RADIO FOR THE MILLION

THE RADIO OWNER'S MAGAZINE

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The
Mullard
S·G·P
MASTER
THREE

Principal Contents

THE receiver with the appeal of modernity, externally as much as technically. It possesses range, volume and quality of reproduction to a standard previously unattained.


THE SPEAKER
WITH THE GOLDEN VOICE
Mighty in volume, mellow in tone, perfect in the reproduction of speech and music, the Mullard "C" model speaker brings reality to your radio, re-creates the artiste in your home.
As the genius of a great musician demands a faultless instrument so does a fine radio set demand a fine speaker. In fairness to your receiver you must hear a Mullard speaker; to hear it is to buy it—to buy it is to take a new interest in radio.
Price 53/6
Mullard
MASTER · RADIO

MUSITORIUM

MULLARD enthusiasts will find in this issue of RADIO FOR THE MILLION assembly instructions for a new development in radio receiver design—the Mullard S.G.P. Master Three. It embodies a Mullard Screened-grid Valve in the high-frequency stage, a Mullard special detector in the detector stage, and a Mullard Pentone in the low-frequency stage. These three valves in combination produce an extremely efficient receiver as one would expect. Mainly, this receiver grants facility to the radio owner to operate a speaker as powerfully upon a group of distant stations as upon the local.

★ ★ ★

THE receiver is not intended merely to enable radio owners to possess a comprehensive log book, but rather something far more thrilling. There is a distinct difference between a long list of stations and a choice of programmes . . . And it is to provide this latter that the Mullard S.G.P. Master Three Receiver has been designed. By virtue of the great amplifying power of the receiver, it lifts radio from the harness which binds it to the local station. It gives to radio, as it were, a span with which to reach out into far distant countries. In daylight or darkness it will provide other programmes—British as well as Continental.

★ ★ ★

BOTH signal strength and selectivity are features—neither has been sacrificed to gain an improvement in the other. This is an important point which cannot be overlooked. Ample selectivity is possible for all if the few simple directions in the description of the receiver are observed.

★ ★ ★

IF quality of reproduction and signal strength are both desired to an equally high measure, any advance in the degree of selectivity beyond that which is advised will deprive the receiver of quality and volume. It may be advanced by reducing the aerial turn numbers . . . The radio enthusiast must choose for himself. We have given you high quality reproduction. We have given you volume. We have given you selectivity compatible with quality and signal strength.

★ ★ ★

WITH the knowledge at present available no more pleasing a receiver could be built. It is fascinatingly efficient. Its performance is nothing short of a delightful experience—tremendously impressive.

The Mullard S·G·P MASTER THREE

Additional technical remarks on this new Mullard receiver design

THE *following pages contain numerous references to points of interest in the Mullard S.G.P. Master Three. Such features as screening, selectivity, range, volume, rectification and quality are mentioned in detail with the object of familiarising readers with the many technical advantages characteristic of the receiver.*

WITH every Mullard P.M. receiver design, it is of no material importance whether or not you have had any previous experience of home assembly. It may be said that the great majority of radio enthusiasts owning receivers to-day, owe their introduction to radio to one or other of the many popular Mullard radio receivers published in previous issues of *Radio for the Million*. If you are on the point of deciding to build this new Mullard set, there is good foundation, therefore, for your preference, as many hundreds of thousands before you have been successfully guided and similarly directed to the pleasures of reliable reception.

Amazingly popular

That Mullard radio receivers have been so amazingly popular with the ordinary public as distinct from technicians, is readily explained. It is that the foremost aim of the designs has been and always is simplicity, which term includes assembly, installation and operation. The Mullard way is the royal way to successful set building and satisfactory radio reception.

This simplicity of design permits the adoption of a plan of assembly calling for not the slightest technical knowledge . . . . . common sense is the only requirement, of which the average Englishman has a fair share, particularly in such things where the application of manual ability is necessary. The public as we see it in the railway carriage, in the omnibus and in the tram car, is able to tackle handicraft without difficulty, providing technical knowledge is not imperative. That Mullard receiver designs are within the manual skill of the ordinary man in the street, and that they do not call for an ounce of technical knowledge, is the main reason for their popularity with the public, as simplicity of design paves the way for simplicity of description.

One right way

Although the design of the Mullard S.G.P. Master Three is unmistakably simple, it is preferable, naturally, to follow an ordered method in the construction. There are always many ways of completing any mechanical assembly; but it may be taken for granted that an experienced mechanic will be able to light upon the one efficient method and the easiest way, by virture of his training. Similarly, there is only one right but many wrong ways to proceed with the assembly of the Mullard S.G.P. Master Three. And it is the object of the notes immediately following to point out, what suggests itself, as the most efficient and most practical method to adopt regardless of experience.

