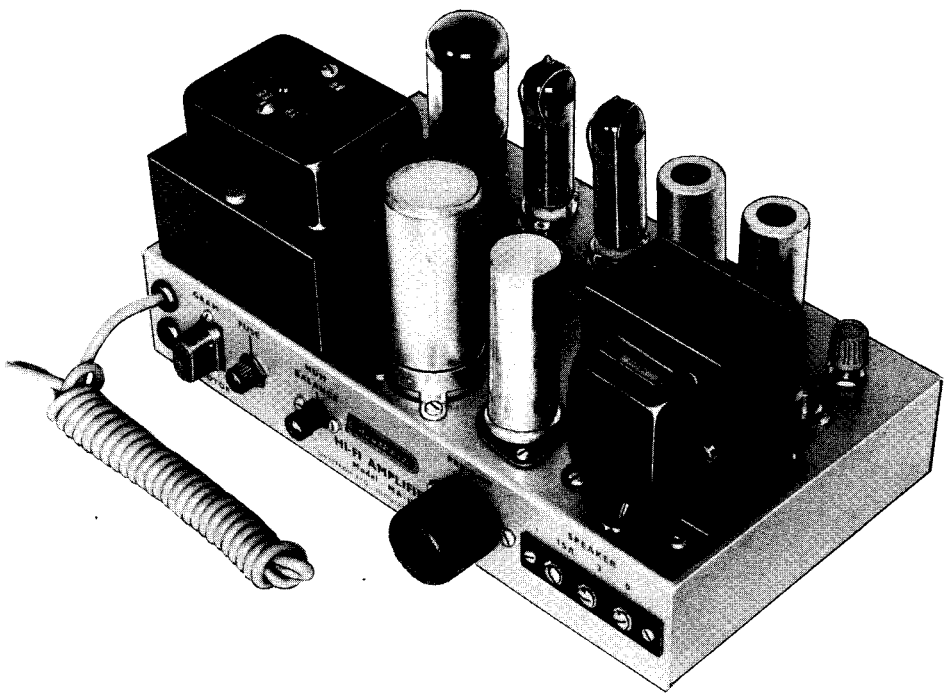
Heathkit
DAYSTROM

Assembly and Operation of the Heathkit HIGH FIDELITY POWER AMPLIFIER

MODEL MA-12



SPECIFICATION

Power Output:	10 watts r.m.s. (12 watts maximum) between 30 c/s and 10 kc/s
Hum and Noise:	-85 dB relative to 10 watts
Frequency Response:	± 1 dB between 20 c/s and 30 kc/s (ref. 1 kc/s; 1 watt)
Sensitivity:	120 mV for 10 watts output
Input Impedance:	1 megohm plus 105 pF
Output Impedance:	2-4 and 14-16 ohms
Damping Factor:	30
Harmonic Distortion:	Less than 0.15% at 10 watts measured at 1,000 c/s
Intermodulation Distortion:	Less than 1% at 10 watts (equivalent sine wave) measured with 40 c/s and 10 kc/s mixed in a ratio of 1:4 (SMPTE standard)
Negative Feedback:	Main loop 26 dB, subsidiary loop 6 dB
Stability Factor:	12 dB
Valve Complement:	EF86, ECC83, EL84 (2), GZ34
Power Supply for Pre-Amplifier, etc.:	25 mA at 300 volts d.c., 6.3 volts at 2.5 amps a.c.
Power Requirements:	100-125 volts, 200-250 volts a.c., 40-60 c/s, 100 watts
Dimensions:	11.1/8" x $6\frac{3}{4}$" x $5\frac{3}{4}$" overall
Finish:	Polychromatic silver grey stove enamel
Net Weight:	$12\frac{1}{2}$ lb.
Shipping Weight:	16 lb.

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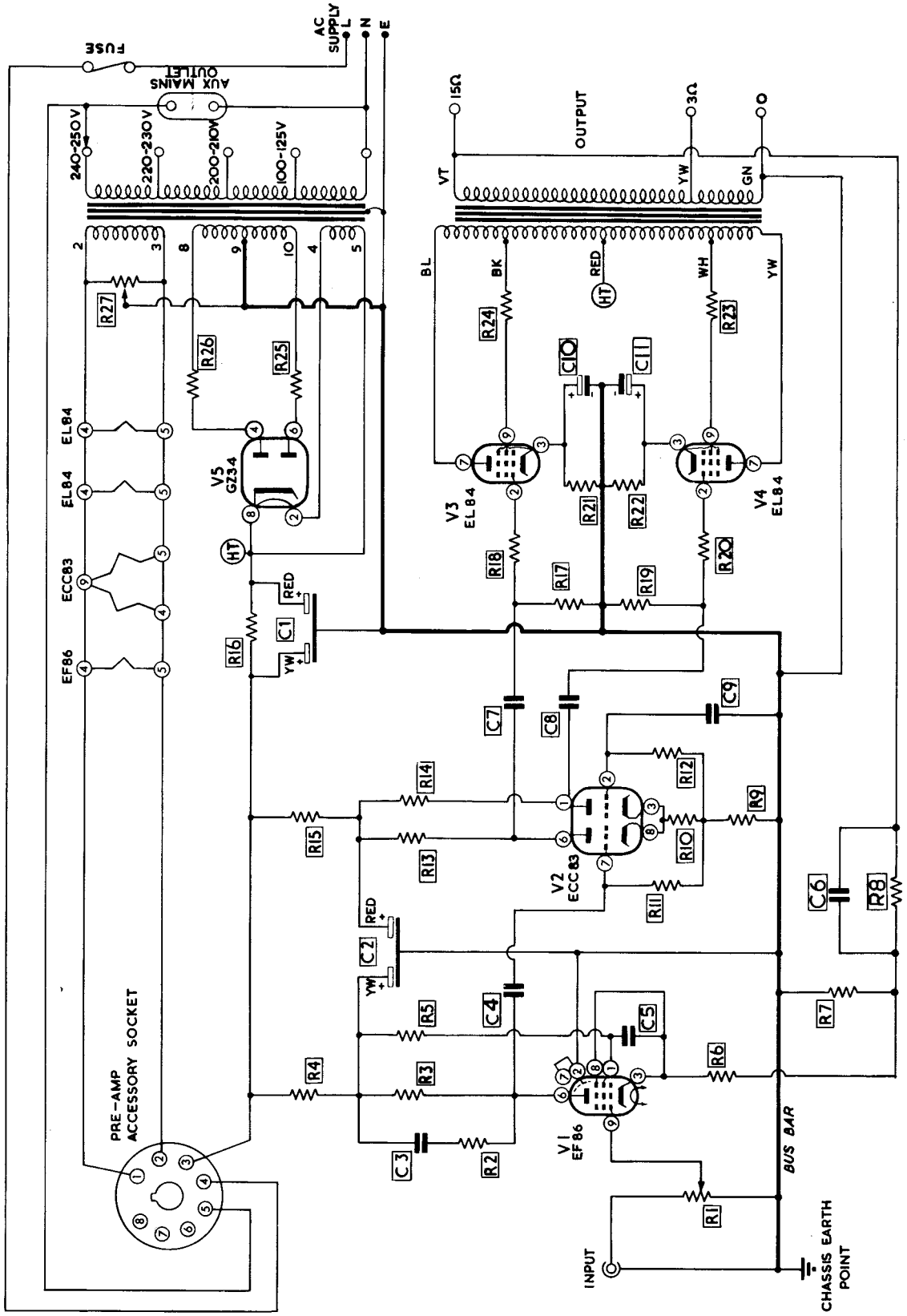


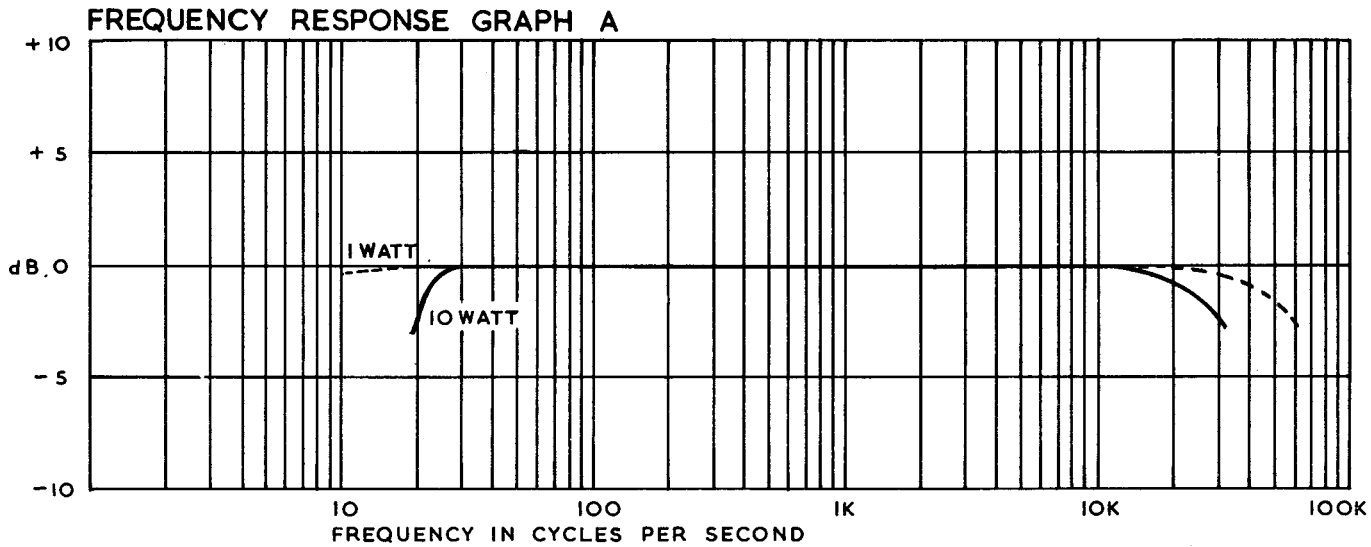
CIRCUIT DIAGRAM OF THE
HEATHKIT HIGH FIDELITY POWER AMPLIFIER MODEL MA-12

INTRODUCTION

The Heathkit Model MA-12 is a compact high-fidelity amplifier having a wide frequency response with a very low distortion. Used with a suitable pre-amplifier, it will do justice to the finest possible programme sources. Two can be used in a stereo system or one can be used with an existing amplifier and the variable gain control adjusted to balance input sensitivities. All the components used are of the highest possible quality and the ratings are extremely conservative, thus ensuring many years of trouble free service.

CIRCUIT DESCRIPTION

The first valve is an EF86 low-noise pentode which is followed by a cathode-coupled phase-splitter (ECC83) feeding the output stage consisting of 2 - EL84's in an ultra-linear arrangement. The rectifier is a large heavy-duty type (GZ34) and the low impedance H.T. line presents an effectively low impedance source contributing in no small way to the excellent overload characteristics. The main feedback loop is taken from the output transformer to the cathode of the EF86 and the bias resistor is unbypassed thus providing a secondary feedback loop of 6 dB. Considerable attention has been given to the stability margin and the main loop of 26 dB can be increased to 38 dB before instability becomes evident.

