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THE

TSL MARK IV F.M. TUNER AND ITS CONSTRUCTION

by
W. J. MAY

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BERNARDS (Publishers) LTD.
The Grampians, Western Gate,
London W.6

by

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FIRST PRINTED JUNE, 1964

Printed by V. Cooper & Partners, Ltd., Flitcroft Street, W.C.2., for Bernards (Publishers) Ltd., The Grampians, Western Gate, London, W.6.

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Foreword

It is now some nine years since Bernards (Publishers) Ltd. produced the first really practical design for FM tuner construction. Since then there has been an unceasing demand for both the manual and the component parts required for its construction.

As many of our constructors are aware, TSL have been importing VHF components for over eleven years and were responsible for the supply of parts used for the original design. Naturally, over the years, improvements have been made and Messrs. Gorler of Mannheim, the manufacturers supplying these components, have not been slow to take advantage of every technical advance and the dictates of present day necessity. As a result two remarkable units have emerged. TSL have supplied considerable quantities of these to British makers concerned only with high quality and now, through this publication, the amateur constructor is enabled to take advantage of all the improvements that these units can offer.

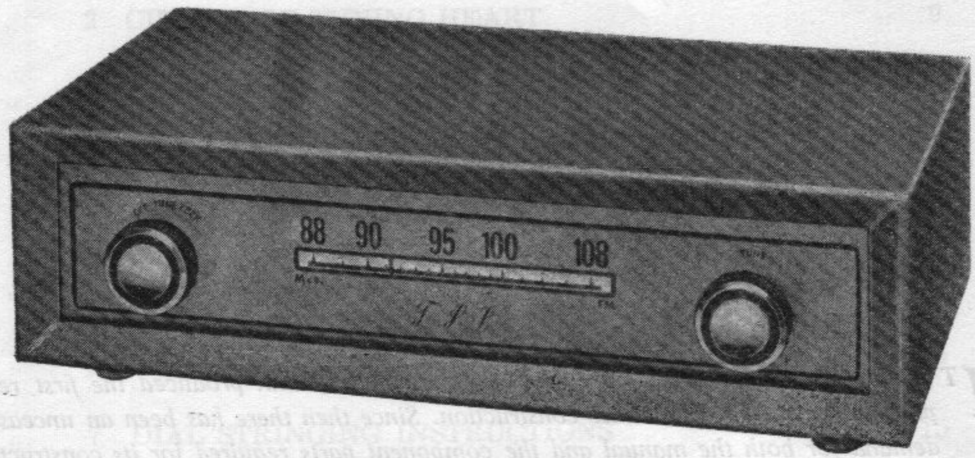
We are offering the same theoretical approach to the subject as previously so that new readers will appreciate the difficulties confronting the designers and understand the subject of VHF reception as a whole.

Technical Suppliers Limited now have available a vast range of components for the home constructor. For the last ten years this Company has specialised in supplying parts for all circuits shown in Bernards comprehensive range of practical and electronic handbooks.

Technical Suppliers Limited can also supply parts for all circuits and designs shown in practically every radio magazine published in this country. Leaflets are available complete with circuit data etc. : which can be supplied on demand. These data sheets are dispatched by return, post paid, for the nominal charge of 1s. 3d.

The circuit in this book has been tested in our laboratories, after being built by a panel of Amateur Constructors, and readers are strongly advised that under no circumstances, are they to alter the values of components shown in the circuits, or accept any substitute components as experience has shown that such changes can only result in poor performance of the apparatus and disappointment to the Constructor.

We invite all authors, whether new or well established, to submit manuscripts for publication. The manuscripts may deal with any facet of electronics but should always be practical. Any circuit diagrams that may be included should have been thoroughly checked by the author. If you are considering trying your hand at writing this type of book we suggest that you let us have a short summary of the subject you intend to cover. We will then be able to let you know the size of book required and perhaps give you some advice on presensation.



MARK-IV FM TUNER

V.H.F. Circuits

The following information is intended for the enthusiast who wishes to familiarise himself with the technique of V.H.F., which has now become all important in the world of Sound Radio.

In a manual of this kind it is not possible to thoroughly explore the question but the salient points will be covered so that constructors will not feel that they are building to a pattern without any idea of the reasoning behind the design.

An F.M. tuner basically follows the same form as an A.M. unit, comprising R.F., Mixer, I.F. and Detector stages. Because of the frequencies involved, the modern trend in high grade V.H.F. equipment is to use triode valves as R.F. amplifiers. Considerably less noise is generated with a triode used as a grounded grid amplifier at V.H.F. than is encountered with the more familiar R.F. pentode.

Most constructors will be conversant with the familiar triode-hexode frequency changer, almost universally adopted for ordinary A.M. designs which use this valve as a multiplicative mixer.

High grade V.H.F. designs avoid this system, firstly, because at the frequencies involved its efficiency falls to about one tenth of its normal value, secondly, critical adjustment of the oscillator voltage is necessary, even after which, the noise level is high. Finally, and most important of all, thermal frequency drift is pronounced making it necessary to retune repeatedly during the first 20 minutes of operation.

A satisfactory solution to this problem is to use an Additive mixer.

The additive mixer is the oldest of all frequency changer systems used in radio. It was discarded many years ago because with receiver designs current in those days it was impossible to eliminate interaction between the two tuned circuits with the result that they tended to pull into synchronisation.

This difficulty does not apply when the system is applied to the V.H.F. band as the difference in frequency between signal and oscillator frequencies (10.7 Mc/s) is one hundred times as great as with the old circuits.

An additive mixer/oscillator can be formed by means of a simple triode and avoids the unpleasant drawbacks of multiplicative mixers.

From the foregoing it will be appreciated that two triodes are necessary for an effective V.H.F. "front end" that is, the stages preceding the I.F. circuits. Circuit layout has been considerably simplified by the introduction of the ECC85 a double triode valve. This valve has adequate screening between sections and enables the functions of V.H.F. grounded grid amplifier and mixer/oscillator to be carried out in one envelope.

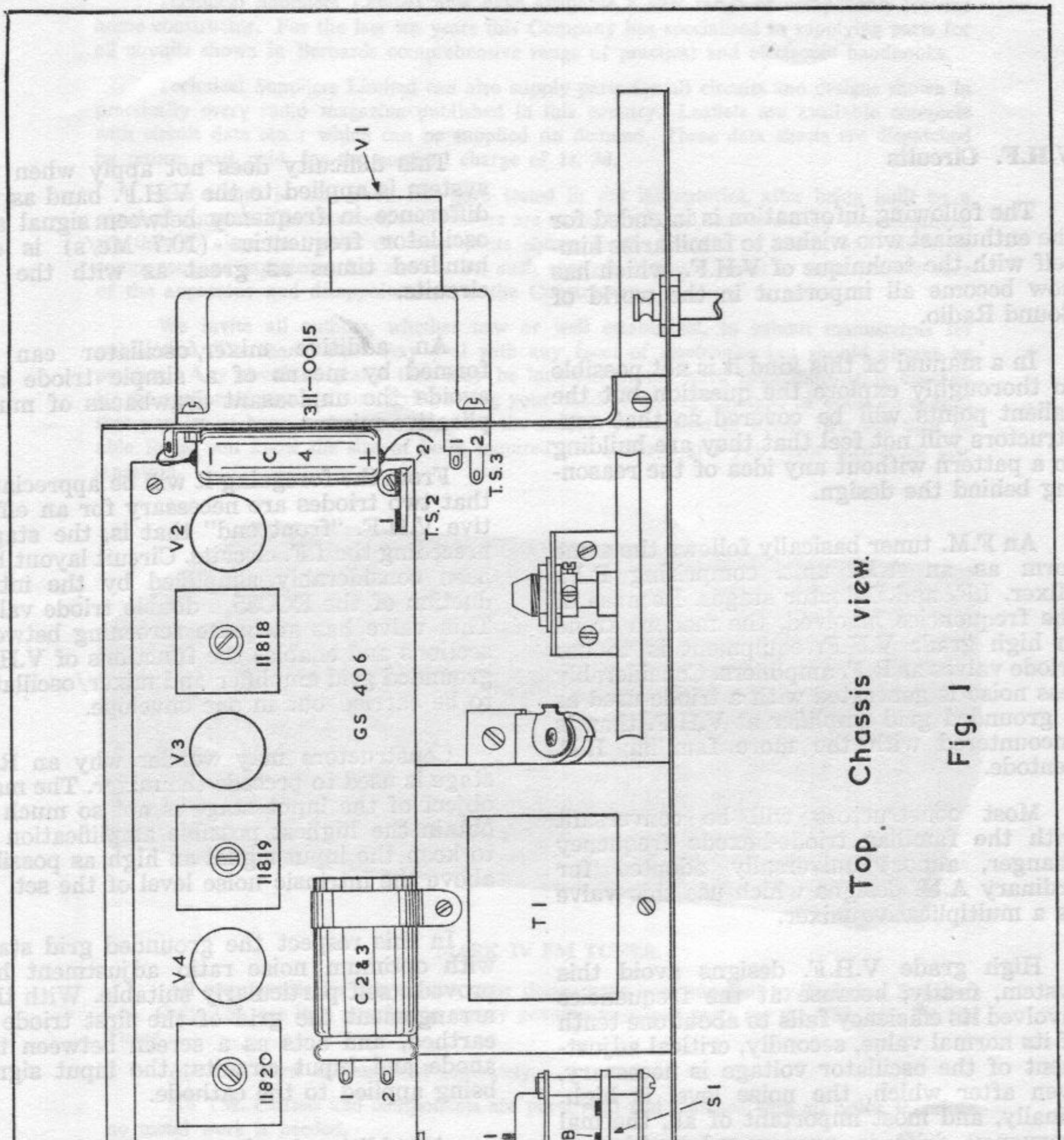
Constructors may wonder why an R.F. stage is used to precede the mixer. The main object of the input stage is not so much to obtain the highest possible amplification as to keep the input signal as high as possible above the intrinsic noise level of the set.

