loudspeakers against the switch-on 'plop': many of these rely on a clamp circuit across the power amplifier input to hold this at 0 V for a few seconds after switch-on. Others, like the one suggested here, depend on a relay to switch off the loudspeaker(s).

1a



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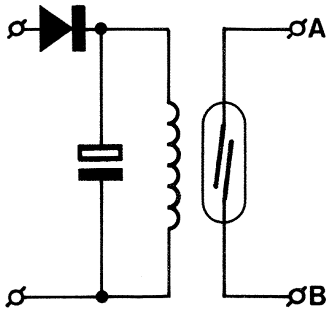
b



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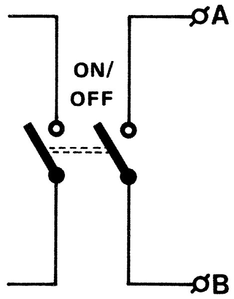
c



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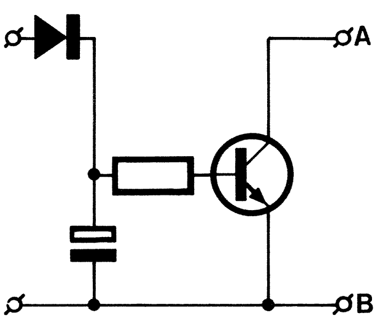
d



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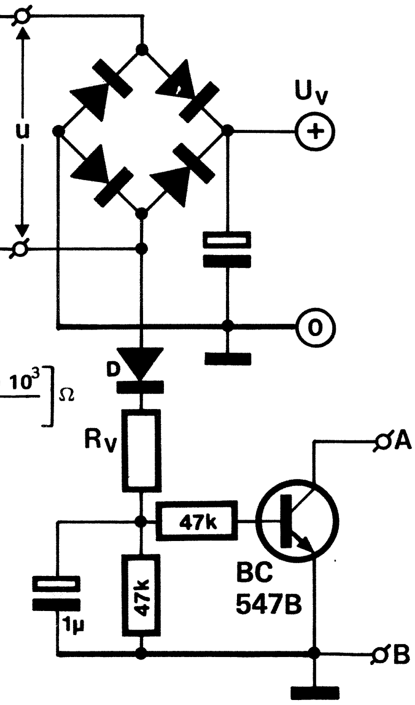
e



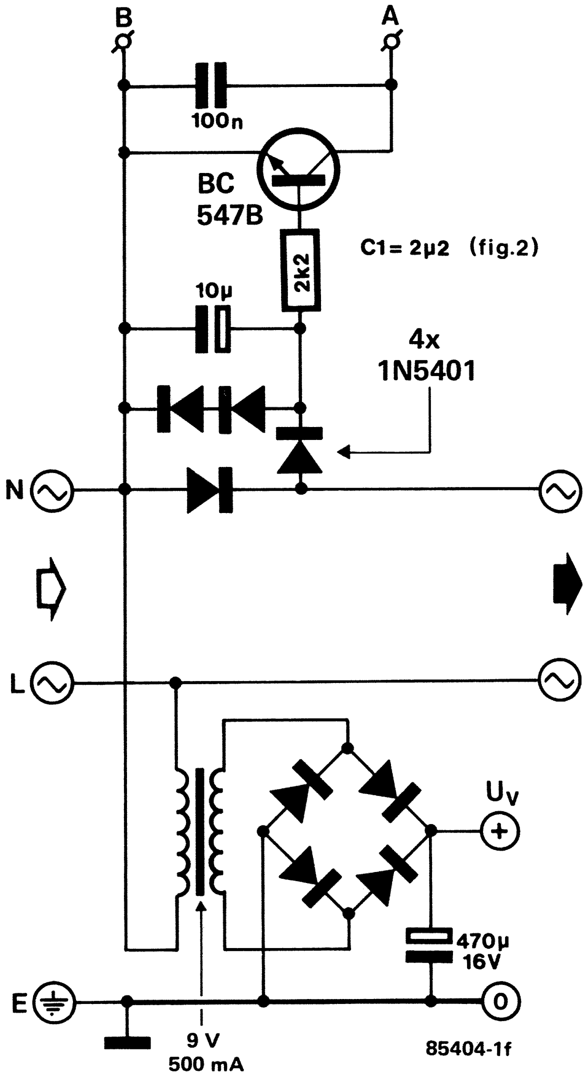
$$R_V = \left[\frac{(33.1\,u - 47)\,10^3}{2}\right]\Omega$$