Commencing assembly

Particularly in the case of those without a single radio receiver to the credit of their manual skill, it is important to purchase all the components scheduled in the list of apparatus before beginning the assembly. The wisest plan of all would be to delay, for a day or two, any actual work on the set until every component is to hand, although most radio dealers throughout the country make a point of keeping complete kits of parts in stock, as it is realised that successful set construction is as much dependent upon strict adherence to the specified list of parts as to the faithful attendance to the various instructions contained in Wiring Step by Step. Except in very remote parts of the country, an order left at the local radio stores in the morning on the way to the office or factory could be collected on the way home in the evening.

Eliminating interaction

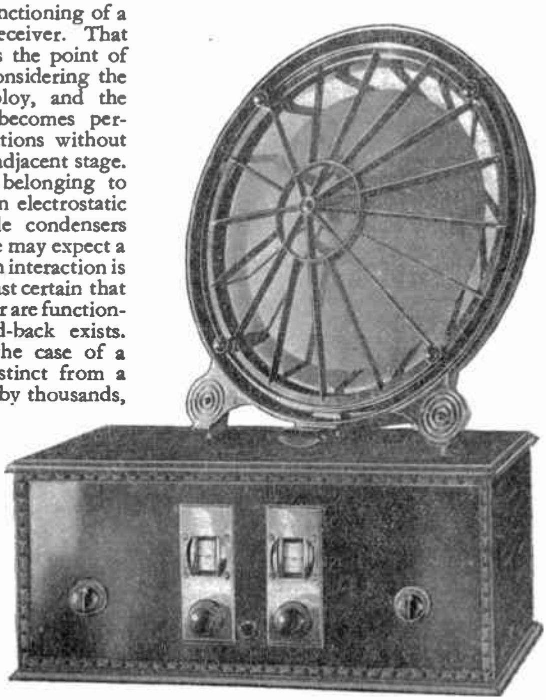
In the Editor's Notebook a rather lengthy review of screening experiments is printed. Here, it is sufficient to remark that the published design adopts the system of screening, which from every angle, gives the most satisfactory results. Builders of the receiver would experience a similar development of opinion did they but spare the time to go over the same programme of research work as we have prior to the preparation of the final design for the Mullard S.G.P. Master Three.

Most will have the right idea in their minds that, were there present any stage interaction of any kind, inefficiency would ensue. Stage interaction has many deleterious effects upon performance which are not always easy to track down. In the main, it may be assumed that interaction interferes with the correct functioning of a stage as a separate unit in the receiver. That each stage is a separate unit is the point of view to bear in mind when considering the amount of screening to employ, and the omission of screening only becomes permissible when each stage functions without harmful interference from any adjacent stage. Should the fields from coils belonging to adjacent stages link up, or even electrostatic coupling between the variable condensers tuning adjacent stages exist, one may expect a decreased performance. When interaction is entirely eliminated, one is at least certain that the various stages in the receiver are functioning properly, in that no feed-back exists.

In practice, let us say in the case of a receiver for private use as distinct from a receiver designed for assembly by thousands, there may be a chance of cutting down some of the screening. But where the receiver is intended as an example to be followed by many thousands of radio enthusiasts, complete satisfaction for everyone demands a margin. The experienced amateur may safely experiment to his heart's content . . . . . but experiments in this direction by the non-technical might not lead to the successful issue anticipated. We have chosen complete screening for the reason that interaction will not exist in any circumstance. And this is a good starting point from which to consider the technical features of the Mullard S.G.P. Master Three Receiver.

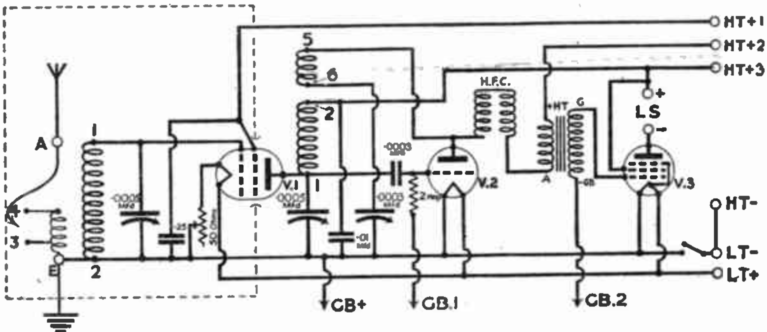
H.F. coupling

Reverting to the method of high-frequency coupling employed in the Mullard S.G.P. Master Three Receiver, reference to the circuit diagram shows that tuned-anode has been adopted. It is obviously simple. Two connections only, with two further terminals for the reaction winding. As we have recounted elsewhere in this issue, considerable experimental work definitely proves



A VIEW of the Mullard S.G.P. Master Three as it would appear in a table cabinet. To the left there is the rheostat control; to the right, the reaction control is located; while in the centre of the panel the battery on and off switch is fitted. Immediately on each side of this switch, the drum dials may be seen.