In this respect the grounded grid stage with optimum noise ratio adjustment has proved itself particularly suitable. With this arrangement the grid of the first triode is earthed, and acts as a screen between the anode and input circuits; the input signal being applied to the cathode.

An additional and very important feature is that this screen isolates the aerial circuit from the local oscillator, thereby minimising the possibility of fundamental or harmonic radiation from the aerial terminals.

Radiation is a point which must be considered.

Excessive radiation is a feature of all poorly designed V.H.F. receivers and it can cause severe interference to television receivers operating on Band III. All receivers and tuner units designed to receive the new



Top Chassis view.
Fig. 1

F.M. transmissions on V.H.F. radiate to some extent but with the components used for this tuner, it is exceptionally low, a certified measurement of 25 μV. per metre. Such a low figure ensures that there will be no interference with neighbouring television receivers. It will be readily appreciated that the layout and wiring of the first stages, that is, R.F. and mixer/oscillator stages is a skilled operation not to be lightly undertaken. Any attempt at haphazard construction can only result in instability, excessive radiation and/or, an almost complete absence of stage gain. With this tuner unit, the difficulties and problems usually expected do not exist.

A complete R.F. stage mixer/oscillator is supplied to the constructor, completely wired and tested by the manufacturer.

Fig. 2 COMPONENT VALUES

C2	1000 pF
C3	1000 pF
C4-8	Trimmers
C5	15 pF
C6	15 pF
C7	3 pF
C9	15 pF
C11	10 pF
C12	8.2 pF
C13	68 pF
R4	200k ohms
R5	1 M ohm

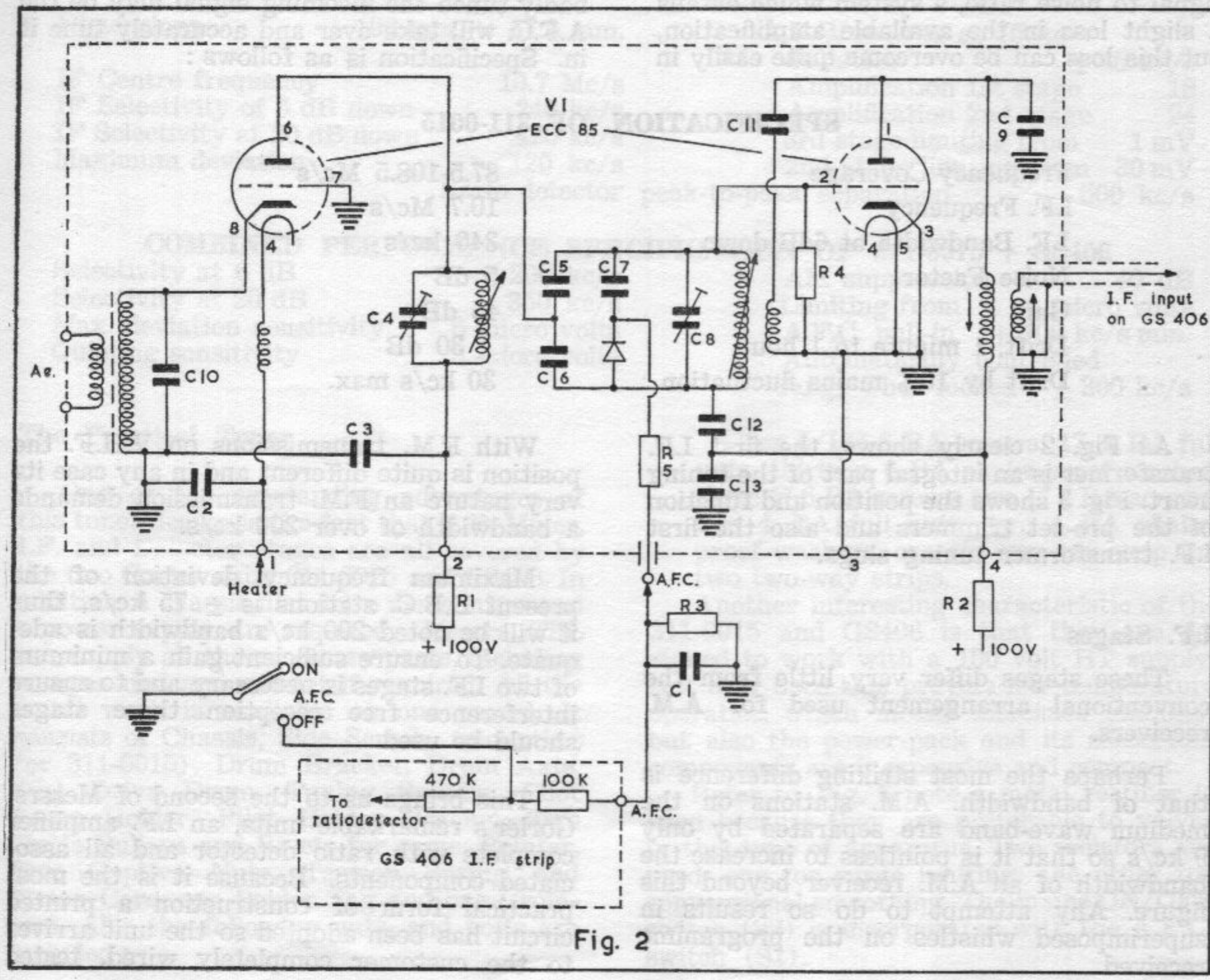


Fig. 2

V.H.F. Tuning Heart unit type 311-0015

The position of this unique unit can be clearly seen from the layout drawing (Fig. 1). It may be seen to the left of the chassis mounted at right angles complete with valve type ECC85. A theoretical circuit diagram of this unit is given in Fig. 2.

Designed expressly for the ECC85, the unit is housed in a die-cast box together with all the necessary components for matching the input to a 75 ohm aerial system. The first I.F. transformer for 10.7 M/cs is mounted within the unit, the secondary winding being terminated in a length of screened cable which facilitates connection to the rest of the I.F. chain. The self capacitance of this screen cable is used for tuning purposes, and is included in the alignment of the complete tuner.

Aerial matching is not arranged for maximum signal transfer, but for the best signal to noise ratio, a system which entails a slight loss in the available amplification, but this loss can be overcome quite easily in the subsequent I.F. stages. This arrangement was dictated by the more important considerations of stability, low temperature co-efficients and easy alignment.

The oscillator, for which the second triode of the ECC85 is used, works in a bridge circuit which incorporates I.F. regeneration in order to neutralise the damping of the 1st I.F. transformer by the internal resistance of the mixing triodes.

Since the unit is pre-adjusted at the factory, the balancing of this circuit is accomplished by carefully chosen fixed capacitors, and only one trimmer is required for subsequent oscillator adjustments. Fig. 3 shows position of trimmers.

It should also be noted that this tuning heart has the facility of A.F.C. (automatic frequency correction). Its pulling power amounts to over ± 200 kc/s so that however badly tuned the incoming signal may be the A.F.C. will take over and accurately tune it in. Specification is as follows :

SPECIFICATION OF 311-0015

Frequency Coverage	87.5-108.5 Mc/s
I.F. Frequency	10.7 Mc/s
I.F. Bandwidth at 6dB down	340 kc/s
Noise Factor	5 dB
Gain	45 dB
Drift, 1 minute to 1 hour	± 30 dB
Drift by 10% mains fluctuation	30 kc/s max.

As Fig. 2 clearly shows, the first I.F. transformer is an integral part of the tuning heart. Fig. 3 shows the position and function of the pre-set trimmers and also the first I.F. transformer tuning slugs.

I.F. Stages

These stages differ very little from the conventional arrangement used for A.M. receivers.

Perhaps the most striking difference is that of bandwidth. A.M. stations on the medium wave-band are separated by only 9 kc/s so that it is pointless to increase the bandwidth of an A.M. receiver beyond this figure. Any attempt to do so results in superimposed whistles on the programme received.