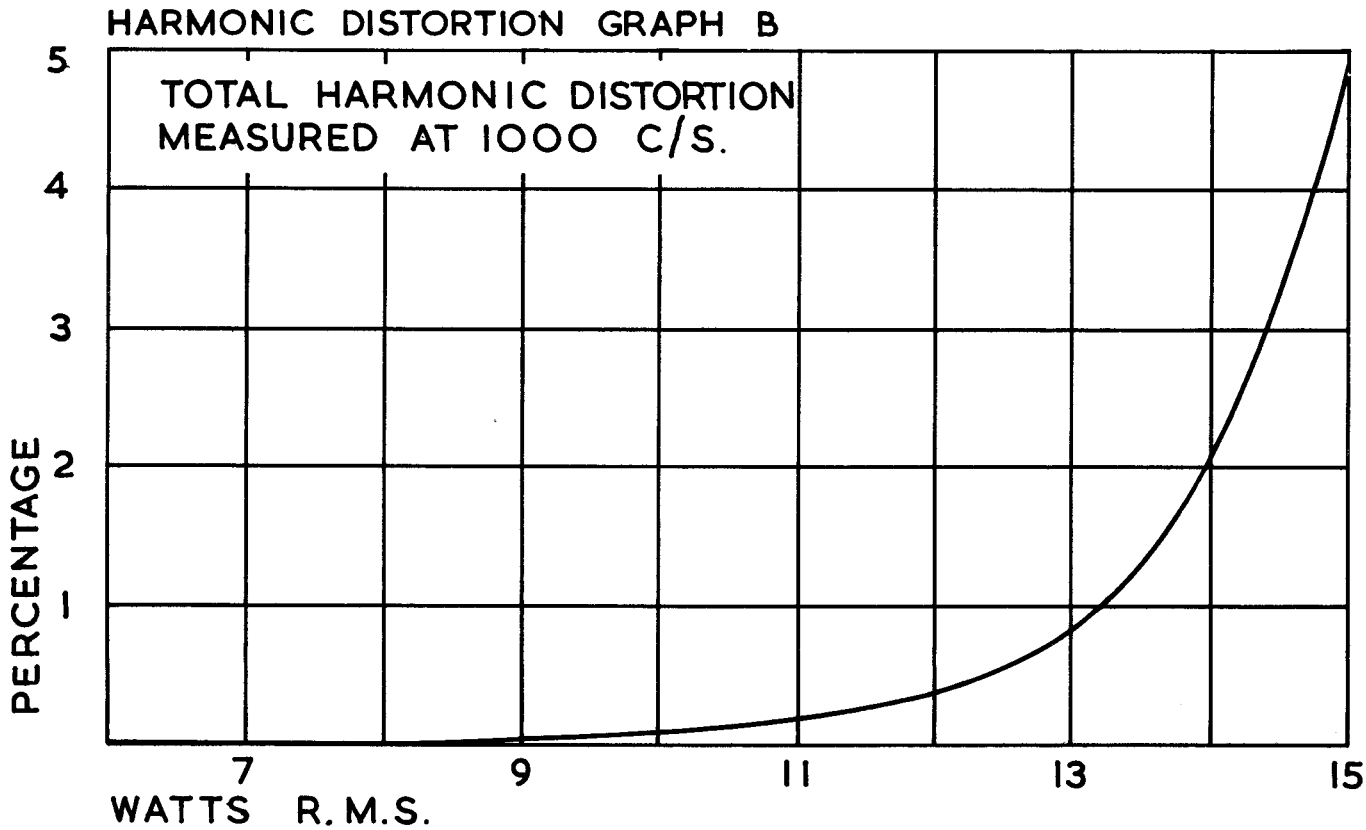


Graph A shows the power response characteristics: note that the power output is well maintained throughout the full audio range. The heart of a modern high fidelity valve amplifier is the output transformer and the type used in the MA-12 is a specially designed multi-sectionalised component having a high primary inductance combined with a low leakage reactance. In order to achieve a reasonable compact size, the latest type grain-oriented laminations are used.

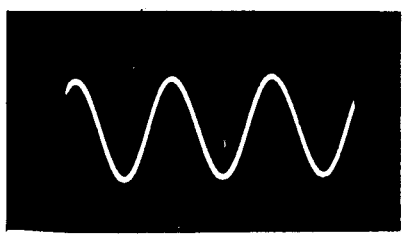
RESISTANCE AND CAPACITANCE CHART

R1	1 MΩ control	R11	1 MΩ HS	R21	270Ω	C2	50-50 μF
R2	6.8 KΩ	R12	1 MΩ HS	R22	270Ω	C3	510 pF
R3	220 KΩ HS	R13	90 KΩ HS	R23	470Ω	C4	.1 μF
R4	220 KΩ HS	R14	100 KΩ HS	R24	470Ω	C5	.1 μF
R5	1 MΩ HS	R15	22 KΩ	R25	50Ω WW	C6	100 pF
R6	2.2 KΩ HS	R16	10 KΩ	R26	50Ω WW	C7	.5 μF
R7	100Ω HS	R17	220 KΩ HS	R27	100Ω control	C8	.5 μF
R8	10 KΩ HS	R18	22 KΩ			C9	.1 μF
R9	68 KΩ HS	R19	220 KΩ HS			C10	25 μF
R10	1 KΩ	R20	22 KΩ	C1	250-60 μF	C11	25 μF

DISTORTION:
The distortion at 10 watts is less than 0.15% total harmonics measured at 1000 c/s as shown in Graph B below.

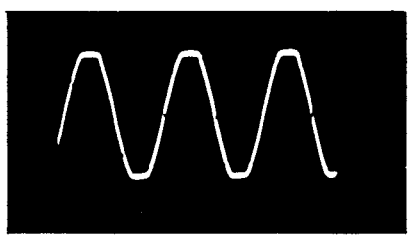


Note the smooth overload curve - a point often neglected especially with amplifiers having a large amount of feedback. Moreover, regardless of the rated output of an amplifier it is extremely important that the overload clipping be symmetrical and that the recovery after overload be smooth and free from oscillation. Oscillogram 1 shows the waveform at 11 watts (note that this is still below the overload point).



Oscillogram 1

In Oscillogram 2, the amplifier is delivering more than 15 watts and has begun to overload. Note, however, that the clipping is perfectly symmetrical.



Oscillogram 2

PRELIMINARY NOTES AND INSTRUCTIONS

The Step-by-Step instructions given in this manual should be followed implicitly to ensure a minimum of difficulty during construction and a completely satisfactory result, including many years of accurate, trouble-free service from the finished instrument.

UNPACK THE KIT CAREFULLY, EXAMINE EACH PART AND CHECK IT AGAINST THE PARTS LIST. In so doing, you will become acquainted with the parts. You will find it helpful to refer to the component identification sheet and also to the general details printed on the inside covers of the manual. If a shortage is found, attach the inspection slip to your claim and notify us promptly.

Lay out all the parts so that they are readily available in convenient categories. Refer to the general information inside the covers of this manual for instructions on how to identify components.

Moulded egg containers make handy trays for holding small parts. Resistors and capacitors may be placed in the edge of a corrugated cardboard box until they are needed.

Unless otherwise stated, use lockwashers under all nuts, and also between controls and the chassis. When shake-proof solder tags are mounted under nuts, the use of lockwashers is unnecessary.

Resistors and capacitors have a tolerance rating of $\pm$ 10% unless otherwise stated. Therefore a 100 KΩ resistor may test anywhere between 90 and 110 KΩ. Frequently capacitors show an even greater variation such as -50% to +100%. This Heathkit accommodates such variations.

Unless otherwise stated all wire used is insulated. Bare wire is only used where lead lengths are short and there is no possibility of a short circuit. Wherever there is a possibility of the bare wire leads of resistors or capacitors, etc., shorting to other parts or to chassis, such leads must be covered with insulated sleeving.

To facilitate describing the location of parts, all valveholders, controls, tagstrips, etc., have been lettered or numbered. Where necessary all such coding is clearly shown in the illustrations. When instructions say, for example, "wire to socket G3", refer to the proper figure and connect a wire to tag 3 of socket G.

Valveholders illustrated in the manual are always shown with their tags numbered in a clockwise sequence, from the blank tag position or keyway, when viewed from underneath.

All resistors may be wired either way round.

All capacitors, excepting electrolytic capacitors, may be wired either way round unless otherwise stated.

Carefully letter and number tagstrips, valveholders, transformers, etc. A wax pencil is ideal for this purpose.

When mounting resistors and capacitors make sure that the value can be read when in position.

Observe polarity on all electrolytic capacitors, i.e. RED = POSITIVE = +.

A circuit description is included in this manual so that those with some knowledge of electronics will be able to obtain a clearer picture of the actual functioning of this instrument. It is not expected that those with little experience will understand the description completely, but it should be of help in the event that they desire to become more familiar with the circuit operation and thus learn more from building the kit than just the placing of parts and the wiring.

Read this manual right through before starting actual construction. In this way, you will become familiar with the general step-by-step procedure used. Study the pictorials and diagrams to get acquainted with the circuit layout and location of parts. When actually assembling and wiring, READ THROUGH THE WHOLE OF EACH STEP so that no point will be missed.

A tick (✓) should be made in the space provided at the beginning of each instruction immediately it has been completed. This is most important as it will avoid omissions or errors, especially whenever work is interrupted in the course of construction. Some Kit-builders have found it helpful in addition to mark each lead in the pictorial in coloured pencil as it is completed.

Successful instrument construction requires close observance of the step-by-step procedure outlined in this manual. For your convenience, some illustrations may appear in large size folded sheets. It is suggested that these sheets be fastened to the wall over your work area for reference purposes during instrument construction.

The Company reserves the right to make such circuit modification and/or component substitutions as may be found desirable, indication being by "Advice of Change" included in the kit.

NOTE: Daystrom Ltd. will not accept any responsibility or liability for any damage or personal injury sustained during the building, testing, or operation of this instrument.

ALL GUARANTEES ARE VOIDED AND WE WILL NOT REPAIR OR SERVICE INSTRUMENTS IN WHICH ACID CORE SOLDER OR PASTE FLUXES HAVE BEEN USED. WHEN IN DOUBT ABOUT SOLDER, IT IS RECOMMENDED THAT ONLY "60/40" RESIN CORE RADIO SOLDER BE PURCHASED.

PROPER SOLDERING PROCEDURE

Only a small percentage of Heathkit purchasers find it necessary to return an instrument for factory service. Of these, by far the largest proportion function improperly due to poor or improper soldering.

Correct soldering technique is extremely important. Good soldered joints are essential if the performance engineered into the kit is to be fully realised. If you are a beginner with no experience in soldering, half an hour's practice with odd lengths of wire and a valveholder, etc., will be invaluable.