SELECTIVITY EASILY ADJUSTED



ABOVE is a circuit diagram of the Mullard S.G.P. Master Three. One of the main points in the design is the fact that selectivity may be adjusted for every individual case. This is effected by the suitable use of the alternative aerial taps, and in extreme cases, by a suitable modification of the aerial turn numbers.

that nothing is to be gained by the use of any other system. Even shunt-feed tuned-grid, in which the tuned circuit comes between grid and filament with a high-frequency choke in the anode, is less efficient than straight tuned-anode as it is usually called. This for the reason that the losses present in the high-frequency choke introduce into the circuit a drop in amplification which is to be avoided if at all possible.

Utility of panel

The basic idea behind the screened-grid Master Three is precisely that of the two previous Master Three Receivers, in that the number of wires joining components has been reduced to the absolute minimum. The Wiring Step by Step gives us the figure of twenty-five rigid wires, two flying leads and eight battery leads. Without so much as a passing thought, these figures indicate that in the new receiver we have emulated our previous successes.

As before, we have the spindles of the tuning condensers earthed to the panel, as also are the spindles of the reaction condenser, the battery switch and the rheostat. This saves numerous wires given under the heading of additional connections when an ebonite panel is used in place of that specified. This elimination of wires has the effect of making success a practical certainty. Every additional wire introduces the possibility of trouble during the process of wiring up the receiver, and probably, during its operation also. Simplicity is the keynote of success in home assembly. It is the Mullard way.

The aerial circuit

Commencing with the aerial circuit, you will note that a separate aerial winding is provided. This is designed with two tappings one of which is taken to pin number three and the other to pin number four of the aerial six-pin coil.

The receiver being designed with two aerial taps, selectivity is controllable—within the limits of the efficiency of the aerial and earth system, of course. Tap number three provides the greater degree of selectivity, and would be used for the reception of distant stations working on a wavelength near to that of the local. When the local station is closed down, aerial tap number four would give greater signal strength and would be chosen for use in preference to the alternative tap number three. There would be a gain of signal strength by the use of the higher tapping.

Suits individual cases

Different aerials have different effects upon the selectivity of the receiver. While on one, the set may tune reasonably sharply, connected to another, it may turn out to be hopelessly flatly tuned. The necessity, therefore, for some means of adjusting selectivity is really imperative if the receiver is to give universal satisfaction. Hence, primarily and finally, an alternative aerial tap is provided in order that individual requirements may be met. But there is more in the design of the receiver than this, as we are about to explain. And it is because interchangeable coils are employed, that this further advantage is present, for an important advantage it is indeed.

AERIAL AFFECTS SELECTIVITY

The interchangeable coil is a simple device, the windings of which may be modified by the non-technical without damaging the functioning of the coil. This is rather an important point as will be seen. Should the receiver upon test prove not quite selective enough even on the most selective tap—tapping number three—it is only a matter of a few minutes slightly to alter the turn numbers of the aerial winding in order to bring it up to the degree of sharp tuning required.

Adjusting selectivity

The aerial winding commences at pin number four and ends at pin number two, at which pin the grid winding also ends. Detach the end of the aerial winding at pin number two without disturbing the grid winding, which as we have said also joins pin number two. Then unwind a few turns from the aerial winding, let us say not more than three at a time. Take off the first three turns and then temporarily reconnect. Make a test under the actual conditions in which the receiver will be normally operated. If the desired degree of selectivity has been attained, resolder the end of the aerial winding to pin number two. If a still greater measure of sharpness of tuning is required, remove one turn further and retest. Remove another turn if the receiver is required to be more selective still; but after the first three have been taken off, do not remove more turns than one at a time, otherwise too many may be taken off, with the result that you will have to rewind the whole of the aerial winding—not too difficult a task but one to be avoided if possible.

Distance

The design of the receiver, therefore, follows a line of thought which gives sufficient selectivity on aerial tap number four to come within the confines of the selective receiver. Everywhere but under exceptional conditions—and there will be mighty few to experience these—selectivity will be adjudged capable of providing the pick of distant programmes free of any interference from the local transmission. This is more than the majority of radio enthusiasts ask for.

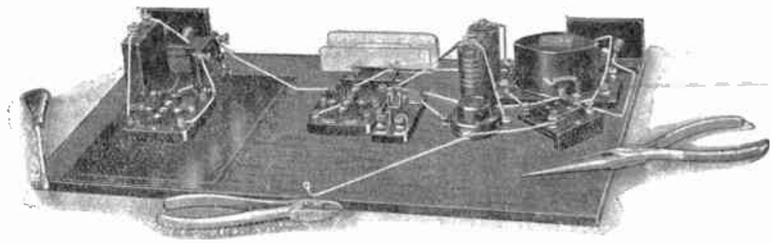
An ideal system

This scheme enables selectivity to be gained up to the last hair breadth. Rather important, don't you think, that it should be, particularly as radio receivers are most used in places near and about broadcasting centres where selectivity is most needed. But it is not to be overlooked that it is fair to neither those near, or those far, from a broadcast station to provide no scheme to adjust selectivity for the varying requirements of each. To produce a receiver without this means of individual adjustment is equivalent to disregarding individual cases, which in its turn, implies that all aerial conditions are alike—a situation we know to be quite reversed in actuality.