With F.M. transmissions on V.H.F. the position is quite different and in any case its very nature an F.M. transmission demands a bandwidth of over 200 kc/s.

Maximum frequency deviation of the present B.B.C. stations is ± 75 kc/s, thus it will be noted 200 kc/s bandwidth is adequate. To ensure sufficient gain a minimum of two I.F. stages is necessary and to ensure interference free reception three stages should be used.

This brings us to the second of Messrs. Gorler's remarkable units, an I.F. amplifier complete with ratio detector and all associated components. Because it is the most practical form of construction a printed circuit has been adopted so the unit arrives to the customer completely wired, tested and aligned. Thus, in one stroke all the pitfalls of V.H.F. receiver construction are overcome. G.S.406 is the code number of this amplifier and its components offer many advantages over the usual run of components offered on the British Market. For instance, powdered carbonyl iron cores are used to tune the transformer windings and the necessary parallel capacitance is made up by polystyrene film capacitors. This combination produces a very low temperature co-efficient (< — 25.10—6/°C) with the result that drift which would ruin the response completely is avoided.

Choice of valves can present quite a problem, unsuitable types can undo all the excellent qualities of the remaining components and lead to thermal drift. Type 6AU6 has been a familiar type to most constructors for some time and its excellence for this type of application cannot be overstressed.

Examine the theoretical circuit of the GS406 : (Fig. 4) progressive limiting is employed, which, for the benefit of less experienced enthusiasts means resistance to interference in the form of AM modulation (car ignition, fluorescent lighting, etc.).

So far no valve has superior characteristics to the 6AU6 when working in this capacity. Detection is by means of a Ratio Detector circuit, there are several other types which could have been chosen, all resulting in extra expense and a number of disadvantages without any improvement as far as performance is concerned.

Technical details of the GS406 are shown below followed by a comprehensive specification showing the performance of the GS406 and 311-0015 when used conjointly.

TECHNICAL SPECIFICATION OF GS406 IF STRIP

Dimensions	190 mm. × 67.5 mm.	A.F.C. reserve at 75 kc deviation	± 45 kc/s
IF Centre frequency	10.7 Mc/s	Amplification 1st stage	18
IF Selectivity of 6 dB down	240 kc/s	Amplification 2nd stage	24
IF Selectivity at 20 dB down	420 kc/s	3rd stage limiting from	1 mV
Maximum deviation	120 kc/s	2nd stage limiting from	30 mV
Ratio detector peak-to-peak separation			500 kc/s

COMBINED PERFORMANCE SPECIFICATION OF 311-0015 + GS406

Selectivity at 6 dB	200 kc/s	AM suppression	40 dB
Selectivity at 20 dB	350 kc/s	Limiting from	4 micro volts
Max. deviation sensitivity	6 micro volts	A.F.C. pull-in	± 200 kc/s min.
Quieting sensitivity	3 micro volts	Automatically controlled range when locked	± 300 kc/s

The Practical Tuner

One of the outstanding advantages of this tuner design is the fact that R.F. Mixer, I.F. and Detector stages are all covered by the two Gorler units 311-0015 and GS406. In addition, a chassis dial drive mechanism and a power supply are required. Messrs. TSL can supply all the necessary parts, including perspex dial and cabinet if required. All the metal work is available as one parcel. It consists of Chassis, Side Screen (mounting for 311-0015), Drum Bracket, Drum Axle, Dial Drive Drum, Tuning Spindle, Pilot Lamp Holder, Pilot Holder Bracket, Two Guide Pulleys and Rivets for same, Pointer, Two Captive Nuts, Tension Spring and Nylon Cord, one Solder Tag and one Grommet. Also the following nuts, and bolts are included :

Ten 5/16" 6 BA screws, 17, 6 BA full nuts, thirteen 6 BA shake-proof washer, three $\frac{5}{8}$" 6 BA screws, two $\frac{1}{4}$" 4 BA screws, two 4 BA full nuts, two 4 BA shake-proof washers, one six-way tag strip and two two-way strips.

Another interesting characteristic of the 311-0015 and GS406 is that they are designed to work with a 100 volt HT supply. Not only does this provide low temperature operation which means increased stability, but also the power-pack and its associated components are inexpensive and compact.

Refer to Fig. 5 note a metal rectifier is used because they are preferable to valves in this type of apparatus. Two resistors are used, one for surge limiting, the other for conventional smoothing. The mains ON/OFF switch (S2) is incorporated with the A.F.C. switch (S1).

RECOMMENDED LIST OF COMPONENTS USED SHOWING RETAIL PRICES

	Component	Maker	Price
1	311-0015 VHF Tuner Heart	TSL	65/4d.
1	GS406 IF Strip or complete with	TSL	75/-d.
	3×6AU6 and 1×EB91 Valves	TSL	or 106/6d.
1	Chassis & Hardware Kit	TSL	30/-d.
1	Mains Transformer Type T.1	TSL	20/-d.
MR1	Metal Rectifier Type FC118	TSL	9/-d.
S1-S2-SP	Three-way switch with combined D/P mains switch	TSL	10/6d.
R1	1k ohm $\frac{1}{2}$-w 1.2k	TSL	6d.
R2	4.7k ohm $\frac{1}{2}$-w—4.3k	TSL	6d.
R3	470k ohm $\frac{1}{4}$—$\frac{1}{2}$-watt	TSL	6d.
R4	180 ohm 3-5 watt	TSL	1/6d.
R5	1k ohm 3-5 watt	TSL	1/6d.
R6	1k ohm $\frac{1}{4}$—$\frac{1}{2}$ watt	TSL	6d.
C1	0.1 mfd	TSL	1/-d.
C2-C3	32+32 mfd 150-250v wg complete with mounting clip	TSL	7/6d.
C4	8 or 16 mfd 150-250v wg	TSL	3/6d.
C5	4700 to 10,000 pF ceramic	TSL	1/-d.
C6	0.05 mfd	TSL	1/6d.
V1	ECC85	TSL	8/6d.
V2	6AU6	TSL	8/6d.
V3	6AU6	TSL	8/6d.
V4	6AU6	TSL	8/6d.
V5	6AL5 or EB91	TSL	6/-d.
1	Perspex Dial	TSL	9/-d.
2	Knobs	TSL	3/-d.
1	6.3v Pilot Bulb	TSL	9d.
1	Metal Case High Gloss Gold Finish	TSL	39/6d.

ASSEMBLY

First, examine the hardware kit, check contents and identify all the parts, next, rivet the two pulleys to the back of the front panel, assemble the side screen, complete with T.S.3 solder tag and 311-0015 onto the main chassis, not forgetting to use shake-proof washers wherever nuts and bolts are employed. At this stage it is necessary to understand how the 311-0015 is tuned. Non-ferrous slugs are moved through the length of the tuning coils by means of a spring loaded nylon cord. When the slugs are completely inside the coil formers, that is with the cord slack the unit is tuned to the high frequency end of the band conversely when the cord is extended the low frequency end is tuned in. Note the position of the pulley from Fig. 3, it may be necessary to turn the bracket with pliers into position. Next, the drum assembly (see Fig. 6) is assembled both collar and drum should be left loose at this stage, only the axle is tightened to the

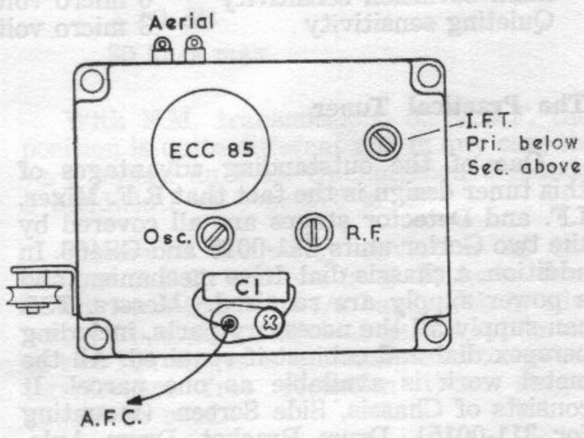


Fig. 3

bracket. Thread the nylon cord through the hole in the collar feeding from the side nearest to the drum, pull through about one inch, knot and cut near to knot. Screw