Highest quality resin-cored solder is essential for efficiently securing this kit's wiring and components. The resin core acts as a flux or cleaning agent during the soldering operation.

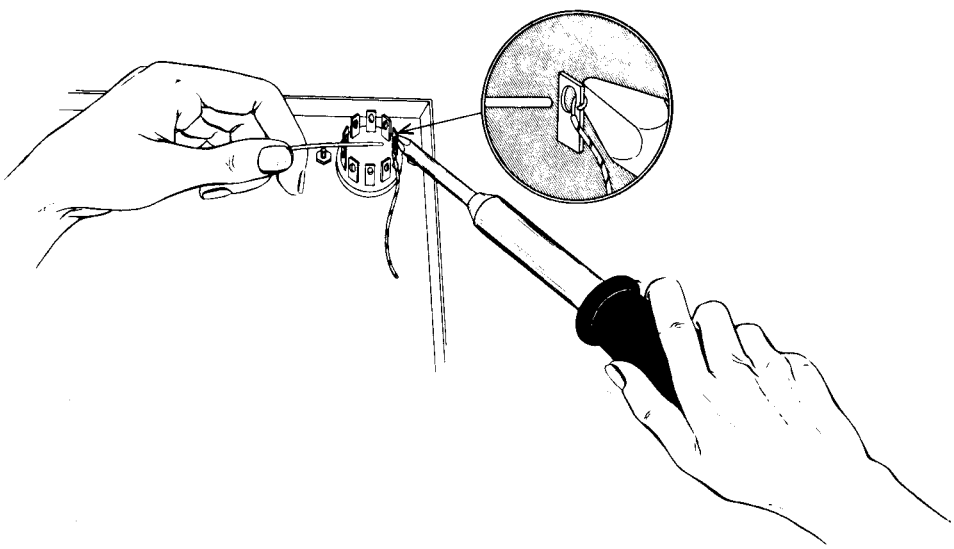
NO SEPARATE FLUX OR PASTE OF ANY KIND SHOULD BE USED. We specifically caution against the use of so-called "non-corrosive" pastes or liquids. Such compounds, although not corrosive at room temperature, will form residues when heated. These residues are deposited on surrounding surfaces and attract moisture. The resulting compounds are not only corrosive but actually destroy the insulation value of non-conductors. Dust and dirt will tend to accumulate on these "bridges" and eventually will cause erratic or degraded performance of the instrument.

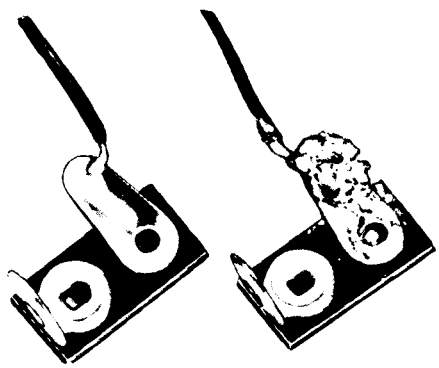
IMPORTANT

IN THE "STEP-BY-STEP" PROCEDURE the abbreviation "NS" indicates that the connection should not yet be soldered, for other wires will be added. At a later stage the letter "S" indicates that the connection must now be soldered. Note that a number appears after each solder (S) instruction. This number indicates the number of leads connected to the terminal in question. For example, if the instructions read, "Connect one lead of a 47 KΩ resistor to tag 1 (S-2)", it will be understood that there should be two leads connected to the terminal at the time it is soldered. This additional check will help to avoid errors.

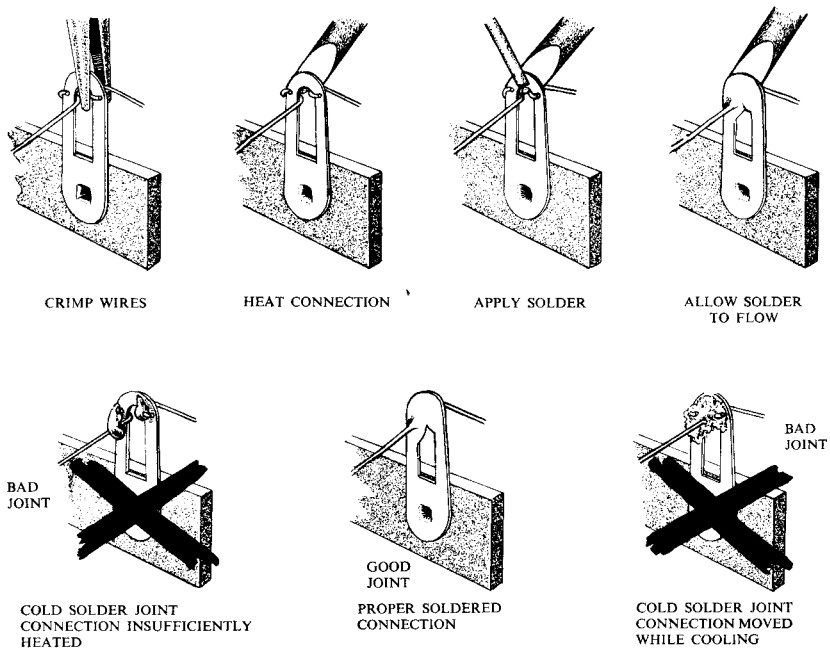
SPECIAL NOTE: Where a wire is passed through a tag to other parts of the circuit, this will be regarded as two connections (S-2).

When two or more connections are made to the same solder tag a common mistake is to neglect to solder the connections on the bottom. Make sure all the wires are soldered.





If the tags are bright and clean and wires free of wax, frayed insulation and other foreign substances, no difficulty will be experienced in soldering. Crimp or otherwise secure the wire (or wires) to the terminal, so a good mechanical joint is made without relying on solder for physical strength.



Typical good and bad soldered joints are shown above.

A poor soldered joint will usually be indicated by its appearance. The solder will stand up in a blob on top of the connection, with no evidence of flowing out caused by actual "wetting" of the contact. A crystalline or grainy texture on the solder surface caused by movement of the joint before it solidifies is another evidence of a "cold" connection and possible "dry" joint. In either event, reheat the joint until the solder flows smoothly over the entire junction, cooling to a smooth, bright appearance.

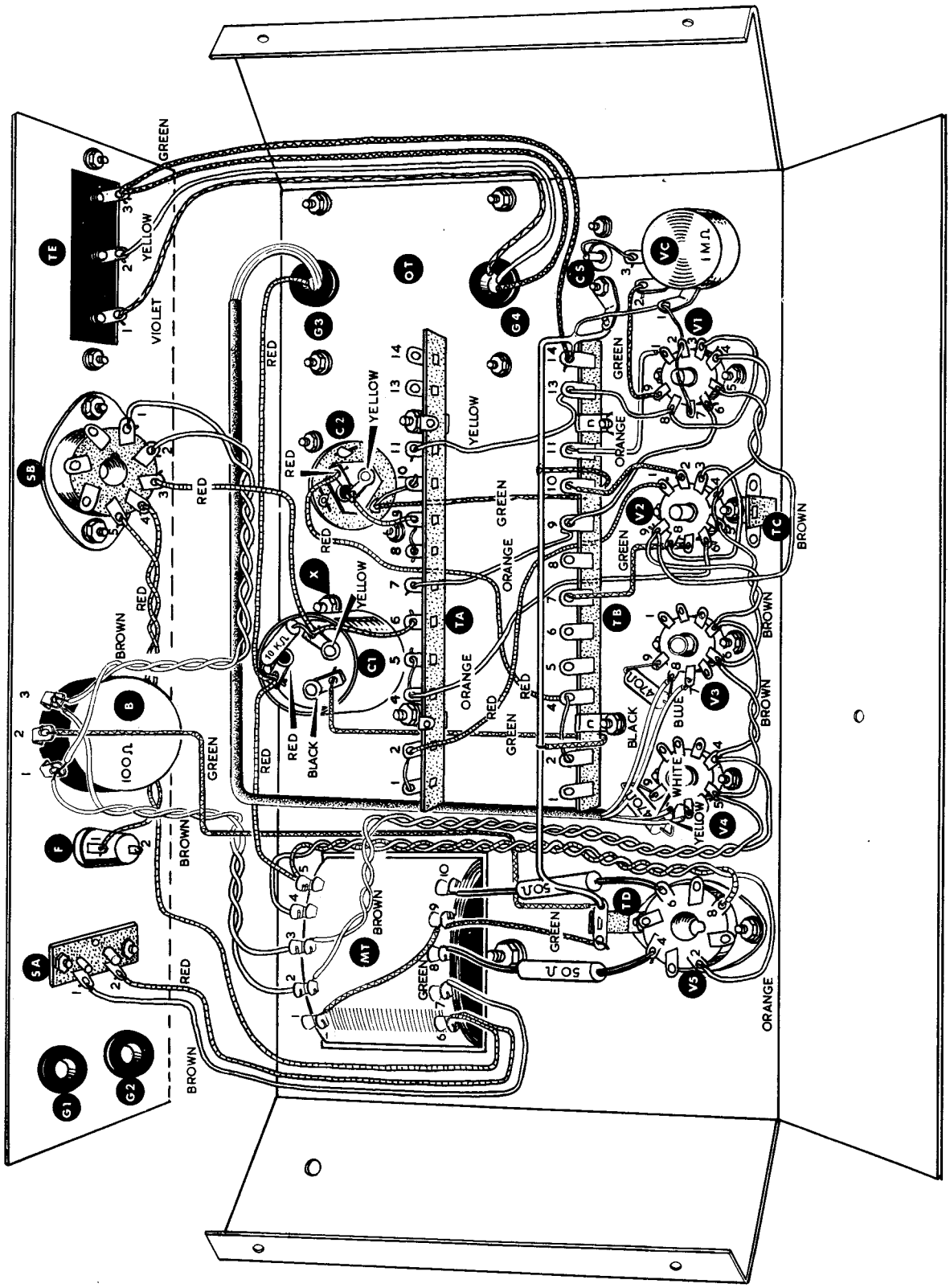
To make a good soldered joint, the clean tip of the hot soldering iron should be placed against the joint to be soldered so that the flat tag is heated sufficiently to melt the solder. Resin core solder is then placed against both the tag and the tip of the iron and should immediately flow over the joint. See illustrations. Use only enough solder to cover the wires at the junction; it is not necessary to fill the entire hole in the tag with solder. Do not allow excess solder to flow into valveholder contacts, ruining the sockets, or to creep into switch sockets and destroy their spring action. Position the work so that gravity tends to keep the solder where you want it.

A clean, well-tinned soldering iron is also important to obtain consistently perfect connections. For most wiring, a 25 to 50 watt iron, or the equivalent in a soldering gun, is very satisfactory. Keep the iron hot and its tip and the connections to be soldered bright and clean. Always place the solder on the heated "work" and then place the bit on top of the solder until it flows readily and "wets" the joint being made. Do not take the solder on to the bit and then try to bring it to the work directly from the soldering iron. Whenever possible a joint should be secured mechanically by squeezing tight with pliers prior to soldering it. The hot soldering bit should frequently be scraped clean with a knife, steel wool or a file, or wiped clean quickly by means of a rag or steel wool.