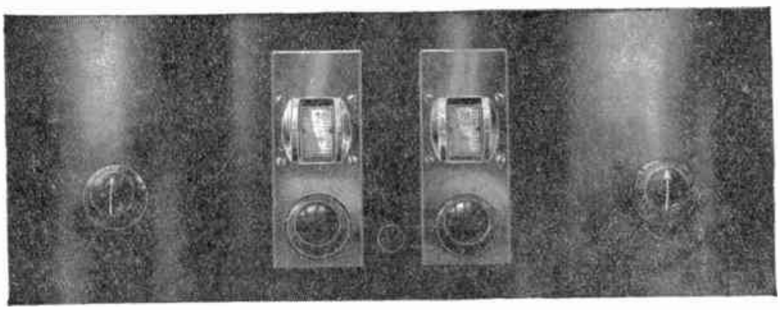
Aerial systems—which by the way includes the earth lead—may vary tremendously. Long lead-in wires, long earth wires, an aerial wire running close and parallel to a lead roof, each, separately and jointly, has a bad effect upon the overall efficiency of the complete aerial system. How many of us carry the lead-in wire through the house from the garden to a room at the front? Far too many, as it is difficult to do otherwise.

AN illustration of the new cabinet, designed especially for the new Mullard screened-grid receiver. The upper compartment contains the receiver, while the lower section houses the speaker, low-tension and high-tension batteries.

EFFICIENT H.F. COUPLING



SHOWING the baseboard components placed into position and partly wired-up. Here the dual mounting of the specified valve-holder is to be seen. That for the screened-grid is vertical. It is mounted flat for the Mullard Pentone. The illustration below shows a closer view of the panel.



How few of us are strict enough with ourselves to shorten the earth lead by taking it to an earthing pin in the front garden? If we know things rightly—many too few by far. Such being the case—the unalterable case it is—we must provide for selectivity despite conditions which might, with a little contriving, be improved. That the aerial system should be improved goes without saying, mainly for the reason that the selectivity of the tuning circuits may be advanced to a degree when it may easily despoil quality of reproduction. The aim of the designer must be a happy mean, allowing for the variance of different aerials, by the provision of such a scheme as is found in the Mullard S.G.P. Master Three by which individual requirements may be individually dealt with.

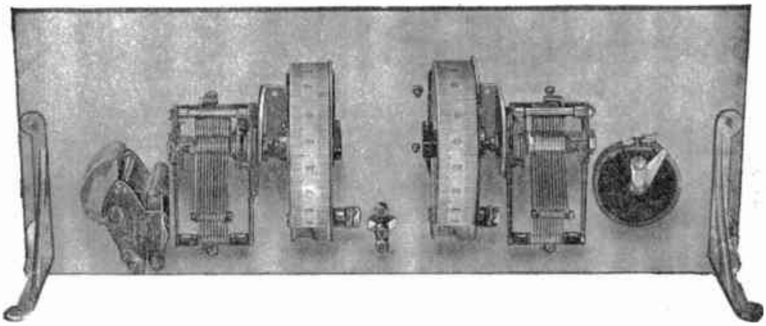
Efficiency with Simplicity

The high-frequency coupling employed in the receiver is the simplest that could possibly be chosen. It fortunately happens however, that the simplest method is also the most efficient . . . . . which is usually the case, is it not? Some would have us believe otherwise, judging by their tenacious and prejudicial clinging to the notion of inexperience that efficiency comes only in the company of elaborative detail. To these knowledgeable people, efficiency can never be associated with simplicity although every engineer—motor, steam, marine, mining, electrical or radio—knows precisely as the result of practical experience, that efficiency is gained only at the stage of greatest simplification. Complications and additions generally increase the risk of breakdown, as well as increasing the necessity for technical knowledge to operate the device, even to secure only a proportion of the performance which with utter simplicity would otherwise be obtained.

Maintaining selectivity

Where only one stage of high-frequency amplification is used, the normal inductance is most efficient providing, however, that complete screening is also a feature of the design. It is certainly the case that, unless complete screening is used, less efficient coils must be used. The high-frequency resistance of the anode coil, as well as that of the aerial coil, not only affects amplification, but lowers also the degree of selectivity.

INTERCHANGEABLE COIL ADVANTAGES



FROM this viewpoint, the longer contact leaf of the battery on-and-off switch would be on the right hand side of the switch spindle.

Showing the way

Here we touch upon another advantage of the interchangeable coil, in so far as the owner of the receiver is concerned with obtaining a high degree of selectivity. The system, as we have already shown, permits a fairly wide adjustment of selectivity. It also has the advantage of giving the owner of the receiver the opportunity of employing varying types of coils up to the limit of stability.