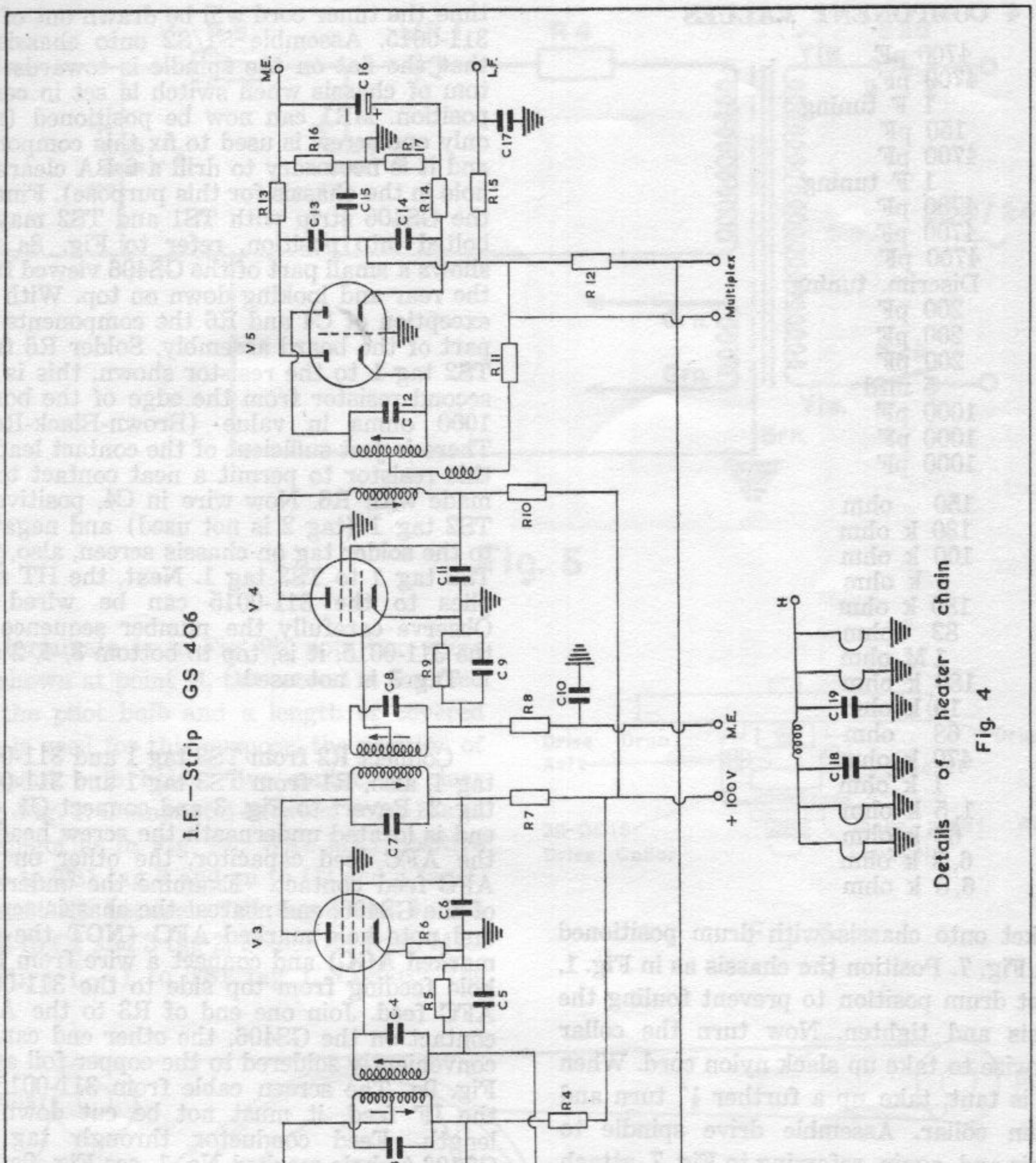

I.F. – Strip GS 406
Details of heater chain
Input from Tuning Heart
A.G.C.
A.F.C.
+ 100V
M.E.
Multiplex
L.F.
H
V2
V3
V4
V5
R1
R2
R3
R4
R5
R6
R7
R8
R9
R10
R11
R12
R13
R14
R15
R16
R17
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
C18
C19

Fig. 4

Fig. 4 COMPONENT VALUES

C1	4700 pF
C2	4700 pF
C3-4	1 F tuning
C5	150 pF
C6	4700 pF
C7-8	1 F tuning
C9	4700 pF
C10	4700 pF
C11	4700 pF
C12	Discrim. tuning
C13	200 pF
C14	200 pF
C15	200 pF
C16	5 mfd
C17	1000 pF
C18	1000 pF
C19	1000 pF
R1	150 ohm
R2	180 k ohm
R3	100 k ohm
R4	1 k ohm
R5	180 k ohm
R6	82 ohm
R8	1 M ohm
R9	180 k ohm
R10	10 k ohm
R11	68 ohm
R12	470 k ohm
R13	1 k ohm
R14	1,5 k ohm
R15	68 k ohm
R16	6,8 k ohm
R17	6,8 k ohm

bracket onto chassis with drum positioned as in Fig. 7. Position the chassis as in Fig. 1, adjust drum position to prevent fouling the chassis and tighten. Now turn the collar clockwise to take up slack nylon cord. When cord is taut, take up a further ⅛" turn and tighten collar. Assemble drive spindle to chassis and, again, referring to Fig. 7, attach drive cord. Viewing chassis from the rear, tie cord to tension spring take over to right-hand pulley and wind on as shown. Note the full turn around the drive spindle.

With the drum still in the position as in Fig. 7 clip on the pointer adjacent to the left-hand pulley looking from rear. When the drive spindle is turned it will be possible, provided the cord is not too slack, for the pointer to travel its full traverse at the same time the tuner cord will be drawn out of the 311-0015. Assemble S1/S2 onto chassis so that the flat on the spindle is towards bottom of chassis when switch is set in centre position. MR1 can now be positioned (note only one screw is used to fix this component and it is necessary to drill a 6 BA clearance hole in the chassis for this purpose). Finally, the GS406 strip with TS1 and TS2 may be bolted into position, refer to Fig. 8a this shows a small part of the GS406 viewed from the rear and looking down on top. With the exception of C4 and R6 the components are part of the board assembly. Solder R6 from TS2 tag 1 to the resistor shown, this is the second resistor from the edge of the board, 1000 ohms in value (Brown-Black-Red). There is just sufficient of the contact lead on this resistor to permit a neat contact to be made with R6. Now wire in C4, positive to TS2 tag 1 (tag 2 is not used) and negative to the solder tag on chassis screen, also, join TS2 tag 1 to TS3 tag 1. Next, the HT supplies to the 311-0015 can be wired in. Observe carefully the number sequence on the 311-0015, it is, top to bottom 3, 4, 2 and 1. Tag 3 is not used.

Connect R2 from TS3 tag 1 and 311-0015 tag 4, also, R1 from TS3 tag 1 and 311-0015 tag 2. Revert to Fig. 3 and connect C1, one end is located underneath the screw head of the AFC feed capacitor, the other on the AFC feed contact. Examine the underside of the GS406, end nearest the chassis screen and note hole marked AFC **(NOT the one marked AGC)** and connect a wire from this hole feeding from top side to the 311-0015 AFC feed. Join one end of R3 to the AFC contact on the GS406, the other end can be conveniently soldered to the copper foil as in Fig. 9a. The screen cable from 311-0015 is the IF feed, it must not be cut down in length. Feed conductor through tag of GS406 to hole marked No. 1, see Fig. 9a for location, the screening is fed through the adjacent hole and soldered. This hole is also clearly marked on Fig. 9a. Now mount T1, together with capacitors C2—C3 and its fixing clip. T1 is so positioned that the flying leads protrude towards the chassis face, the opposite side to C2 and C3. Insert grommet into chassis (Fig. 1). Refer to Fig. 1 and solder the two RED leads from T1 to TS1 tags 1 and 4 respectively. Connect the two YELLOW wires to S2 contacts 1 and 2 (lower pair). Feed the two GREEN wires through the chassis via the grommet

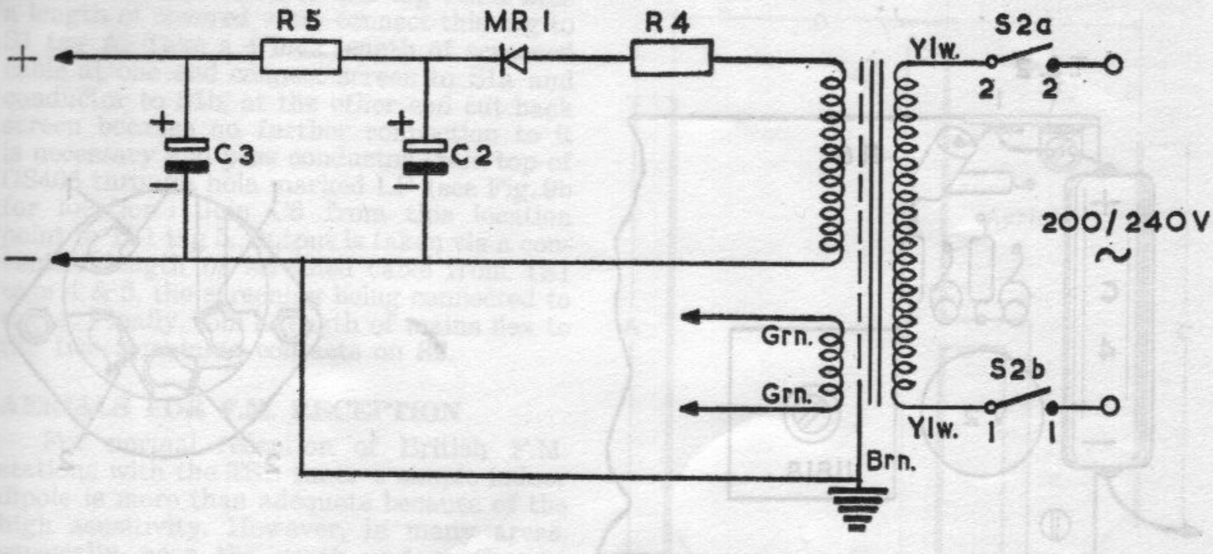


Fig. 5

and terminate as in Fig. 9b, note two wires are shown at point H, the second is the feed for the pilot bulb and a length of covered wire is used for this purpose, the position of the pilot bulb holder live contact is clear from Fig. 1. Connect C5 between point H and V5 spigot as in Fig. 9b. Wire MR1 positive (+) to TS1 tag 3 and on to C2 and 3 tag 1. Connect R5 between TS1 tag 3 and 6. TS1 tag 6 to C2 and 3 tag 2. Solder R4 from MR1 negative (—) to TS1 tag 1. Connect the