Do not apply too much solder to the soldered joint. Do not apply the solder to the iron only, expecting that it will roll down onto the connection. Try to follow the instructions and illustrations as closely as possible.

Do not bend a lead more than once around a connecting point before soldering, so that if it should have to come off due to a mistake or for maintenance it will be much easier to remove.

Follow these instructions and use reasonable care during assembly of the kit. This will ensure the deserved satisfaction of having the instrument operate perfectly the first time it is switched on.


TE
GREEN
YELLOW
VIOLET
SB
RED
BROWN
B
100Ω
GREEN
F
SA
G1
G2
G3
G4
OT
C2
YELLOW
X
10 KΩ
C1
RED
BLACK
TA
ORANGE
MT
BROWN
CS
VC
1MΩ
V1
GREEN
ORANGE
V2
TB
TC
V3
BLUE
BLACK
V4
WHITE
YELLOW
TD
50Ω
V5

PICTORIAL 1

STEP-BY-STEP ASSEMBLY INSTRUCTIONS

( ) If there is an amendment sheet to this manual, make sure that you have made the alterations at the appropriate places.

CHASSIS ASSEMBLY

Refer to Pictorials 1 and 3 for the following steps:

NOTE: The term hardware refers to a screw, a nut and a lockwasher unless otherwise stated.

(✓) Position the chassis as shown.

(✓) Mount two skirted valveholders on the top side of the chassis at positions V1 and V2 using 6BA x $\frac{1}{4}$" hardware. Install a 1-way tagstrip underneath the outer valveholder fixing nut and lockwasher at position TC. Orientate valveholders as shown.

(✓) Mount two non-skirted 9-pin valveholders on the top side of the chassis at positions V3 and V4 using 6BA x $\frac{1}{4}$" hardware.

(✓) Mount one 8-pin valveholder at position V5 using 4BA x $\frac{1}{4}$" hardware. Install the 1-way tagstrip TD at the inside fixing screw of this valveholder and secure with the lockwasher and fixing nut. The central keyway of this valveholder must face towards the outside of the chassis as shown.

(✓) Mount the 1 megohm potentiometer at position VC. The lockwasher should be placed next to the potentiometer and the flat washer underneath the fixing nut.

(✓) Mount the insulated capacitor mounting plate at position C2 using 6BA x $\frac{1}{4}$" hardware.

(✓) Mount an 8-pin valveholder at position SB using 4BA x $\frac{1}{4}$" hardware. Position the valveholder so that the keyway is towards the speaker terminal cut-out at position TE.

(✓) Mount the 3-way terminal strip at position TE on the outside of the chassis using 6BA x $\frac{1}{4}$" hardware.

(✓) Mount 3/8" rubber grommets at positions G1, G2, G3 and G4.

(✓) Mount the auxiliary mains outlet socket SA at position shown in Pictorial 1. Use 6BA x $\frac{1}{4}$" hardware. NOTE: This socket is mounted on the inside of the chassis. Tag 1 is the smaller of the two sockets.

(✓) Refer to Pictorial 3 and mount the capacitor mounting clip C1 to the 250-60 μF capacitor using a 4BA x $\frac{1}{2}$" screw and nut. Fix the clip to the body of the capacitor at a position 1.1/8" from the tagged end. Pass tagged end of the capacitor through the chassis and mount at position C1 using 4BA x $\frac{1}{4}$" hardware at location X only. Position the capacitor so that the coloured tags are as shown in Pictorial 1.

(✓) Mount two 14-way tagstrips, facing inwards, at position TA and TB. Use 4BA x $\frac{1}{4}$" hardware with lockwashers above and below the mounting feet. NOTE: One of the four screws also secures the capacitor clip at position C1.

(✓) Tags 3 and 12 of tagstrips TA and TB are not used; bend down these tags as shown.

(✓) Remove the nuts from the mains transformer and mount transformer at position MT. Orientate transformer so that tag numbers are as shown and secure with nuts and 2BA lockwashers on the chassis underside.

(✓) Mount the output transformer at position OT and at the same time feed the coloured wires through their respective grommets as shown in Pictorial 1. Secure transformer with 4BA x $\frac{1}{4}$" hardware.

(✓) Mount the fuseholder on the inside of the chassis at position F with tags positioned as shown. Place the nut provided on the outside of the chassis and tighten lightly.

(✓) Mount the 100Ω potentiometer at location B using 6BA x $\frac{1}{4}$" screws with a lockwasher under each screwhead.

(✓) Carefully bend down the three tags as shown.

( ) Mount the signal input coaxial socket at position CS using 6BA x $\frac{1}{4}$" hardware. Position one 6BA solder tag underneath the fixing nut at position shown in Pictorial 1. NOTE: Before mounting, carefully scrape away the enamel from the underneath of the chassis in the area of the fixing nut. This is the only point at which the amplifier earth busbar will be connected to the chassis. The chassis around other components does not require this treatment.

( ) Mount the 50-50 uF capacitor on the top side of the chassis at position C2 and check that the YELLOW tag is positioned as shown. To mount the capacitor, pass the prongs through the slots in the insulated mounting plate and twist each prong 45 degrees with pliers to secure.

( ) Fit the small knob to the shaft of the 1 megohm input control VC and tighten grub screw to secure.

This completes the component assembly.

CHASSIS WIRING

Refer to Pictorial 1 for the following steps:

( ) Cut to length and, using $\frac{3}{4}$" of sleeving on each lead, connect a 50Ω 3 watt resistor between MT8 (S-1) and V5 tag 4 (S-1). NOTE: MT8 means tag number 8 on the mains transformer MT. (S-1) denotes that only one wire has to be soldered to this tag.

( ) Cut to length and, using $\frac{3}{4}$" of sleeving on each lead, connect a 50Ω 3 watt resistor between MT10 (S-1) and V5 tag 6 (S-1).

( ) Thread the 9" piece of 7 mm. sleeving over the output transformer primary wires coming from G3. These are coloured BLUE, BLACK, YELLOW, WHITE.

( ) Form this cable sheath as shown in Pictorial 1. Cut wires to length and connect as follows:

- ( ) BLACK to V3 tag 8 (NS).
- ( ) BLUE to V3 tag 7 (S-1).
- ( ) WHITE to V4 tag 8 (NS).
- ( ) YELLOW to V4 tag 7 (S-1).

NOTE: Where coloured insulated wire is called for, the insulation should be trimmed $\frac{1}{4}$" off each end of the wire to expose the conductor for soldering.

( ) Twist together an $8\frac{1}{2}$" length of RED and ORANGE wire. At one end connect the RED wire to V5 tag 8 (S-1) and the ORANGE wire to V5 tag 2 (S-1).

( ) Route the wires across the chassis as shown and connect the RED wire to MT5 (NS) and the ORANGE wire to MT4 (S-1).

( ) Connect a $4\frac{1}{2}$" length of RED wire from MT5 (S-2) to C1 RED tag (NS).

( ) Locate the RED wire from grommet G3, cut to length and connect to C1 RED tag (NS).

( ) Connect a 10 KΩ 1 watt resistor (BROWN, BLACK, ORANGE) between C1 RED tag (S-3) and C1 YELLOW tag (NS).

( ) Connect a $2\frac{1}{4}$" length of RED wire between C1 YELLOW tag (NS) and SB3 (S-1).

( ) Connect a $1\frac{3}{4}$" length of RED wire between C1 YELLOW tag (S-3) and tagstrip TA6 (NS).

( ) Connect a 2" length of GREEN wire between MT1 (NS) and MT9 (NS).

( ) Connect a $2\frac{1}{4}$" length of GREEN wire between MT9 (S-2) and TD left-hand tag (S-1).

( ) Twist together two $8\frac{1}{2}$" lengths of RED wire and at one end, connect either wire to SB4 (S-1) and the other to SB5 (S-1).

( ) Route the RED twisted pair along the bend of the chassis to F tag 1 (S-1) and MT6 (NS).

( ) Connect a $4\frac{1}{2}$" length of RED wire between MT6 (S-2) and SA2 (S-1).

( ) Connect a 5" length of BROWN wire between MT7 (NS) and SA1 (S-1).

( ) Connect a $6\frac{1}{2}$" length of GREEN wire between potentiometer B tag 2 (S-1) and TD right-hand tag (NS).

( ) Twist together two $4\frac{1}{2}$" lengths of BROWN wire. At one end, connect either wire to MT2 (NS) and the other to MT3 (NS).

( ) Route the BROWN twisted pair along the bend of the chassis and connect to B1 (NS) and B3 (NS).

( ) Twist together two $6\frac{1}{2}$" lengths of BROWN wire and at one end, connect either wire to SB2 (S-1) and the other to SB1 (S-1).

( ) Route this pair along the bend of the chassis and connect to B1 (S-2) and B3 (S-2).

( ) Twist together two 7" lengths of BROWN wire and at one end, connect either wire to MT2 (S-2) and the other to MT3 (S-2).

( ) Route these wires across the chassis as shown and connect to V4 tag 5 (NS) and V4 tag 4 (NS).

( ) Twist together two 3" lengths of BROWN wire and connect one end to V4 tag 5 (S-2) and V4 tag 4 (S-2).

( ) Route the wires as shown and connect to V3 tag 4 (NS) and V3 tag 5 (NS).

( ) Twist together two $3\frac{3}{4}$" BROWN wires. At one end, connect either wire to V3 tag 4 (S-2) and the other to V3 tag 5 (S-2).

( ) Route the wires as shown and connect one wire to V2 tag 9 (NS) and the other wire through V2 tag 5 (S-2) to V2 tag 4 (NS).

( ) Twist together two $3\frac{3}{4}$" lengths of BROWN wire and connect either wire to V2 tag 9 (S-2) and the other to V2 tag 4 (S-2).

( ) Route the wires as shown and connect to V1 tag 5 (S-1) and V1 tag 4 (S-1).

( ) Connect a $2\frac{1}{2}$" length of ORANGE wire between V1 tag 1 (S-1) and TB11 (NS).

( ) Connect a $2\frac{1}{2}$" length of YELLOW wire from V1 tag 3 (S-1) around the valveholder to V1 tag 8 (NS).

( ) Connect a 2" length of YELLOW wire from V1 tag 8 (S-2) close to the chassis and up to TB13 (NS).

( ) Connect a $3\frac{1}{4}$" length of YELLOW wire between TB13 (NS) and TA11 (NS). Route wire close to chassis.

( ) Connect a 7" length of GREEN wire between TB14 (NS) and TE3 (NS). Route the wire along the bend of the chassis.

( ) Protruding through grommet G4 is a GREEN wire of the output transformer secondary. Route this wire with the other GREEN wire into the bend of the chassis and connect to TE3 (S-2).

( ) Take the YELLOW wire coming through G4, route along with the other wires and connect to TE2 (S-1).