Using anode bend

The designer's intention to gain a high degree of selectivity did not conclude at this stage. He has introduced into the receiver another feature which sharpens up tuning considerably. This is the provision of anode bend rectification. Briefly, this method of rectification, by the considerable reduction of damping on the grid of the detector valve, greatly increases the efficiency of the detector stage. This has the effect of sharpening the tuning curve, and under the correct working conditions for anode bend rectification, also greatly increases the amplification to be obtained from the detector stage.

At first, owing to the greatly increased sharpness of tuning with anode bend rectification, the receiver is a little tricky to operate, but this is quickly mastered. As a matter of fact, when once it has been mastered, the system is thereafter exclusively preferred to the alternative method, leaky grid. For two reasons, the first on account of the improvement in selectivity to be secured by its use, and the second, the noticeably improved quality of reproduction present in any receiver which makes use of it in preference to leaky grid.

Reaction is obtained by a popular and efficient method. It is controlled by the variable condenser indicated as C 3 on the Plan of Assembly. On a set such as this, reaction is vitally important. When it is under perfect control, the reception of distant stations becomes mere child's play compared with the difficulty experienced when reaction effects are poor. Bear in mind that reaction should be controllable to such a degree of ease, that it may be advanced up to the point of oscillation smoothly and without any tendency to flop over into oscillation. This pleasant state may be reached by the correct adjustment of the high tension voltage on H.T.+2 (Battery Lead No. 4) subject, of course, to the specified valve suitable for the voltage of your low-tension battery being used.

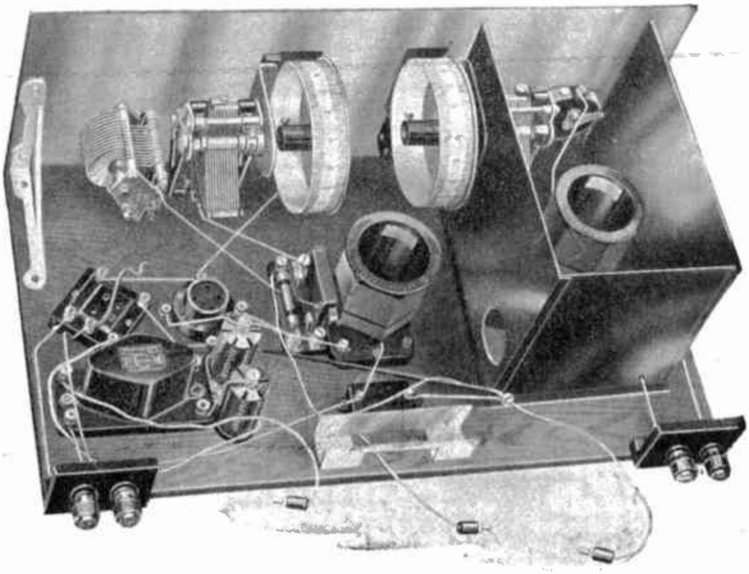
Prevents floppy reaction

That complete screening is employed decidedly prevents any trace of floppy reaction effects. With a low value high-tension voltage, it will not be possible to obtain reaction effects with anode bend rectification. Something in the neighbourhood of ninety to a hundred is essential. If less than this value is the maximum voltage available, it will be necessary to turn to leaky grid with a resultant falling off of selectivity.

In practice, the high-tension value on the detector should be carefully adjusted, if real success with the receiver is aimed at.

While referring to this matter of high-tension, it would not be out of place to mention, that for the Mullard S.P.G. Master Three Receiver it is best to make use of a

QUALITY FROM ONE L.F.



AS was the case with the previous Mullard Master Three Receivers, all battery leads are taken direct from the terminals of the components. Needless to suggest the method eliminates a number of rigid wires.

Mullard H.T. Supply Unit. Dry batteries at the best of times are rather troublesome . . . . . they run down all too quickly. And, it may be more or less considered a fact that, when high-tension current is derived from a run down battery, not only is quality seriously affected but troubles from floppy reaction very often arise also. Readers may take it, that a poor high-tension supply generally impairs the entire performance of the receiver, lessening the sensitivity, decreasing the quality of reproduction and introducing operative difficulties. All of these will at once disappear just as soon as the poor high-tension supply is replaced by a goodly supply. There is no question but that this is to be obtained from a good mains supply unit.

Only One L.F. Stage

Similar to the aerial and detector stages, the low-frequency side of the Mullard S.G.P. Master Three Receiver is extremely simple. It is designed with only one stage, transformer-coupled. This is excellent for one or two reasons.