C1 = 2µ2

(fig.2)

85404-1e

f

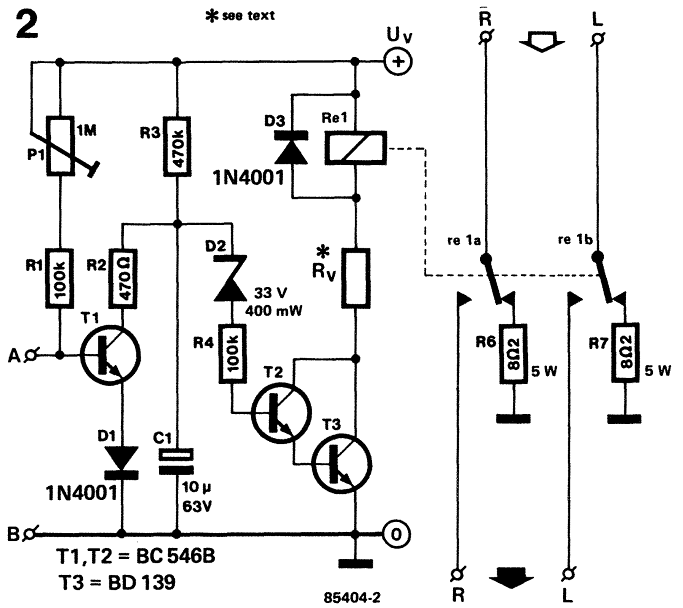


C1 = 2µ2 (fig.2)

85404-1f

Terminals A and B of the circuit in figure 2 are connected to one of the sensing circuits in figures 1a. . . 1f, of which the pros and cons will be discussed shortly. Whichever of these circuits is used, A is shorted to B immediately the power is switched on. This cuts off transistor T1 instantly, which causes capacitor C1 to charge. After a few seconds, the voltage across C1 causes zener D2 to break down. Transistor T2 and T3 then conduct; the relay is energized, and the loudspeakers are connected in circuit.
When the power is switched off, T1 conducts and this causes C1 to discharge very rapidly. The voltage across C1 quickly drops below the breakdown level of D2; transistors T2 and T3 are cut off, and the relay returns to its quiescent state, which disconnects the loudspeakers.
Input circuit 1a relies on a light-dependent resistor (LDR) fitted close to the mains on indicator lamp. When the lamp lights, the resistance of the LDR drops sharply, so that terminal A is virtually shorted to B.
The input in 1b relies on a reed relay connected to the secondary winding of the mains transformer. As soon as the mains is switched on, the relay contacts close.
The third possibility, shown in 1c, is that the mains on/off switch has a third contact that connects A to B when the mains is switched on.
A further option is illustrated in 1d, where a transistor is connected to the secondary of the mains transformer via a diode and resistor. The transistor conducts when the mains is switched on.
The inputs in 1e and 1f also provide power for the protection circuit. That in 1e has a bridge rectifier connected across the secondary winding of the mains transformer. When the mains is switched on, the BC 547 conducts and shorts A to B.
Finally, the circuit in 1f is connected direct to the mains. Here again, as soon as the mains is switched