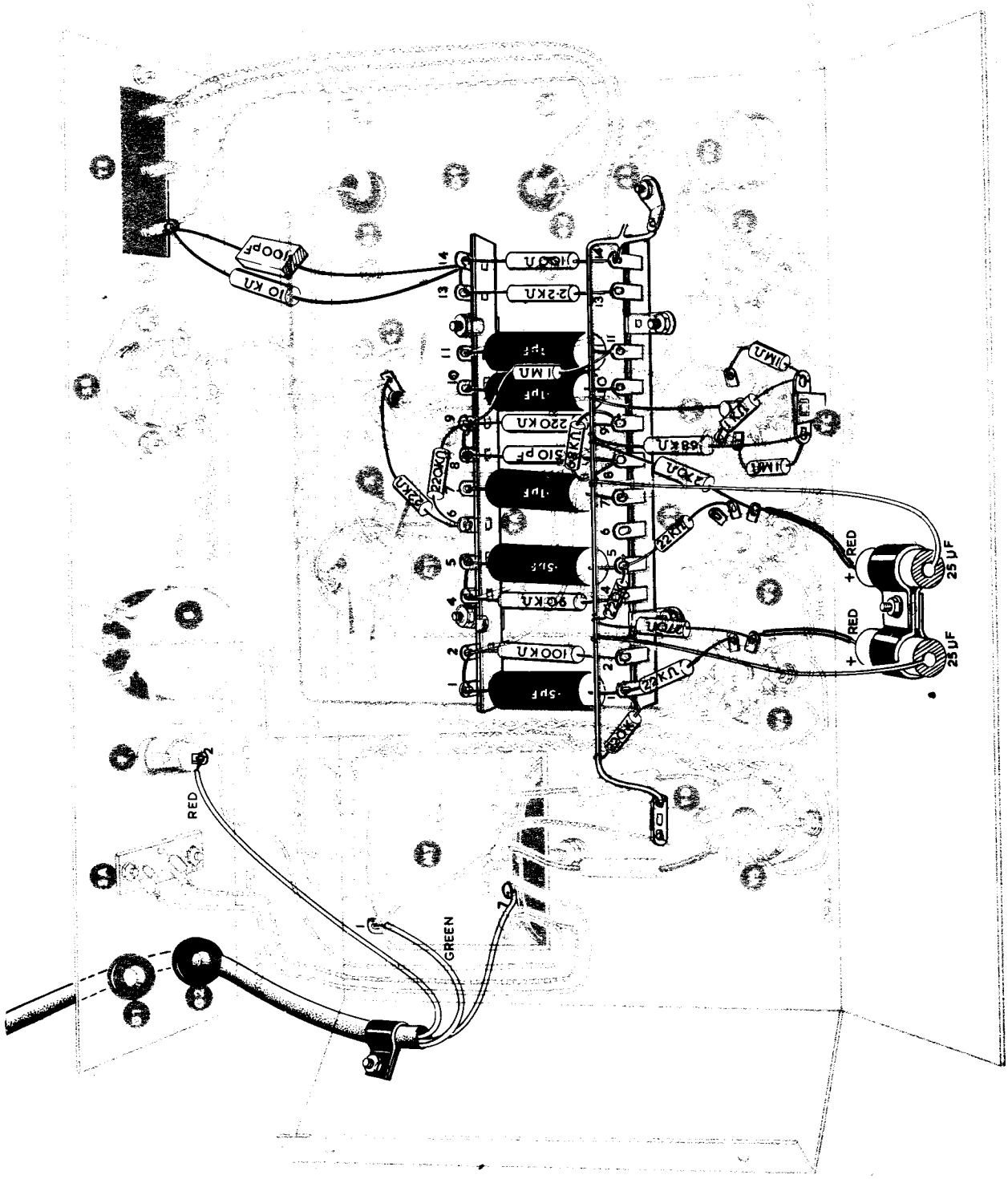
( ) Take the VIOLET wire coming through G4, route along with the other wires and connect to TE1 (NS).

( ) Connect a short length of the thin bare wire between socket CS (S-1) and VC3 (S-1).

( ) Connect a 2" length of GREEN wire between VC2 (S-1) and V1 tag 9 (S-1).

( ) Connect a $2\frac{1}{2}$" length of ORANGE wire between V1 tag 6 (S-1) and TB9 (NS).

( ) Connect a $3\frac{1}{2}$" length of ORANGE wire between TB9 (NS) and TA7 (NS).


100pF
10 KΩ
2·2KΩ
·1µF
1 MΩ
·1µF
220KΩ
510 pF
·1µF
·5µF
9·6KΩ
100KΩ
·5µF
1MΩ
1MΩ
68KΩ
47KΩ
22MΩ
RED
25 µF
RED
25 µF
RED
GREEN

PICTORIAL 2

NOTE: If some wires which are not already soldered show a tendency to fall out or work loose, the constructor may apply a very small amount of solder to fix the joint. As the statement (NS) means 'Do not solder yet' it must be remembered that there are one or more wires still to be connected at the joint. Any temporary soldering must not, therefore, block the tag hole or make difficult further connections.

( ) Connect one end of a 5" length of RED wire to C2 RED tag (NS). At the other end, strip 1" of insulation and connect through TB tag 4 (NS) to TB2 (NS).

( ) Connect a $1\frac{3}{4}$" length of GREEN wire between TB10 (NS) and V2 tag 2 (NS).

( ) Connect a $2\frac{1}{2}$" length of YELLOW wire between V2 tag 3 (S-1) and V2 tag 8 (NS). Dress this lead close around the valveholder.

( ) Connect one end of a $5\frac{1}{2}$" length of RED wire to V2 tag 1 (S-1). At the other end, strip $\frac{3}{4}$" of insulation and connect through TA2 (NS) to TA1 (NS). Route this wire underneath TB.

( ) Connect one end of a 5" length of ORANGE wire to V2 tag 6 (S-1). At the other end, strip $\frac{3}{4}$" of insulation and connect through TA4 (NS) to TA5 (NS). Route this wire underneath TB.

( ) Connect a $1\frac{1}{2}$" length of GREEN wire between TB7 (NS) and V2 tag 7 (NS).

( ) Connect a 470Ω resistor (YELLOW, VIOLET, BROWN) between V4 tag 9 (S-1) and V4 tag 8 (S-2).

( ) Connect a 470Ω resistor (YELLOW, VIOLET, BROWN) between V3 tag 9 (S-1) and V3 tag 8 (S-2).

( ) Connect one end of a 2" length of RED wire to C2 YELLOW tag (S-1). Connect the other end through TA9 (NS) to TA8 (NS).

( ) Cut a length of 16 swg. (thick) bare wire to $9\frac{1}{4}$" long. At $1\frac{1}{4}$" from one end bend to a right angle. At 1" from the other end bend another right angle on the same plane. This wire will be used as the earth busbar.

( ) Hold this wire over the chassis, with the longer right angled end towards VC and the other end towards TD. Tailor slightly if necessary to fit TD right-hand tag (S-2) and the earth solder tag (S-1) near to VC. This busbar should now be over the inner fixing screws of V1, V2, V3 and V4, running parallel to the chassis at a distance of approximately 1.3/8" from it.

( ) Connect a length of thin bare wire through V1 tag 7 (S-1), V1 centre post (S-2), V1 tag 2 (S-2), VC1 (S-2), the 16 swg. earth busbar (S-2) and TB14 (NS).

( ) Connect a 5" length of GREEN wire between the nearest twisted mounting prong of C2 (NS) and the 16 swg. earth busbar (S-1). Route this wire underneath TA and TB.

( ) Connect a $6\frac{1}{4}$" length of GREEN wire between C1 BLACK tag (S-1) and the 16 swg. earth busbar (S-1). Route this wire underneath TA and TB.

( ) Connect a short length of thin bare wire between the twisted mounting prong of C2 (S-1) and TA10 (NS).

This completes the wiring shown in Pictorial 1. Check the work so far completed.

Refer to Pictorial 2 for the following steps:

( ) Connect one end of a 100Ω high stability resistor (value marked) to TB14 (S-3). Connect the other end through TA14 (NS) to TA13 (NS).

( ) Connect a 2.2 KΩ high stability resistor (value marked) between TB13 (S-3) and TA13 (S-2).

( ) Connect a 10 KΩ high stability resistor (BROWN, BLACK, ORANGE, PINK) between TA14 (NS) and TE1 (NS).

( ) Connect a 100 pF mica capacitor between TA14 (S-4) and TE1 (S-3).

( ) Connect a 22 KΩ $\frac{1}{2}$ watt resistor (RED, RED, ORANGE) between C2 RED tag (S-2) and TA6 (NS).

( ) Connect a 220 KΩ high stability resistor (RED, RED, YELLOW, PINK) between TA6 (S-3) and TA9 (NS).

(✓) Connect a .1 μF tubular capacitor between TB11 (NS) and TA11 (S-2).

(✓) Connect a .1 μF tubular capacitor between TA10 (S-2) and TB10 (S-2).

(✓) Connect a 1 MΩ high stability resistor (BROWN, BLACK, GREEN, PINK) between V2 tag 2 (S-2) and TC right-hand tag (NS).

(✓) Connect a 1 KΩ ½ watt resistor (BROWN, BLACK, RED) between TC right-hand tag (S-2) and V2 tag 8 (S-2).

(✓) Connect a .1 μF tubular capacitor between TA7 (S-2) and TB7 (S-2).

(✓) Connect a 1 MΩ high stability resistor (BROWN, BLACK, GREEN, PINK) between V2 tag 7 (S-2) and TC left-hand tag (NS).

(✓) Connect a 68 KΩ high stability resistor (BLUE, GREY, ORANGE, PINK) between TC left-hand tag (S-2) and earth busbar (S-1).

(✓) Connect a 1 MΩ high stability resistor (BROWN, BLACK, GREEN, PINK) between TB11 (S-3) and TA9 (NS).

(✓) Connect a 220 KΩ high stability resistor (RED, RED, YELLOW, PINK) between TB9 (NS) and TA9 (S-5).

(✓) Connect a 510 pF capacitor between TB8 (NS) and TA8 (S-2).

(✓) Shorten both leads to ¾" and connect a 6.8 KΩ resistor (BLUE, GREY, RED) between TB9 (S-4) and TB8 (S-2).

(✓) Connect a length of thin bare wire between V2 centre post (S-1) and 16 swg. earth busbar (S-1).

(✓) Connect a 90 KΩ high stability resistor (WHITE, BLACK, ORANGE, PINK) between TA4 (S-3) and TB4 (S-3).

(✓) Connect a 100 KΩ high stability resistor (BROWN, BLACK, YELLOW, PINK) between TA2 (S-3) and TB2 (S-2).

(✓) Connect a .5 μF tubular capacitor between TA5 (S-2) and TB5 (NS).

(✓) Connect a .5 μF tubular capacitor between TA1 (S-2) and TB1 (NS).

(✓) Connect a 22 KΩ ½ watt resistor (RED, RED, ORANGE) between V3 tag 2 (S-1) and TB5 (NS). Position lead to clear tag 1.