The fact that a transformer immediately follows the detector valve enables the employment of a special Mullard detector, which, in its turn, permits the use of anode bend rectification. This valve has special characteristics which make it particularly adaptable for use in the type of receiver being described. In the broad-sheet dealing with this receiver, slight reference is made to the fact that from the point of view of quality, a single stage of L.F. appears to give more faithful quality. Consideration of the point, rather inclines one to the opinion that low frequency amplification has its faults and that two stages perpetuate and accentuate them.

By the limitation of the L.F. arrangements to a single stage, faithful reproduction is more readily obtained for the reason that there is less apparatus harmfully to affect the impulses. No L.F. system is perfect. No L.F. system is absolutely faithful. All have their characteristic faults. It is better for the performance of the set, naturally, to limit the effect of these faults. Now that the Mullard P. M. Pentone Valve is available, this limitation becomes practical.

GOOD DAYLIGHT RECEPTION

ONE of the many tone arm and gramophone pick-up arrangements which may be successfully used with the receiver. Instructions for connecting this into circuit appear at the end of the article.

Brilliant reproduction

This valve renders possible the design of a radio receiver with a single stage of L.F. which will operate a speaker. Programmes would not be confined to the local station as reports and experience confirm. For example, on the original receiver it is possible to receive a station such as Langenberg on a powerful though insensitive dynamic speaker in daylight, on a short aerial raised only four feet above a lead roof, the receiver being earthed to one side of the mains. Even the eight-valve super-heterodyne receiver cannot do much more than this in daylight.

Careful listening decidedly convinces one that the single stage of low-frequency amplification gives brilliant reproduction. Music is sharply defined as regards its higher harmonic response; brass has its characteristic timbre which thrills the soldier, violins regain their entreating charm, voices become charged with personality . . . . . the arrangement brings us nearer to living and pulsating music.

An attractive cabinet

The front cover illustration depicts a new style radio receiver cabinet. The grille set below the receiver compartment suggests its intention. In point of fact, the idea of the cabinet is most attractive, in that it provides every advantage of the portable receiver, except a self-contained aerial. It is so constructed that, with the exception of the aerial and earth leads, it is self-contained.

The advantages of such an arrangement are obvious for the disadvantages of unsightly batteries and rambling leads are at once disposed of. It becomes possible to install the receiver in the favoured room without offence to the eyes of the lady of the house. Moreover, the speaker itself assumes an appointed place, whereas in the case of the more conventional table cabinet, it is always a difficult thing to know what best to do with it. Then one also considers that the idea has enabled the production of more artistic cabinet design, which is actually what it really does. In most instances, the home assembled receiver suffers under the disadvantage of having an unattractive appearance, solely on account of the cabinet in which it is housed. The novel scheme suggested in this issue gives the home assembled receiver equal status with the commercial receiver. It looks something more than a radio receiver; it is entitled to the description of a piece of furniture. And we can only repeat that which we have said elsewhere concerning it, that, if the expense can be afforded choose the de-luxe cabinet to house your Mullard S.G.P. Master Three Receiver.

AN illustration of the cabinet showing how the leads from the terminal mounts are taken inside the lower compartment to the speaker and batteries.

GEOGRAPHICAL TESTS

Those builders of the Mullard S.G.P. Master Three Receiver who have preferred to use the transportable de-luxe cabinet, will be interested to read the following suggestion regarding the mounting of the speaker unit. Examination of the lower compartment reveals the fact that a special mounting block is attached to the inside front panel of the cabinet, making it possible to fix the unit by means of wood screws, without these piercing through to the front. For best results, it is recommended that a ring of felt is interposed between the mounting block and the fixing ring of the unit. This will prevent any possibility of cabinet dither. The removable back of this compartment to which we make reference is fabric panelled. The reason for this will be apparent to most. It allows the cone to operate without back pressure which would be present were the cabinet designed with a solid wood panel in place of the fabric now being used.

To receive programmes

The ultimate aim in assembling a receiver is the reception of broadcast programmes. While all of us derive considerable interest from the actual work of assembly, it would be true to say that, our thoughts during this process are mainly directed towards the time when the receiver is completely installed. Therefore, a word or two on the performance of the Mullard S.G.P. Master Three Receiver will make informative reading to those present readers who are about to make it.

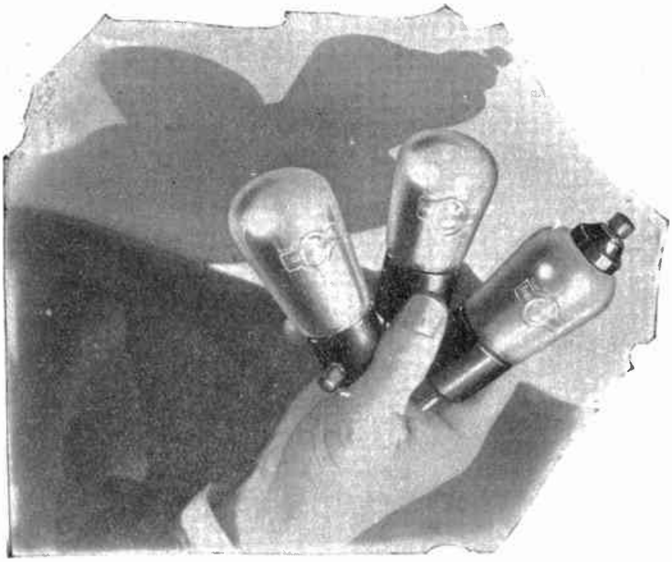
Distant or local stations ?