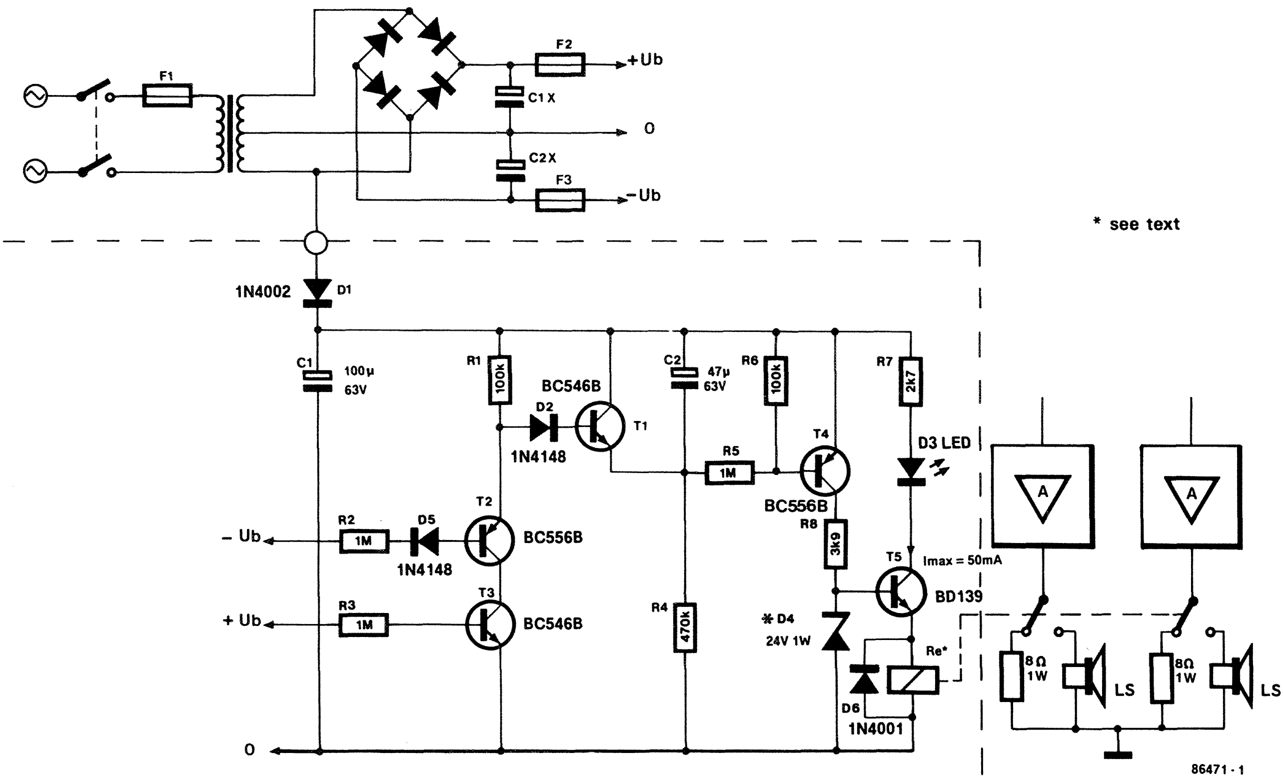
2



on, the BC 547 conducts and terminal A is shorted to B.
Whichever of the input circuits is used depends on circumstances and/or individual preferences. If one of circuits 1a. . . 1d is used, a separate power supply is required for the protection circuit. As suggested, the output voltage, U_v, of this should be 40. . . 60 V d.c. For lower values of U_v, the rating of D2 must be reduced accordingly.
Resistance R_v depends on the relay used, and is calculated from
$R_v = [(U_v - U_r - 2.5)/I_r]\ \Omega$
where U_r and I_r are the operating voltage (in volts) and current (in amperes) of the relay used respectively.
The relay contacts must be able to carry a large current: 10 A is not unusual in many amplifiers.
The rating of R_v is $[U_r I_r]$ W.
If the 'plop' is still heard, increase the value of R3 as required — in reasonably small steps.

015 LOUDSPEAKER PROTECTION II

This is an all-transistor design for incorporation in AF amplifiers that produce nasty clicks in the loudspeakers when turned on or off, jeopardizing the voice coils by passing a large current surge.
Assuming that AF amplifier and protection circuit are off, C_1 and C_2 are empty of charge and Re is deactivated. At power-on, D_1 rapidly charges C_1. Provided both the negative and the positive supply voltage are present and at the correct level, T_2 and T_3 conduct, while T_1 is off, enabling C_2 to be slowly charged via R_4. If the voltage across C_2 is sufficiently high for T_4 to conduct, T_5 will draw base current and energize Re, which connects the loudspeakers to the amplifier outputs. Zener diode D_4 fixes the voltage across the coil of Re, so that differently rated relays may also be used in the circuit, provided D_4 is changed accordingly. However the relay coil current should not exceed about 50 mA,



while the changeover contacts should be rated in accordance with the amplifier output power and impedance; for a 2 × 100 W at 8 Ω type, for instance, the relay contacts should be rated at least 8 A.