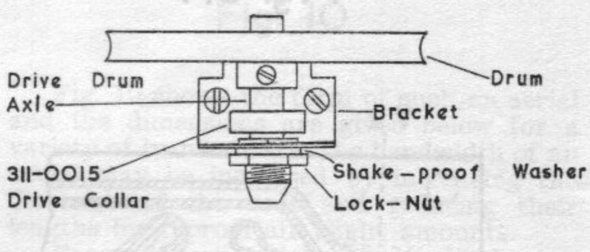


Fig. 6

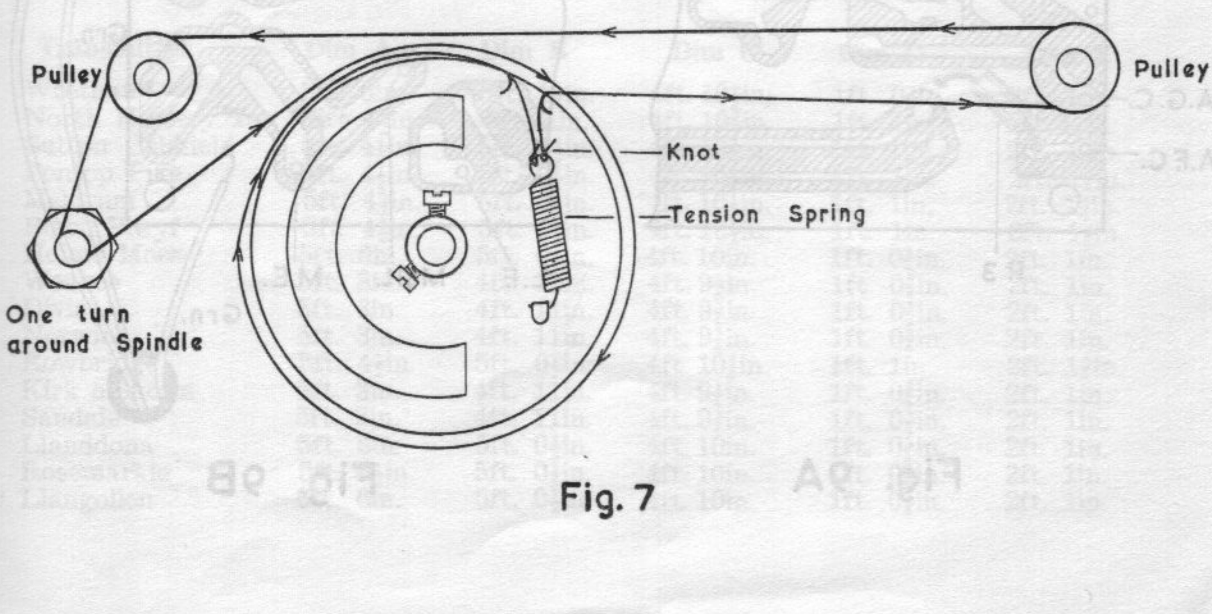


Fig. 7

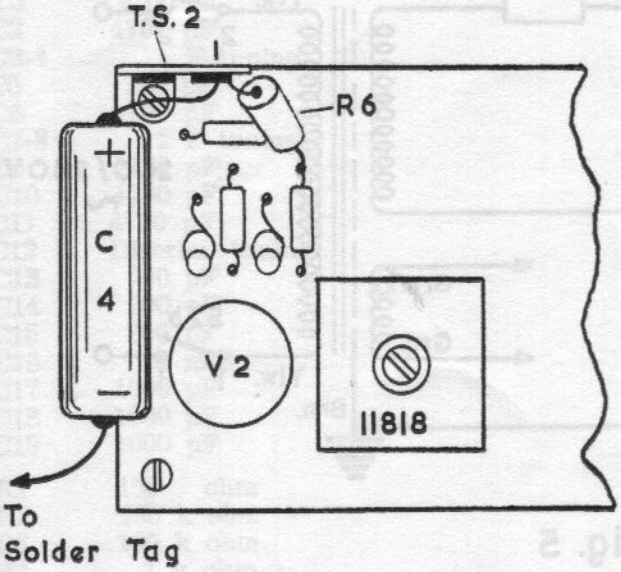


Fig. 8A

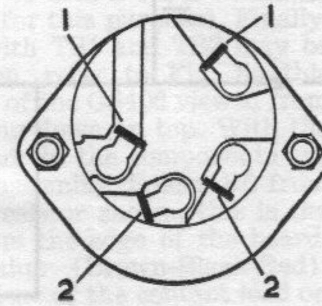


Fig. 8B

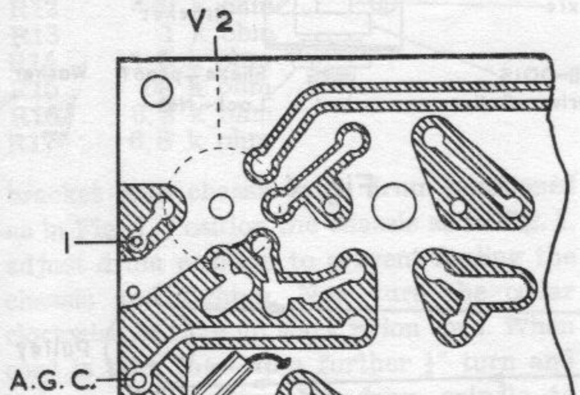


Fig. 9A

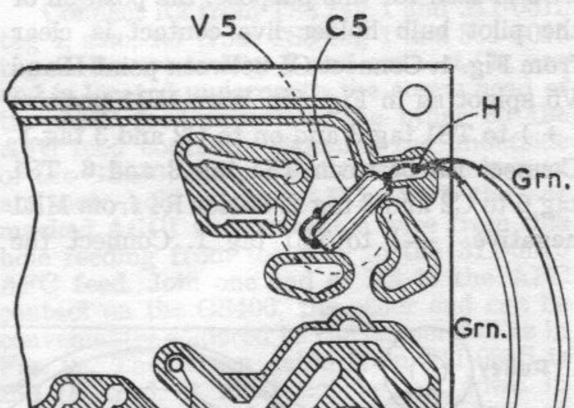


Fig. 9B

BROWN lead from T1 to TS1 tag 4 and with a length of covered wire, connect this tag to S1 tag A. Take a 4 inch length of screened cable at one end connect screen to S1a and conductor to S1b, at the other end cut back screen because no further connection to it is necessary and pass conductor from top of GS406 through hole marked LF (see Fig. 9b for location.) Join C6 from this location point to TS1 tag 5. Output is taken via a convenient length of screened cable from TS1 tags 4 & 5, the screening being connected to tag 4. Finally, join a length of mains flex to the two remaining contacts on S2.

AERIALS FOR F.M. RECEPTION

For normal reception of British F.M. stations with the TSL tuner a simple indoor dipole is more than adequate because of the high sensitivity. However, in many areas, especially near the south and south-west coasts, it is possible to receive continental stations with this tuner if a good outdoor aerial is used. An outdoor aerial is also useful in areas of particularly poor signal strength such as are found in the North of Scotland.

The basic form of the most common type of F.M. aerial is a dipole having an overall length of half the wavelength of the centre frequency to be received. To this may be added a reflector of slightly greater length behind the dipole and a director of shorter length in front of it. The addition of these two elements will improve the sensitivity considerably and will also make the aerial more directional.