(✓) Connect a 22 KΩ ½ watt resistor (RED, RED, ORANGE) between V4 tag 2 (S-1) and TB1 (NS). Position lead to clear tag 1.

(✓) Connect a 220 KΩ high stability resistor (RED, RED, YELLOW, PINK) between TB1 (S-3) and 16 swg. earth busbar (S-1).

(✓) Connect a 220 KΩ high stability resistor (RED, RED, YELLOW, PINK) between TB5 (S-3) and 16 swg. earth busbar (S-1).

(✓) Mount the two 25 μF electrolytic capacitors, using the plastic cable clamps and 6BA x ½" hardware. Note how the fixing feet of the clamps are interleaved with each other to fit the large diameter of the capacitors. Check polarity of capacitors with Pictorial 2 and note that the positive ends of these capacitors are towards the valve-holders. ✓

(✓) Connect the left-hand 25 μF capacitor; use a ¾" length of sleeving on the RED positive wire and connect to V4 tag 3 (NS). Connect the BLACK negative wire to 16 swg. earth busbar (S-1).

(✓) Connect the right-hand 25 μF capacitor; use a ¾" length of sleeving on the RED positive wire and connect to V3 tag 3 (NS). Connect the BLACK negative wire to 16 swg. earth busbar (S-1).

(✓) Connect a ~~270Ω~~ 240Ω 1 watt resistor (RED, VIOLET, BROWN) between V3 tag 3 (S-2) and the 16 swg. earth busbar (S-1).

(✓) Connect a ~~270Ω~~ 240Ω 1 watt resistor (RED, VIOLET, BROWN) between V4 tag 3 (S-2) and the 16 swg. earth busbar (S-1).

(✓) Take the mains cable and strip back the outer sheath over a length of $3\frac{1}{2}$". Pass this end of the mains cable through G2.

(✓) Fix the metal cable clamp to the cable and secure with 6BA x $\frac{1}{2}$" hardware.

(✓) Connect the mains cable as follows:-
( ) RED to F2 (S-1). ( ) BLACK to MT7 (S-2). ( ) GREEN to MT1 (S-2).

(—) If a second amplifier is used for a stereo system, connect the mains cable of the second amplifier to the auxilliary mains plug as follows:- pass the plug cover over the cable, remove the GREEN wire and connect the BLACK wire to the small pin and the RED wire to the large pin. Fit the cover to the plug.

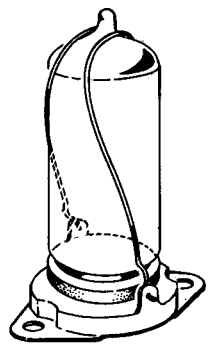
This completes the wiring and component mounting shown in Pictorial 2. A wire by wire check should now be made of the work so far done.

( ) Refer to Detail 1 and fit valve retaining clips at V3 and V4.

( ) Insert valves V1, V2, V3 and V4 as shown in Pictorial 3. Do not insert V5 at this time.

( ) Install the valve screening cans over valves V1 and V2.

( ) Insert the fuse in the fuseholder F.



Detail 1

INITIAL TEST

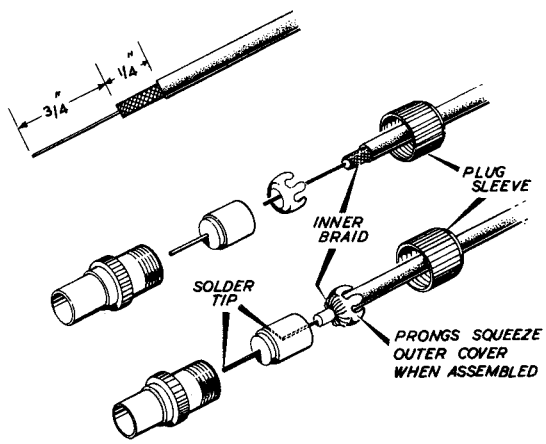
If in the following tests, the amplifier does not perform correctly, refer to the section IN CASE OF DIFFICULTY.

( ) Set the mains transformer voltage selector plug to suit your local supply voltage. Connect a short length of wire between SB4 and SB5 to enable the MA-12 to be checked without the pre-amplifier. NOTE: In cases where the amplifier is to be used with a pre-amplifier not fitted with an a.c. mains ON/OFF switch, or on its own without a pre-amplifier, the constructor may leave the strap across SB4 and SB5, switching the MA-12 at the a.c. power point. Alternatively, a small toggle switch may be fitted to the MA-12 and connections made to SB4 and SB5 for mains switching.

( ) Apply mains to the MA-12 without GZ34 rectifier valve V5 inserted. Check that V1, V2, V3 and V4 heaters glow. If possible, check with an AC meter.

(✓) Switch off mains. Check that the amplifier HT rail is not shorted to the chassis at any point. A resistance reading of more than 30 KΩ should be possible between V5 tag 8 and chassis.

( ) Connect a 3 ohm or 15 ohm speaker to the appropriate speaker terminals.



Detail 2

( ) Insert rectifier valve and switch on the mains. Observe the GZ34 valve carefully to see any signs of flashing or spluttering as the valves start to function. If the loudspeaker starts to 'motor boat' or the amplifier goes into oscillation, this indicates that feedback may be positive instead of negative. Should this happen, switch off immediately. Check that the VIOLET and GREEN leads to TE1 and TE3 are not reversed, but as shown in Pictorial 1.

( ) Refer to Detail 2 and fit a coaxial plug to one end of the coaxial cable. The other end must be terminated in a plug to suit your particular requirements.

( ) Apply a tone or radio signal to the amplifier input and check that the output is controlled by the amplifier input control.

If it is intended to secure the amplifier permanently to a shelf or within a cabinet, four holes $\frac{1}{4}$" diameter should be drilled in the shelf or cabinet to form an oblong 9 5/32" x $4\frac{1}{4}$". When the rubber feet are fixed to the chassis base the screws should be reversed so that the amplifier stands up on the screw ends. Pass these threaded ends through the shelf or panel and secure with lockwashers and four extra 2BA nuts. Read next step before proceeding.

( ) Mount four rubber feet to the chassis bottom plate using 2BA x 3/8" hardware, with nuts and lockwashers on the inside. NOTE: See above for fixing to shelf or cabinet and use 2BA x $1\frac{1}{2}$" screws.

( ) Fix bottom plate to the chassis underside using four 3/8" sheet metal screws to secure.

INSTALLATION

When the amplifier is completely tested, it should be permanently installed in the system. It may be installed wherever convenient, with the following precautions.

(a) Allow sufficient ventilation to prevent overheating. If the rubber feet are dispensed with it is essential that a series of holes or a slot be cut in the mounting shelf to permit a free air circulation.

(b) Provide access room for connecting cables.

(c) Protect the amplifier from dampness or physical damage. Since the valves run quite hot, the unit should be installed where it cannot be tampered with by small children.

Pictorial 4 shows two MA-12 amplifiers and a control unit (Heathkit USC-1) wired in a stereo system.

An a.c. outlet is provided and it may be used to supply power to a tuner, gramophone motor or tape recorder. If used for a record changer, be sure the unit is allowed to pass through its change cycle so that it shuts itself off. Otherwise, idler wheels in the changer may be left in contact with the spindles thus causing 'flats' to develop. A complete discussion upon how to install the high fidelity system is too lengthy to include in this manual. For those interested in a more comprehensive study of high fidelity sound reproduction, the following journals are recommended:-

Hi-Fi News
The Gramophone
Record Review
Wireless World
Practical Wireless
Radio Constructor

and the American periodicals - 'High Fidelity', 'Audio' and 'Electronic World'. The following books are also specially recommended:-

Hi-Fi Year Book
'Loudspeakers' by G. Briggs
'Sound Reproduction' by G. Briggs
'Stereo Handbook' by G. Briggs
High Fidelity Sound Reproduction by Malloy
The Gramophone Handbook by P. Wilson
High Quality Sound Reproduction by J. Muir

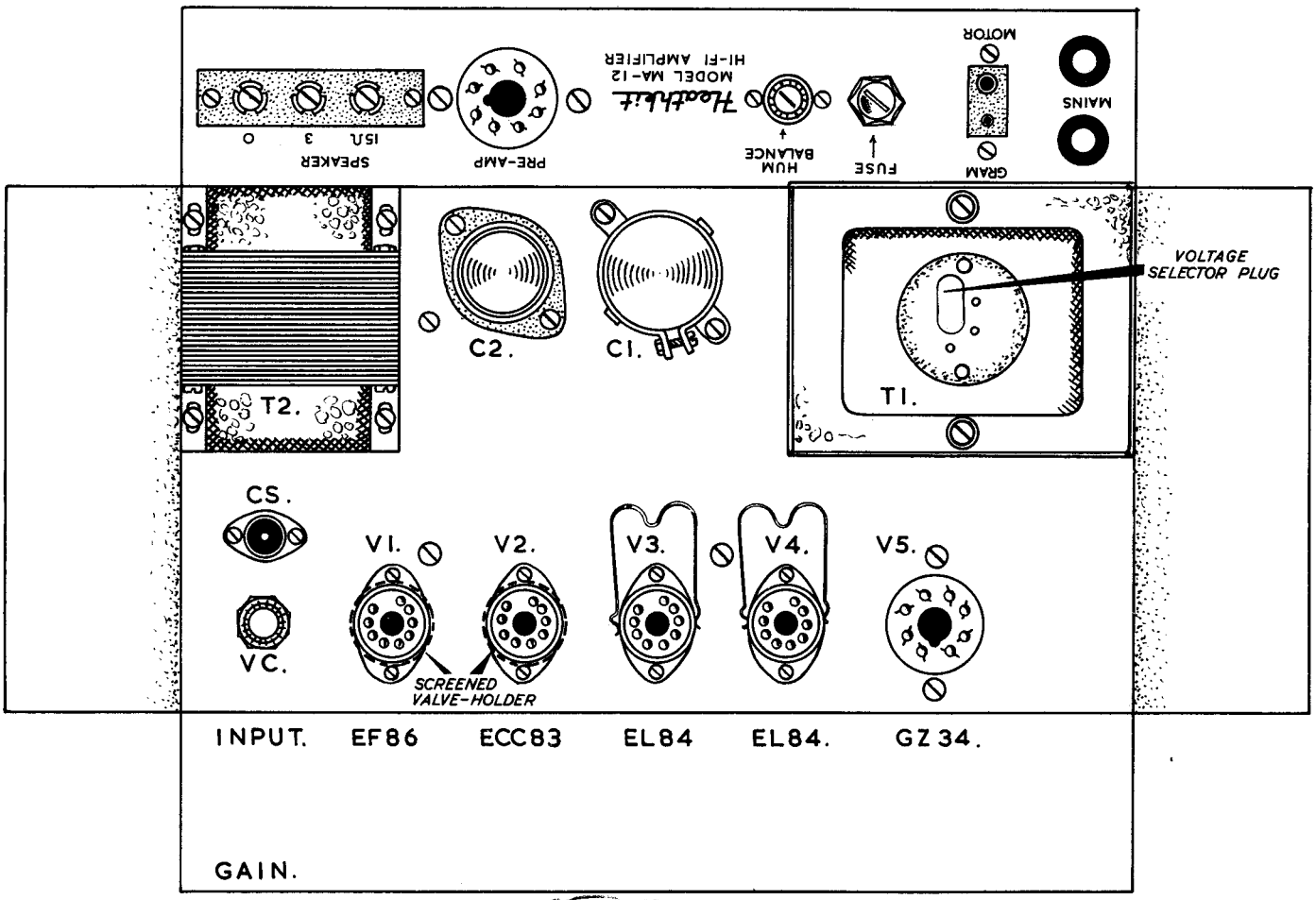
ADJUSTMENT

The controls of both the control unit and amplifier should be adjusted to give the best signal-to-noise ratio, i.e. the amplifier input control should be turned down as far as possible to match the output of the control unit. Generally, this will be about mid-rotation. If two amplifiers are used with a stereo control unit, then their input controls should be adjusted equally.