Should either one or both supply voltages ($-U_b$; $+U_b$) disappear for some reason or other (amplifier malfunction, short-circuited smoothing capacitor, etc.), the relevant transistor T_2 or T_3 will be disabled, causing T_1 to receive base current via R_1; C_2 will be discharged forthwith and Re is deactivated in consequence since T_4 and T_5 are turned off. The amplifier channels can now produce clicks they like; the output is safely applied to two resistors matching the output impedance.

The protection circuit is fed off the voltage across C_1, which is purposely rated at only 100 μF to enable Re to be deactivated almost immediately after the amplifier has been switched off. Power-off clicks, if produced, will therefore end up in the dummy resistors rather than the expensive loudspeaker voice coils.

The protection unit is most readily fitted on a piece of veroboard, while Re should be mounted close to the loudspeaker output terminals to keep contact losses as low as possible.

016 LOUDSPEAKER PROTECTION III

Many modern AF power output stages are capable of delivering considerable power levels in the supersonic frequency range. When the loudspeaker can not handle that power, the voice coil is rapidly overheated, and causes a short-circuit. If the power output stage is not properly protected, it breaks down and supplies a direct current that effectively destroys the loudspeaker.

The present loudspeaker protector is composed of three sections: a measuring amplifier, a detector, and a relay driver. Four channels are shown here as an example. Potential divider R_1-R_2 determines the sensitivity of the protection circuit, while D_1-D_2 protect the input of A_1. Opamp A_5 is set up as a low pass filter with a cut-off frequency of 0.5 Hz, so that it can function as a DC detector. The second section of the circuit is composed of four detectors A_9-A_{12}. A_9 compares any negative direct voltages to a reference set with R_8-R_9, while C_3-R_7 determine the delay time. Opamp A_{10} has a similar function for positive direct voltages. The circuit is actuated when

$$\frac{V_{in}R_2}{R_1+R_2} - 0.65 > \frac{15R_2}{R_8+R_9}$$

Comparators A_{11} and A_{12} function as the power limiter. Positive and negative peak voltages are rectified in D_3-D_4 and averaged with the aid of R-C combinations R_{36}-C_{33} and R_{26}-C_{23}. The relatively long periods of these networks precludes erroneous triggering of the circuit on peaks in the input signal. The power limiter is actuated when

$$\frac{V_{in}R_2\sqrt{2}}{R_1+R_2} - 0.65 > \frac{15R_{28}}{R_{28}+R_{29}}$$

This equation is also valid for the positive detector set up around A_{12}. The stated component values result in $P_{max} \approx 30$ W in 8Ω.
When the input signals are all right, the open collector outputs of A_9-A_{12} are in their high impedance state, so that the output voltage is +15 V via R_{40}. When a fault condition exists at one or more of the inputs, junction R_{40}-R_{41} is pulled down to —15 V.
The central part in the relay driver is bistable FF_1. Gate N_1 is a resettable power-up delay circuit which clocks FF_1. The logic high level at the D (data) input is only transferred to output Q when the R (reset) input is logic high. It is seen that a reset pulse can originate either from the mains detector N_3-N_4, or from the fault detectors A_9-A_{12}.
The loudspeaker protector is conveniently fed from the amplifier's symmetrical supply, but care should be taken to dimension D_{48} and R_v such that the indicated voltage across C_{44} and C_{45} is not exceeded. If the amplifier supply delivers less than 28 V, IC_6 may be omitted, and the loudspeaker relay, Re, replaced with a 12 V type fed from the +15 V rail. Voltage divider R_{43}-R_{44} should then be redimensioned such that the input of N_4 is held at about +13 V when $R_{43}+R_{44} \approx 100$ kΩ.