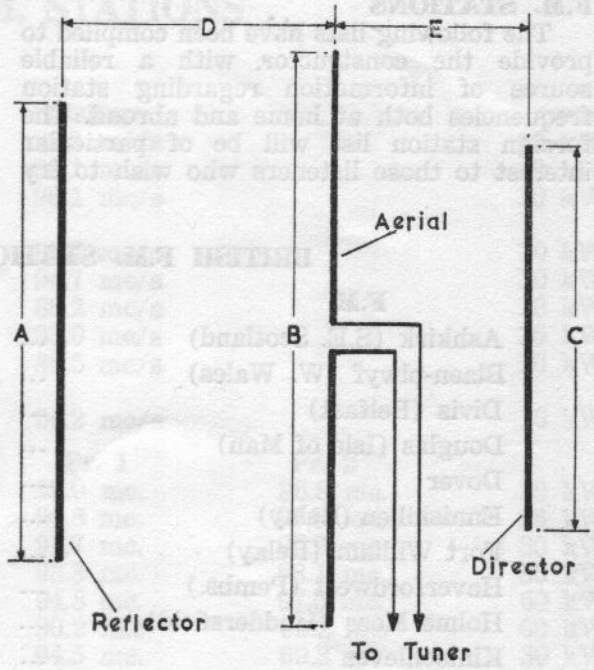


Fig. 10

Fig. 10 shows the form of such an aerial and the dimensions are given below for a variety of transmitters. The bandwidth of an aerial may be increased by increasing the diameter of the rods and reducing their lengths by appropriate slight amounts.

For an indoor aerial a simple dipole may be constructed using ordinary P.V.C. covered wire and the dimensions shown in column B.

F.M. AERIALS AND THEIR DIMENSIONS

Transmitter	Dim A	Dim B	Dim C	Dim D	Dim E
Wrotham	5ft. 6in.	5ft. 1½in.	4ft. 10½in.	1ft. 0¾in.	2ft. 1in.
North Hessery Tor	5ft 4½in.	5ft 1in.	4ft. 10¾in.	1ft. 1in.	2ft. 1¼in.
Sutton Coldfield	5ft. 4½in.	5ft. 0½in.	4ft. 10¾in.	1ft. 1in.	2ft. 1¾in.
Pontop Pike	5ft. 4½in.	5ft. 0½in.	4ft. 10¾in.	1ft. 1in.	2ft. 1¾in.
Meldrum	5ft. 4½in.	5ft. 0½in.	4ft. 10½in.	1ft. 1in.	2ft. 1¾in.
Blaen Plwyf	5ft. 4½in.	5ft. 0½in.	4ft. 10½in.	1ft. 1in.	2ft. 1¾in.
Holme Moss	5ft. 6in.	5ft. 0½in.	4ft. 10in.	1ft. 0¾in.	2ft. 1in.
Wenvoe	5ft. 3in.	4ft. 11in.	4ft. 9¾in.	1ft. 0¾in.	2ft. 1in.
Divis	5ft. 3in.	4ft. 11in.	4ft. 9¾in.	1ft. 0¾in.	2ft. 1in.
Norwich	5ft. 3in.	4ft. 11in.	4ft. 9¾in.	1ft. 0¾in.	2ft. 1in.
Rowbridge	5ft. 4½in.	5ft. 0½in.	4ft. 10¾in.	1ft. 1in.	2ft. 1¾in.
Kirk o'Shotts	5ft. 3in.	4ft. 11in.	4ft. 9¾in.	1ft. 0¾in.	2ft. 1in.
Sandale	5ft. 3in.	4ft. 11in.	4ft. 9¾in.	1ft. 0¾in.	2ft. 1in.
Llanddona	5ft. 6in.	5ft. 0½in.	4ft. 10in.	1ft. 0¾in.	2ft. 1in.
Rosemarkie	5ft. 6½in.	5ft. 0½in.	4ft. 10in.	1ft. 0¾in.	2ft. 1in.
Llangollen	5ft. 6in.	5ft. 0½in.	4ft. 10in.	1ft. 0¼in.	2ft. 1in.

F.M. STATIONS

The following lists have been compiled to provide the constructor with a reliable source of information regarding station frequencies both at home and abroad. The foreign station list will be of particular interest to those listeners who wish to try and receive distant stations and to be able to identify them. Under good conditions, and with a sensitive aerial, stations may be picked up from Northern France, Belgium, Holland and the West side of Germany. Under very exceptional circumstances even more distant stations may be received.

BRITISH F.M. STATIONS NOW IN OPERATION

F.M.	Power	Light	Third	Home
Ashkirk (S.E. Scotland) ...	18	89.1	91.3	93.5
Blaen-plwyf (W. Wales) ...	60	88.7	90.9	93.1
Divis (Belfast) ...	60	90.1	92.3	94.5
Douglas (Isle of Man) ...	5.5	88.4	90.6	92.8
Dover ...	6.5	90.0	92.4	94.4
Enniskillen (Relay) ...	2.5	88.9	91.1	93.3
Fort William (Relay) ...	1.5	89.3	91.5	93.7
Haverfordwest (Pembs.) ...	10	89.3	91.5	93.7
Holme Moss (Huddersfield) ...	120	89.3	91.5	93.7
Kinlochleven ...	0.002	89.7	91.9	94.1
Kirk o'Shotts (S. Scotland) ...	120	89.9	92.1	94.3
Les Platons (Channel Islands) ...	1.4	91.1	94.8	97.1
Llanddona (Anglesey) ...	12	89.6	91.8	94.0
Llandrindod Wells ...	1.3	89.1	91.3	93.5
Llangollen (N. E. Wales) ...	11	88.9	91.1	93.3
Londonderry ...	13	88.3	90.6	92.7
Meldrum (Aberdeen) ...	60	88.7	90.9	93.1
North Hessary Tor (S. Devon) ...	60	88.1	90.3	92.5
Oban ...	1.5	88.9	91.1	93.3
Orkney ...	20	89.3	91.5	93.7
Oxford ...	22	89.5	91.7	93.9 (Mid)
				95.9 (West)
Peterborough ...	21	90.1	92.3	94.5
Pontop Pike (Newcastle) ...	60	88.5	90.7	92.9
Redruth (W. Cornwall) ...	9	89.7	91.9	94.1
Rosemarkie (N. Scotland) ...	12	89.6	91.8	94.0
Rowridge (I. of W.) ...	60	88.5	90.7	92.9
Sandale (Carlisle) ...	120	88.1	90.3	92.5 (Scottish)
				94.7 (North)
Sheffield (Relay) ...	0.06	89.9	92.1	94.3
Skye ...	2.0	—	—	93.9
Sutton Coldfield ...	120	88.3	90.5	92.7
Tacolneston (Norwich) ...	120	89.7	91.9	94.1
Thrumster (Wick) ...	10	90.1	92.3	94.5
Wenvoe (Cardiff) ...	120	89.9	96.8	92.1 (West)
				94.3 (Welsh)
Wrotham (S. E. England) ...	120	89.1	91.3	93.5

FOREIGN F.M. STATIONS

BELGIUM

	STATION	FREQUENCY	POWER
French Network			
	Anlier	91.5 mc/s	10 kW
	Bruxelles	96.1 mc/s	10 kW
	Houdeng	96.1 mc/s	10 kW
Flemish Network			
	Ruiselede	98.7 mc/s	10 kW
	Brussels	94.7 mc/s	10 kW
	Ruiselede	88.2 mc/s	10 kW
	Ruiselede	93.0 mc/s	10 kW
	Genk	88.5 mc/s	10 kW
German Pr.			
	Liege	94.2 mc/s	10 kW

DENMARK

	Pr. 1	Pr. 2	
Odense	89.0 mc.	96.8 mc.	30 kW
Kobenhavn	90.8 mc.	96.5 mc.	26 kW
Arhus	91.7 mc.	95.9 mc.	30 kW
Alborg	93.3 mc.	88.1 mc.	30 kW
Naestved	94.8 mc.	97.5 mc.	60 kW
Vestjylland	90.2 m.c.	99.2 mc.	60 kW
Bornholm	94.5 mc.	99.3 mc.	30 kW
Sonderjylland	95.1 mc.	99.9 mc.	60 kW

FRANCE

Paris Inter—	Lille II	88.7 mc/s	12 kW
	Paris (Grenelle)	96.1 mc/s	5 kW
	Metz II	93.3 mc/s	12 kW
	Mulhouse II	96.3 mc/s	12 kW
PGR.: Regional—	Caen II	91.5 mc/s	12 kW
PGR.: National—	Caen III	87.8 mc/s	12 kW
	Bourges II	89.4 mc/s	12 kW
	Dijon II	88.0 mc/s	2 kW
	Paris II (Tour Eiffel)	97.6 mc/s	12 kW
	Toulouse II	87.9 mc/s	2 kW
FM PGRG—	Cannes I	88.7 mc/s	2 kW
(France IV)	Metz I	89.7 mc/s	12 kW
	Paris I	90.35 mc/s	12 kW
	Toulouse I	91.5 mc/s	2 kW
	Mulhouse I	92.1 mc/s	12 kW
	Lille I	92.2 mc/s	12 kW
	Lyon	92.7 mc/s	12 kW
	Bourges I	93.0 mc/s	12 kW
	Strasbourg	95.0 mc/s	2 kW
	Marseille	95.4 mc/s	12 kW
	Caen I	95.6 mc/s	12 kW
	Dijon I	95.8 mc/s	2 kW
	Nancy	96.9 mc/s	0.25 kW
	Toulouse	90.3 mc/s	0.25 kW
	Bordeaux	98.1 mc/s	2 kW
	Reims	99.2 mc/s	12 kW

GERMANY

Der Bayerische Rundfunk			
	Lindau	88.3 mc/s	0.5 kW
	Burgst./H.Bogen	88.8 mc/s	18 kW
	Traunst./Hochb.	89.05 mc/s	3 kW
	Berchtesgaden	89.7 mc/s	0.5 kW

GERMANY (contd.)