If the USC-1 is used, then its controls should be set as follows:-

Volume - position 3
Balance - 12 o'clock
Mono/Stereo switch at STEREO

The USC-1 rear panel controls should now be adjusted to give (a) average listening level on both channels at this setting of volume. If the volume control is then advanced, overload distortion should not occur before maximum rotation. (b) The same approximate level of sound should be obtained as each input is selected at the same setting of the volume control.



PICTORIAL 3

AMPLIFIER INTERCONNECTIONS FOR STEREO INSTALLATION INCLUDING TAPE RECORD/REPLAY

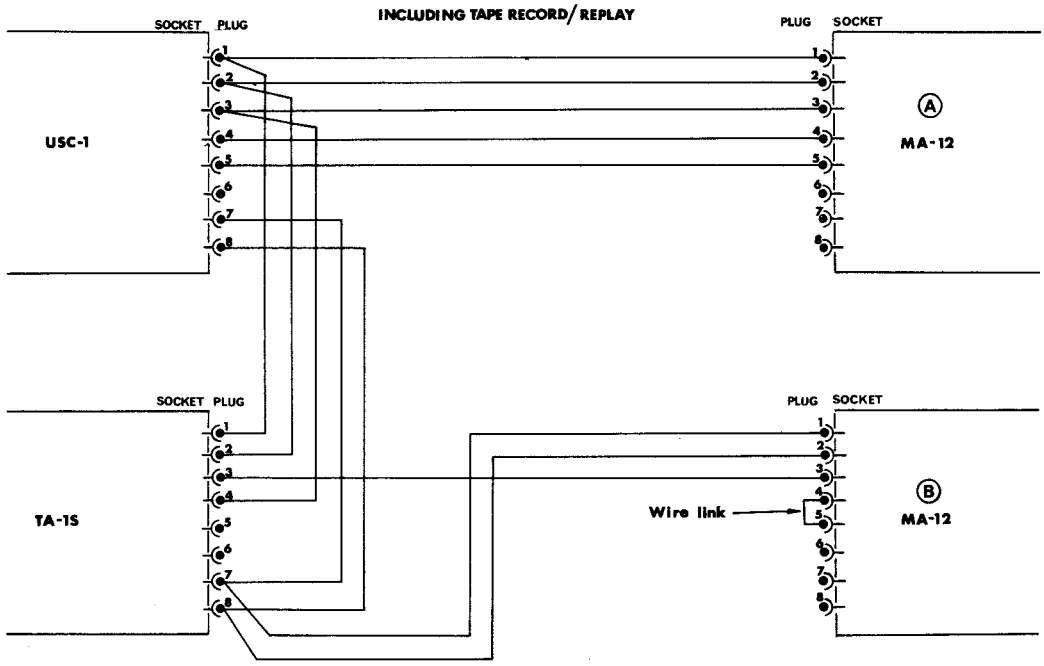
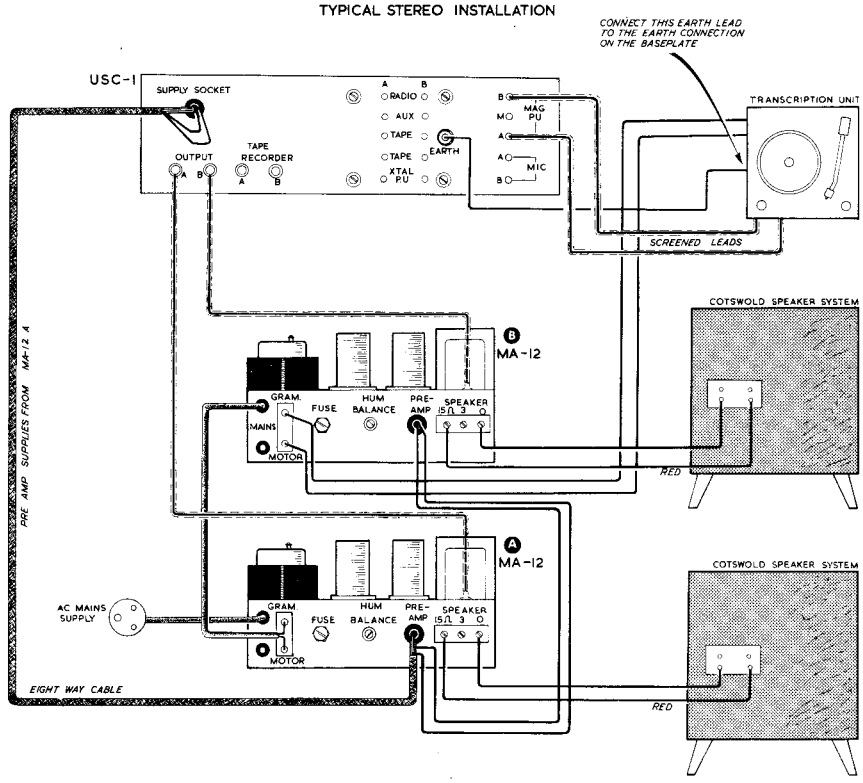
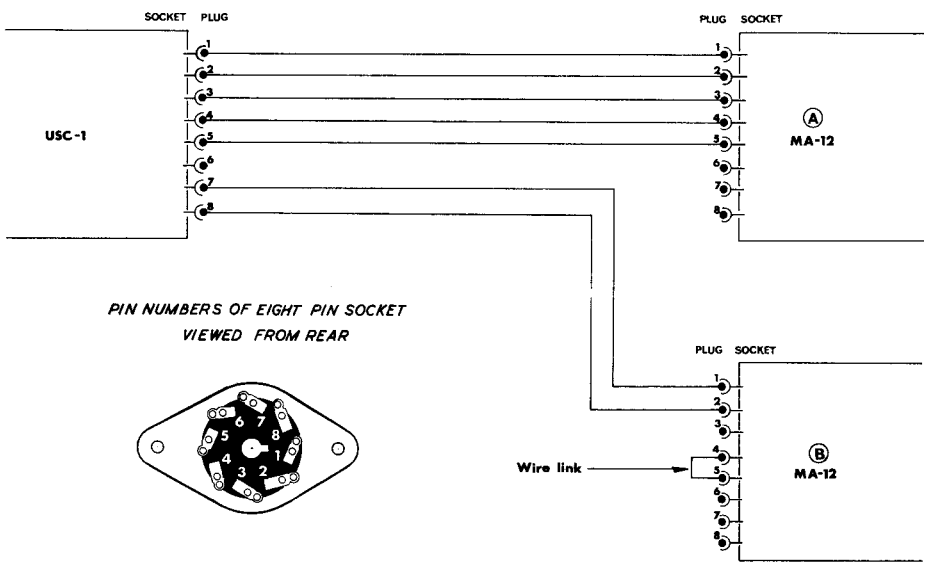


Figure 1

TYPICAL STEREO INSTALLATION



AMPLIFIER INTERCONNECTIONS



PIN NUMBERS OF EIGHT PIN SOCKET VIEWED FROM REAR

PICTORIAL 4

USING THE MA-12 WITH OTHER AMPLIFIERS

Although the MA-12 is primarily designed for use with the USC-1 stereo control unit and UMC-1 monaural control unit, it can be used with any unit either stereo or mono having the necessary control functions.

Sufficient power is available from the MA-12 to operate both H.T. and heater circuits of a pre-amplifier. Here are the appropriate connections of socket SB:-

6.3 volts a.c. at 2.5 amps	Socket Pin 1 and 2
300 volts d.c. at 25 mA *	Socket Pin 3
a.c. switching extension	Socket Pin 4 and 5
HT negative	Via the screened braid of the coaxial cable to the input socket

* For this requirement, change R16 to 1 KΩ 2 watt resistor.

IN CASE OF DIFFICULTY

1. Recheck the wiring. Trace each lead in coloured pencil on the pictorials as it is checked. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something consistently overlooked by the constructor.

2. It is interesting to note that about 90% of the kits that are returned for repair do not function properly due to poor connections and soldering. Therefore, many troubles can be eliminated by reheating all connections to make sure that they are soldered as described in the section PROPER SOLDERING PROCEDURE.

3. Check that all valves are in their proper locations. Make sure that all valves light up properly.

4. Check the valves with a valve tester or by substitution of valves of the same type which are known to be good.

5. Check the values of the parts. Be sure that the proper part has been wired into the circuit as shown in the Pictorials and as called for in the wiring instructions.

6. Check for bits of solder, wire ends or other foreign matter which may be lodged in the wiring.

7. If, after careful checks, the trouble is still not located and a voltmeter is available, check voltage readings against those shown in the VOLTAGE CHART. NOTE: All voltage readings were taken with a 20,000Ω/volt meter and may vary as much as 20%.

8. A review of the CIRCUIT DESCRIPTION will prove helpful in indicating where to look for trouble.

9. The following 'control grid disturbance' tests will prove helpful in indicating which stages are operating.

CAUTION: There are high voltages present at various points in the amplifier, DO NOT TOUCH these. Be certain that you have located the correct test point before proceeding. Satisfactory completion of these tests merely indicates that a signal can be passed through the amplifier but does not indicate 100% performance.

Holding the blade of a small screwdriver between the fingers, intermittently touch the following locations:-

( ) Pin 2 of V3 and V4. Weak clicks should be heard from the speaker.

( ) Tagstrip TB tags 1 and 5. A slight hum should be heard (clicks).

( ) Remove the fingers from the blade and intermittently touch pins 1 and 6 of V2. Clicks should be heard from the speaker, indicating that the coupling capacitors C7 and C8 are intact.

( ) Location pin 7 of V2. A hum should be heard.

( ) Removing the fingers again, touch pin 6 of V1, clicks should be heard.

( ) Finally, touch the centre pin of socket CS and rotate the input control clockwise. A loud hum should be heard.

( ) The following junctions should be specially checked for proper soldering.

Tagstrip TA2, 4, 9, 14.
Tagstrip TB4, 14.