A number of receivers conforming to the published design have been tested in various parts of the country, by people who did not so much as have the assistance of a circuit diagram. They simply had the receiver sent to them for test and report. Battery connections only were given. In order to permit of easy analysis, each receiver was accompanied by a questionnaire. The headings, to which comments were required, were as follows: sensitivity, volume, selectivity, reaction, design, quality and rectification. It was found to be the general experience that the degree of volume obtainable on the new receiver was greater than that experienced with an efficient four-valve neutralised high-frequency receiver. This performance clearly shows that the valves are operated under conditions which produce the characteristically high measure of amplification.

Despite the insistent attraction of distant programmes, the majority of us listen more to the local programmes than to the whole group of transmissions emanating from distant stations. It is these excursions,

THE specified types of Mullard P.M. Valves for the Mullard S.G.P. Master Three Receiver, the Mullard Screened grid, the Mullard P.M. Special Detector and the Mullard P.M. Pentone

Those readers with a preference for six volt valves may now obtain a six-volt Screened-grid and a six-volt Pentone —the Mullard P.M.16 and the Mullard P.M. 26 respectively. The P.M. 6D completes the trio for the receiver.



A WIDE MARGIN OF POWER

however, into the fascination of distant reception that infuse into radio its undying charm. In the world of radio the spirit of adventure which urges us to search into the wide expanse for music and speech from across the seas, descends like the call of the sea to the sailor, the backwoods to the trapper, the forest to the hunter, the road to the traveller and the air to the aviator. It is the programme from the local station for all that, which really entertains us most, or rather it is the station, the programmes of which interest us most. This is to be understood bearing in mind that its transmission is unaffected by external disturbances such as fading, atmospherics and serious interference from overlapping transmissions.

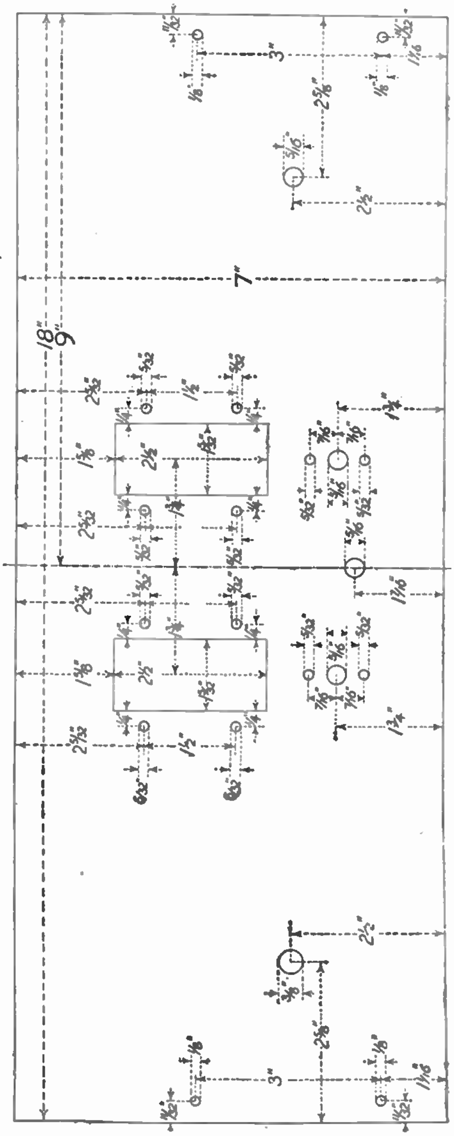
The main appeal

And from the purely straightforward aesthetical standpoint of entertainment, the local transmission, free of these disturbances, really composes the main appeal of radio as a means of constantly providing us with a variety of musical, vocal and educational items.

With this view in mind, there is ground for the expenditure of time and money on the kit of parts necessary for the Mullard S.G.P. Master Three. It is an economical receiver to run for the constant reception of the local station. It gives ample volume for speaker operation within a radius of ninety to a hundred miles of a main broadcast station, and within a radius of fifteen to twenty miles in the case of relay stations. Inside the areas indicated above, the transmission of the local station will be received as excellently and as powerfully as anyone could ever desire. In point of fact it may be experienced at close range to a local broadcast station that use of the volume control becomes imperative for comfortable listening.