	STATION	FREQUENCY	POWER
	Huhn.b./b.Hb.	98.1 mc/s	20 kW
	Bad Reichenh	90.3 mc/s	0.5 kW
	Wendelstein I	93.65 mc/s	100 kW
	Pfaffenberg b / Aschaffenburg	94.2 mc/s	19 kW
	Bamberg I	94.45 mc/s	12 kW
	Ochsenkopf / Fichtelgeb. I	96.05 mc/s	60 kW
	Munchen I	95.95 mc/s	0.5 kW
	Kreuzb./Rhon I	97.75 mc/s	3 kW
	Dillberg I	98.75 mc/s	18 kW
Radio Bremen			
First Pr.—	Bremen I	96.9 mc/s	18 kW
	Bremerhaven I	95.9 mc/s	0.5 kW
Second Pr.—	Bremen II	89.4 mc/s	18 kW
	Bremerhaven II	91.8 mc/s	0.5 kW
Hessischer Rundfunk			
First Pr.—	Feldberg	88.53 mc/s	10 kW
	Hardberg	93.30 mc/s	0.25 kW
	Meissner	93.30 mc/s	0.25 kW
	Biedenkopf	91.20 mc/s	10 kW
	Wurzberg	96.0 mc/s	0.25 kW
Second Pr.—	Meissner	89.69 mc/s	10 kW
	Hardberg	89.70 mc/s	0.25 kW
	Wurzberg	89.74 mc/s	0.25 kW
	Biedenkopf	91.20 mc/s	10 kW
	Feldberg	92.13 mc/s	10 kW
Norddeutscher Rundfunk			
First Pr.—	Oldenb.	87.6 mc/s	100 kW
	Dannen	89.7 mc/s	15 kW
	Norden/O.	89.7 mc/s	15 kW
	Heide	90.0 mc/s	15 kW
	Lingen	92.4 mc/s	15 kW
	Bungsb.	95.7 mc/s	0.5 kW
	Hamb.	96.3 mc/s	50 kW
	Gotting.	96.65 mc/s	1.2 kW
	Flensb.	97.8 mc/s	15 kW
	Hannov.	97.85 mc/s	1.25 kW
	Kiel.	99.0 mc/s	1.2 kW
	Harz.	99.9 mc/s	100 kW
Second Pr.—	Lubeck	87.9 mc/s	0.5 kW
	Harz.	88.2 mc/s	100 kW
	Hambg.	88.5 mc/s	50 kW
	Gotting.	88.8 mc/s	2 kW
	Lingen	88.8 mc/s	15 kW
	Brauns.	88.8 mc/s	0.5 kW
	Bungsb.	91.5 mc/s	0.5 kW
	Flensbg.	93.0 mc/s	15 kW
	Osterlg.	93.3 mc/s	15 kW
	Dannen	93.3 mc/s	15 kW
	Heide	93.6 mc/s	15 kW
	Osnabr.	93.6 mc/s	3 kW
	Hannov.	93.9 mc/s	5 kW
	Kiel.	94.1 mc/s	2 kW
	Oldenb.	95.4 mc/s	2 kW
Third Pr.—	Flensbg.	89.45 mc/s	15 kW
	Kiel	90.6 mc/s	2 kW

GERMANY (contd.)

STATION	FREQUENCY	POWER
Hannov.	90.9 mc/s	5 kW
Oldenb.	91.2 mc/s	100 kW
Hambg.	92.1 mc/s	50 kW
Gotting.	92.4 mc/s	1 kW
Harz.	96.0 mc/s	100 kW
Dannen.	98.7 mc/s	3 kW
Saarlandischer Rundfunk		
Schaumberg	96.0 mc/s	10 kW
Schwarzenberg	98.9 mc/s	1.5 kW
Suddeutscher Rundfunk		
Stuttgart I	94.5 mc/s	100 kW
Aalen I	92.7 mc/s	50 kW
Heidelberg I	91.5 mc/s	80 kW
Waldenburg I	90.0 mc/s	100 kW
Geislingen I	91.2 mc/s	0.5 kW
Ulm I	87.9 mc/s	0.5 kW
British Forces Network		
Langenberg	89.15 mc/s	60 kW
Nordhelle	89.15 mc/s	18 kW
Verden	90.3 mc/s	60 kW
Bonn	91.4 mc/s	3 kW
Herford	92.9 mc/s	6 kW
Berlin	94.3 mc/s	3 kW
Drachenberg	99.3 mc/s	60 kW
German F.M. stations that might be received		
Oldenburg I	87.6 mc/s	100 kW
Heidelberg II	87.9 mc/s	40 kW
Langenberg I	87.9 mc/s	100 kW
Harz-West II	88.2 mc/s	100 kW
Hamburg II	88.5 mc/s	50 kW
Langenberg	89.1 mc/s	60 kW
Hoh. Meissner II	89.7 mc/s	90 kW
Langenberg II	90.3 mc/s	50 kW
Verden	90.3 mc/s	50 kW
Wald II	90.6 mc/s	100 kW
Biedenkopf II	91.2 mc/s	55 kW
Brotjacklregel II	91.5 mc/s	60 kW
Feldberg/Ts II	92.1 mc/s	55 kW
Teutoburger Wald III	94.2 mc/s	100 kW
Biedenkopf I	95.4 mc/s	55 kW
Oldenburg II	95.4 mc/s	100 kW
Langenberg III	95.7 mc/s	100 kW
Harz-West III	96.0 mc/s	100 kW
Teutoburger Wald I	99.6 mc/s	100 kW
Harz-West I	99.9 mc/s	100 kW

HOLLAND

STATION	FREQUENCY	POWER
Hoogezand	91.8 mc/s	
	94.9 mc/s	15 kW
Hulsberg	95.1 mc/s	
	97.5 mc/s	5 kW
Irnsum	88.2 mc/s	
	97.2 mc/s	5 kW
Mierlo	93.5 mc/s	
	99.9 mc/s	15 kW
Markelo	96.2 mc/s	
	98.3 mc/s	50 kW

PRODUCTS MANUFACTURED & DISTRIBUTED BY TECHNICAL SUPPLIERS LTD.

Item No.		*Retail Price* £	s.	d.	
1	TSL Continental 3-Pin Plug		3	0	ea.
2	TSL Continental 5-Pin Plug		3	3	„
3	TSL Continental Type 3-Pin Line Socket		3	3	„
4	TSL Continental Type 5-Pin Line Socket		3	9	„
5	TSL Continental 3-Pin Chassis Socket		1	3	„
6	TSL Continental 5-Pin Chassis Socket		1	6	„
7	TSL Screened Steel Standard Jack Plug		3	6	„
7a	TSL Standard Jack Socket		2	0	„
8	TSL Super Sensitive Diode Detector		1	6	„
8a	TSL VHF Ultra Sensitive Diode Detector		3	0	„
9	TSL Ultra Sensitive A.F. Transistor		3	6	„
10	TSL S.P.S.T. Toggle Switch		2	9	„
11	TSL D.P.D.T. Toggle Switch		4	0	„
12	TSL Sub-Miniature Slab Ferrite Aerial		3	6	„
13	TSL Plastic Sub-Miniature Receiver Case		1	0	„
15	TSL 365 pF Sub-Miniature Tuning Capacitor		12	6	„
16	TSL 3.5mm. dia. Jack Plug and Socket		3	0	„
16a	2.5mm. dia. version of above Jack & Socket		3	0	„
16b	TSL 3.5mm. Miniature Jack Sockets		1	0	„
16c	TSL 2.5mm. Sub-Miniature Jack Socket		1	0	„
17	TSL Rubber Grommets, Assorted Sizes		1	0	pkt.
20	TSL Insulated Phono Plugs (ten colours)			9	ea.
20a	TSL Insulated Phono Line Couplers (ten colours)		1	0	„
21	TSL Panel Mounting Phono Sockets			6	„
21a	TSL RCA Type Phono Plugs			6	„
21b	TSL Panel Mounting Dual Phono Sockets		1	0	„
21c	TSL 4-Way Phono Socket		1	9	„
22	TSL Transistor Holder		1	6	„
23	TSL High Impedance Crystal Earpiece		10	6	„
24	TSL Plastic Cabinet Feet		1	6	pkt.
25	TSL Aerial Solderless Co-ax Plugs		1	3	ea.
26	Miniature Electrolytic Capacitors:				
	3-4V—50, 100 & 250 mfd.		1	9	„
	6-8V—50 & 100 mfd.		1	9	„
	12-15V—10, 25 & 50 mfd.		1	9	„
	25-30V—2, 5, 10, 25 & 50 mfd.		1	9	„
	3-4V—500 & 1,000 mfd.		2	3	„
	6-8V—250 & 500 mfd.		2	3	„
	12-15V—1, 2, 5, 10, 15, 100 & 250 mfd.		2	3	„
	25-30V—100 mfd.		2	3	„
27	TSL Mains Neon Indicator		3	6	„
29	TSL Polythene Cable Clips		1	0	pkt.
30	TSL Driver & Push-Pull Output Transformers		10	6	pr.
31	TSL Transistor Solder		1	0	pkt.
32	TSL Preset Tuning Capacitor		1	0	ea.
33	TSL D.P.S.T. Toggle Switch		3	6	„
34	TSL Sub-Miniature 500 pf Tuning Capacitor		12	6	„
35	TSL D.P.D.T. Slider Switch		3	6	„
36	TSL Sub-Miniature 200 pf+200 pf Tuning Capacitor		16	0	„
37	TSL Low Impedance Dynamic Earpiece		7	6	„
38	TSL 3.5mm. Metal Screened Jack Plug & Socket		4	0	pr.
41	World's Smallest I.F. Transformers	1	5	0	per set 4
42	TSL "Maxigain" Ferrite Rod Aerial		3	6	ea.
43	TSL Dial for Tuning Capacitor		2	6	„
43a	TSL Sub-Miniature Dial		2	6	„