Ensure that all wires are properly soldered at these tags.

SPECIFIC TROUBLES

Distortion: Faulty valves, a leaky 0.5 μF coupling capacitor or resistors that have changed value due to overheating during assembly. An ohmmeter will prove helpful in checking for leaky capacitors and resistors that are out of tolerance. Ensure that the 100Ω, 100 KΩ, 6.8 KΩ and 68 KΩ resistors have not been transposed. Distortion may be caused by the signal overloading the early stages of the amplifier. To prevent this, the input control should be set so that the amplifier is just fully loaded, with the control unit's volume control near maximum (see ADJUSTMENT).

Hum: Before suspecting internal causes, remove the input cable and turn the input control fully anticlockwise. If hum is then apparent, proceed with the following checks:-

Excessive hum in an amplifier is usually caused by poor heater to cathode insulation in a valve, poor chassis connections or faulty electrolytic smoothing capacitors. Capacitors and valves should be checked by direct substitution or by having them tested.

The field from the amplifier's mains transformer may be 'radiating' directly into the input wiring. The amplifier should therefore, be moved as far away from the control unit as the leads will allow, and the amplifier rotated through 360° to find a null where hum pick-up is minimum.

VOLTAGE CHART

VALVE TYPE	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V1 EF86	N	0	1.3	H	H	49	0	1.3	N
V2 ECC83	222	42	83	H		222	41	83	H
V3 EL84	-	0	12.3	H	H	-	336	338	338
V4 EL84	-	0	12.3	H	H	-	336	338	338
V5 GZ34	-	340*	-	278 V a.c.	-	278 V a.c.	-	340*	-
SB SOCKET	H	H	313	240 V a.c.	240 V a.c.	-	-	-	-

CAPACITOR C2 RED	284	CAPACITOR C2 YW	165

All voltages measured with a 20,000Ω/volt meter.
N - not significant.
H denotes heaters. 6.3V are present between points marked thus.
* denotes rectifier heaters. 5V a.c. present between points marked thus.

SERVICE INFORMATION

SERVICE

If, after applying the information contained in this manual, you are still unable to obtain proper performance, it is suggested that you take advantage of the technical facilities which we make available to our customers.

The Technical Consultation Department is maintained for your benefit. This service is available to you at no charge. Its primary purpose is to provide assistance for those who encounter difficulty in the construction, operation or maintenance of HEATHKIT equipment.

Although the Technical Consultants are familiar with all details of this kit, the effectiveness of their advice will depend entirely upon the amount and the accuracy of the information furnished by you. Please use this outline:

1. Before writing, fully investigate each of the hints and suggestions listed in this manual under In Case of Difficulty. Possibly one of these will solve your problem.

2. When writing, clearly describe the nature of the trouble and mention all associated equipment. Specifically report operating procedures, switch positions, connections to other units and anything else that might help to isolate the cause of trouble.

3. Report fully on the results obtained when testing the unit initially and when following the suggestions under In Case of Difficulty. Be as specific as possible and include voltage readings if test equipment is available.

4. Identify the kit model number, invoice number and date of purchase, if available.

5. Print or type your name and address, preferably at the head of the letter.

With the preceding information, the consultant will know exactly what kit you have, what you would like him to do for you and the difficulty you wish to correct. The date of purchase tells him whether or not engineering changes have been made since it was sent to you. He will know what you have done in an effort to locate the cause of trouble and, thereby, avoid repetitious suggestions. In short, he will devote full time to the problem at hand, and through his familiarity with the kit, plus your accurate report, he will be able to give you a complete and helpful answer. If replacement parts are required, they will be sent to you, subject to the terms of the Guarantee.

HEATHKIT equipment purchased locally and returned to Daystrom Limited for service must be accompanied by your copy of the dated sales receipt from your authorised HEATHKIT dealer in order to be eligible for parts replacement under the terms of the Guarantee.

If the completed instrument should fail to function properly and attempts to find and cure the trouble prove ineffective, the facilities of Daystrom's Service Department are at your disposal. Your instrument may be returned carriage paid to Daystrom Limited, Gloucester, and the Company will advise you of the service charge where not covered within the terms of the Guarantee (i.e. a faulty component supplied by us).

For information regarding modification of HEATHKIT equipment for special applications, it is suggested that you refer to any one or more of the many publications that are available on all phases of electronics. They can be obtained at or through your local library, as well as at most electronic equipment stores. Although Daystrom Ltd. sincerely welcomes all comments and suggestions, it would be impossible to design, test, evaluate and assume responsibility for proposed circuit changes for special purposes. Therefore, such modifications must be made at the discretion of the kit builder, using information available from sources other than Daystrom Limited.

REPLACEMENTS

Material supplied with HEATHKIT products has been carefully selected to meet design requirements and ordinarily will fulfill its function without difficulty. Occasionally improper instrument operation can be traced to a faulty component. Should inspection reveal the necessity for replacement, write to Daystrom Limited and supply all of the following information.

A. Thoroughly identify the part in question by using the part number and description found in the manual Parts List.
B. Identify the type and model number of kit in which it is used.
C. Mention date of purchase.
D. Describe the nature of defect or reason for requesting replacement.

Daystrom Limited will promptly supply the necessary replacement. PLEASE DO NOT RETURN THE ORIGINAL COMPONENT UNTIL SPECIFICALLY REQUESTED TO DO SO. Do not dismantle the component in question as this will void the guarantee. This replacement policy does not cover the free replacement of parts that may have been broken or damaged through carelessness on the part of the kit builder.

SHIPPING INSTRUCTIONS

Before returning a unit for service, be sure that all parts are securely mounted.

ATTACH A LABEL TO THE INSTRUMENT GIVING
NAME, ADDRESS AND TROUBLE EXPERIENCED.

Pack in a rugged container, preferably wood, using at least three inches of shredded newspaper, wood wool or plastic cushioning material on all sides. DO NOT DESPATCH IN THE ORIGINAL KIT CARTON AS THIS CARTON IS NOT CONSIDERED ADEQUATE FOR SAFE SHIPMENT OF THE COMPLETED INSTRUMENT. Note that a carrier cannot be held liable for damage in transit if packing, in HIS OPINION, is insufficient.

PRICES: All prices are subject to change without notice.

MODIFICATIONS TO SPECIFICATIONS: Daystrom Limited reserves the right to discontinue instruments and to change specifications at any time without incurring any obligation to incorporate new features in instruments previously sold.

* * * * * * * * * * * * * * *

The Heathkit builder is again strongly urged to follow step-by-step instructions given in this Manual to ensure successful results. Daystrom Limited assumes no responsibility for any damages or injuries sustained in the assembly or handling of any of the parts of this kit or the completed instrument.

PARTS LIST

PART No.	PARTS Per Kit	DESCRIPTION
Resistors, ½ watt		
H-471C10	2	470Ω (Yellow, Violet, Brown)
H-102C10	1	1 KΩ (Brown, Black, Red)
H-682C10	1	6.8 KΩ (Blue, Grey, Red)
H-223C10	3	22 KΩ (Red, Red, Orange)
Resistors, 1 watt and 3 watt		
1-271C10	2	270Ω (Red, Violet, Brown)
1-103C10	1	10 KΩ (Brown, Black, Orange)
3-514	2	50Ω wire-wound (value marked)
Resistors, high stability		
Q-101HS5	1	100Ω (value marked)
H-222HS5	1	2.2 KΩ (value marked)
H-103HS5	1	10 KΩ (Brown, Black, Orange, Gold, Pink)
H-683HS5	1	68 KΩ (Blue, Grey, Orange, Gold, Pink)
H-903HS5	1	90 KΩ (White, Black, Orange, Gold, Pink)
H-104HS5	1	100 KΩ (Brown, Black, Yellow, Gold, Pink)
H-224HS5	4	220 KΩ (Red, Red, Yellow, Gold, Pink)
H-105HS5	3	1 MΩ (Brown, Black, Green, Gold, Pink)
Capacitors		
20-512	1	100 pF silver mica
20-519	1	510 pF silver mica
23-502	3	.1 µF tubular, 400 volt
23-518	2	.5 µF tubular, 350 volt
25-501	2	25 µF, 25 volt, electrolytic
25-523	1	50-50 µF, 350 volt, electrolytic
25-524	1	250-60 µF, 350 volt, electrolytic
Potentiometers		
11-502	1	100Ω wire-wound, lin
10-501	1	1 MΩ, log
Tagstrips, Valveholders, Plugs, Sockets		
431-1	2	1-way tagstrip
431-516	2	14-way tagstrip
431-505	1	3-way terminal strip
438-503	1	8-pin plug and plastic cover
434-503	2	8-pin valveholder
434-501	2	9-pin valveholder, skirted
434-502	2	9-pin valveholder, non-skirted
432-506	1	Coaxial socket
438-504	1	Coaxial plug
434-527	1	Auxilliary mains socket
438-506	1	Auxilliary plug
Valves		
411-501	1	EF86 valve
411-504	1	GZ34 valve
411-507	1	ECC83 valve
Valves (cont'd.)		
411-511	2	EL84 valve
Transformers		
51-507	1	Output transformer
54-520	1	Mains transformer
Metal Parts		
200-521	1	Chassis
601-108	1	Bottom plate
Wire, Solder, etc.		
89-504	1 length	3-core mains cable
331-501	1 length	18 swg. solder
340-501	1 length	22 swg. bare wire (thin)
340-502	1 length	16 swg. bare wire (thick)
343-503	1 length	Coaxial cable
344-501	1 length	Brown connecting wire
344-502	1 length	Red connecting wire
344-503	1 length	Orange connecting wire
344-504	1 length	Yellow connecting wire
344-505	1 length	Green connecting wire
346-501	1 length	1½ mm. sleeving
346-505	1 length	7 mm. sleeving
Hardware (screws, nuts, washers, etc.)		
250-501	18	6BA x ¼" binderhead screw
250-526	2	6BA x ½" binderhead screw
250-513	13	4BA x ¼" binderhead screw
250-517	1	4BA x ½" binderhead screw
250-511	4	2BA x 3/8" binderhead screw
250-541	4	2BA x 1½" binderhead screw
250-8	4	No. 6 x 3/8" sheet metal screw
252-501	18	6BA nut
252-3	14	4BA nut
252-503	8	2BA nut
254-501	19	6BA lockwasher
254-1	17	4BA lockwasher
254-502	10	2BA lockwasher
259-505	1	6BA shakeproof solder tag
Miscellaneous		
73-501	4	3/8" grommet
206-501	2	Valve screening can
207-502	2	Plastic cable clamp
207-504	1	Metal cable clamp
258-508	2	Valve retaining clip
260-501	1	Capacitor mounting clip
261-501	4	Rubber foot
421-501	2	4 amp cartridge fuse (1 spare)
423-501	1	Fuseholder
438-516	1	Voltage selector plug
462-507	1	Knob
481-501	1	Insulated capacitor mounting plate
630-501	1	6BA/4BA plastic nut-starter
595-598	1	Instruction manual