Item No.		*Retail Price* £ s. d.
44	TSL S.P.S.T. Slide Switch	2 6 ea.
45	TSL Sinclair Micro Alloy Transistors (MATS)	
	MAT 100 ...	7 9
	„ 120 ...	7 9
	„ 101 ...	8 6
	„ 121 ...	8 6
	ADT 140 ...	15 0
46	TSL Flexible Test Prods	6 0 pr.
47	TSL Uninsulatedd Crocodile Clips	5¼ ea.
48	TSL Insulated Crocodile Clips	7½ „
48a	TSL Glass Radio Fuses	3 „
49	TSL Banana Plugs (ten colours)	6 „
49a	TSL Banana Plug Line Couplers (ten colours) ...	6 „
49b	TSL Miniature Banana Plugs (ten colours) ...	6 „
49c	TSL Miniature Banana Plug Line Couplers (ten colours)	6 „
49d	TSL Chassis Socket for Wander Plug	1 0 „
50	TSL Car Aerial Plugs	1 3 „
51	TSL Car Aerial Sockets	1 0 „
53	TSL Continental Loudspeaker Plug	2 6 „
53a	TSL Continental Loudspeaker Socket	2 0 „
54	TSL Miniature D.P.D.T. Slide Switch	3 0 „
55	TSL Polystyrene Capacitors :	
	.001, .0015, .0022, .0033, .0047, .0068,	
	.01, .015 & .022 mfd.	9 „
	.033, .047, .068, .1 mfd.	1 0 „
	.47 & 1 mfd. (Mold Seal)	2 6 „
	400 V.W.	
	.001, .0015, .0022, .0033, .0047, .0068, .01 mfd.,	9 „
	.015, .022, .033, .047, mfd.	1 0 „
	.1 mfd. (Mold Seal)	1 6 „
57	Ferrite Aerial Rod 8″ x ⅜″	5 0 „
59	TSL-Gorler A.M. Transistor 455/472 KC/S I.F. Amplifier Type 322-0001	4 12 6 „
60	TSL-Gorler 1 Watt Transistor A.F. Amplifier Type GS12005	4 12 6 „
61	TSL-Gorler 1½ Watt Transistor Audio Amplifier Type 324-0004	4 17 6 „
61a	TSL-Gorler Type 324-0007 2 Watt Transistor Audio Amplifier	5 2 6 „
61b	TSL-Gorler Type 324-0011 2½ Watt Transistor Audio Amplifier	5 7 6 „
63a	TSL-Gorler Super VHF/FM Transistorised Tuning Heart Type 312-0015 or 0022 or 0029 Inc. P.T. ...	6 2 9 „
64	TSL-Gorler Transistorised 10.7 Mc/s FM I.F. Strip Type 322-0009	6 6 0 „
64a	TSL-Gorler Type 322-0005 Transistorised 4 Stage F.M. I.F. Amplifier 10.7 Mc/s	8 7 6 „
64b	TSL-Gorler Type 322-0008 Transistorised AM/FM Combined IF Amplifier Strip	9 17 6 „
65	TSL VHF/FM Transistorised Tuning Heart Type 75L. Capacity Tuned. Inc. P.T.	4 13 0 „
67	TSL Lorenz Micro-Miniature Loudspeaker Type LP45F. Inc. P.T.	1 4 9 „
68	TSL Lorenz Loudspeaker Type 70LP. Inc. P.T. ...	1 4 9 „
70	TSL Lorenz Type LPH65 Treble Loudspeaker Inc. P.T.	1 13 1 „
72	TSL Lorenz Type LP312-2 Super High Fidelity Loudspeaker System	15 17 6 complete

Item No.		*Retail Price* £	s.	d.	
73a	TSL Crystal Microphone		16	0	ea.
76	TSL Type LHP2 Crossover System	2	7	6	„
77	TSL "Mark 4" VHF/FM Valve Tuner Built and Tested. Inc. P.T.	18	7	4	„
80	Transistor 5K ohms Volume Control		3	6	„
81	Sinclair Micro Miniature A.F. Amplifier in Kit Form	1	9	6	„
82	TSL Non-Reversible 2-Pin Plug & Socket		1	0	per pr.
84	Parts available for building SINCLAIR SLIMLINE come to a total of	2	9	6	
85	GOLDHAWK Diode Radio Tuning Jack Kit of Parts plus P.T.		18	8	
86	TSL-Gorler Type 344-0005 Transistor Super High Gain I.F. Transformers		13	0	ea.
87	TSL-Gorler 344-0006 Transistor Super High Gain I.F.		12	6	„
88	TSL-Gorler Type 345-0008 Transistor		12	0	„
89	TSL-Gorler Type 345-0009 FM		12	0	„
90	Mullard Transistors :				
	OC44, list 9/3. Our list price		7	6	„
	OC45, list 9/– „ „ „		7	3	„
	OC71, list 6/6 „ „ „		5	0	„
	OC72, list 8/– „ „ „		6	6	„
	OC81D, list 8/– „ „ „		6	6	„
	OC81, list 8/– „ „ „		6	6	„
91	TSL High Stability ½ Watt Noise-free Precision Resistors			6	resistor
92	TSL Silver Mica and Ceramic :				
	0.5 pF.—500 pF.		1	0	ea.
	560 pF.—10,000 pF.		1	3	„
	0.015 mfd.—0.1 mfd.		1	6	„
	0.22 mfd.—1 mfd.		1	9	„
93	TSL Constant Velocity Equaliser System Type MX5	1	10	0	„
94	TSL 25 Amp Crocodile Clips			9	„
95	TSL 50 Amp Crocodile Clips		1	3	„
96	TSL-Kitboard Full size		3	6	„
96a	TSL-Kitboard Half size		2	6	„
97	TSL-Bildaboard		1	0	„
97a	TSL-Bildaboard		2	0	„
98	TSL-Sinclair Mirco Injector	1	7	6	„
100	TSL-Forderer Portable Aerials for VHF	1	15	0	„
101	Welwyn 2% High Stability Resistors			9	„
102	TSL Wander Plugs			9	„
105	T.V. Co-ax Aerial Socket for chassis mounting			9	„
106	B.H.14 Watt Hi Fi Amplifier in Kit Form	9	9	0	„
107	B.H.!4 Watt Hi Fi Amplifier manufactured and ready for use	11	11	0	„
108	Heavy duty steel protection cover in antique copper rose finish	1	12	6	„
109	Dielectric Tuning Capacitor .0005 special low loss design for crystal sets & valve or transistor sets		4	0	„
110	Parts for building the Mk. 4 High Fidelity super performance FM Tuner, including P.T. come to	14	2	1	„
111	Heavy duty steel finish in antique copper rose carrying case suitable for Mk. 4 FM Tuner	1	19	6	„
112	Parts for building Sinclair Micro 6 Super Receiver	2	19	6	„
113	Sundown Mk. 1 Automatic Transistorised Parking Light	3	3	0	„
114	Sundown Mk. 2 Automatic Transistorised Parking Light	2	5	0	„
115	TSL "Audio Heart" 1 Watt transistorised printed circuit high fidelity Amplifier in Kit Form	2	12	6	„

Item No.		Retail Price £ s. d.
116	TSL "Audio Heart" 1 Watt transistorised printed circuit high fidelity Amplifier built & tested	2 19 6 ea.
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