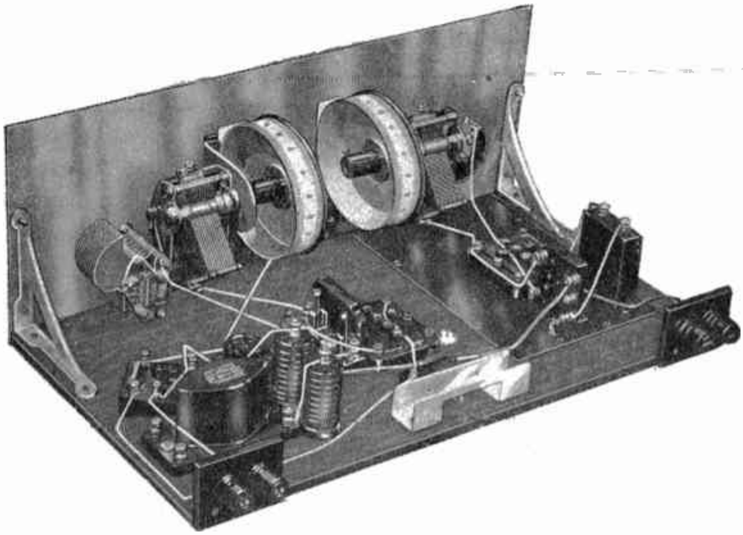
Ample volume

This, however, is not a disadvantage as it enables good quality reception to be characteristic of the receiver by virtue of the wide margin of power. It was found in every test district that there was ample volume. Moreover, the volume was such with the Mullard Pentone in the output, that, for the reception of the local station, the employment of a Mullard Super-power Valve—either a Mullard P.M. 252 or a Mullard P.M. 254, according to the voltage of the low-tension battery being used—was found to give more than enough volume for really powerful speaker operation.



SHOULD any reader wish to prepare the panel himself, this scale drawing will be found to give all the measurements required. It is not supposed that anyone making use of aluminium will do this, but, on the other hand, where high-tension current is taken from D.C. mains, involving an ebonite panel, it may prove a useful guide.

SCREENED-GRID H.F. VALVE



ANOTHER view of the receiver which provides a number of useful points to note during the construction. Connecting Links were actually used for the wiring-up of original receiver.

Human nature, as it is subjective to the call of radio, finds itself an easy prey to the fascination of tuning-in and listening to broadcast stations outside the home country. While we have given prominence to the suitability of the Mullard S.G.P. Master Three for the reception of the local station, it contains the power and the capacity completely to satisfy those radio enthusiasts who enjoy radio most when their hands are operating the dials.

Efficient valve combination

In our view it is not enough that a radio receiver should confine its utility to one or other of its requirements. It should be designed to fill the bill for both the reception of the local station and of the distant station, and that either should come over with the same degree of efficiency as standard performance demands. It happens that this receiver, by reason of the combination of valves employed, is able to do this.

The screened-grid high-frequency valve introduces range—the power to receive distant stations. It gives range because it amplifies greatly. It gives greater range than the three-electrode valve simply because it possesses a higher amplification factor although to this feature must be added the effect of the S.G. valve permitting the design and use of far simpler circuits—a state of affairs which we know to be a long step on the way towards maximum efficiency.

This new valve makes up for much of the inefficiency which unavoidably exists in most of our aerial systems when we come to the real test of a radio receiver. It partially counterbalances the loss of signal strength which is present in screened areas, rendering possible the reception of the more powerful distant stations, normally unobtainable with a three-electrode high-frequency amplifier.

The screened-grid valve scores

When only a very short aerial is practicable—and a great many of us suffer under this disability—the amplifying power of the screened-grid valve presents us with the advantages of an aerial with good pick-up characteristics. Further, the absorption effects of an adjacent aerial wire—very often in densely populated cities and towns as many as three or four aerials are to be seen strung across one roof—the S.G. valve enables the reception of signals which otherwise would never reach the anode circuit of the H.F. valve.

Each and all of these powers of the screened-grid valve are translated into terms of range when it is embodied into a radio receiver. We are brought power. We are given the wings of flight into other lands. We are no longer confined to the ordinary or to the commonplace for we are taken at the speed of light, and as if by a magic wand, into industrious Germany, into spirited France, into languishing Spain, into romantic Italy, into sparkling Switzerland, and into the classic countries of the Norsemen —Norway, Sweden, Denmark and Finland.

The list of stations

Distant stations are easily received for two main reasons, the primary one of which is the power of the Mullard S.G.P. Master Three Receiver. But this available power is of little utility if it cannot be utilised by every owner of the set. Therefore, accompanying power we have simplicity of tuning. In practice both features are equally important although from the point of view of the radio enthusiasts who assemble this receiver, there is some ground for the opinion that ease of tuning assumes the greatest importance.

The group of distant stations which are to be received on the receiver, largely depends upon the locality in which it is installed. This interesting thought was confirmed by a close analysis of the detailed test reports prepared by radio enthusiasts in the broadcast centres mentioned earlier in this article. One fellow living at one end of the town, for example, may find his list of stations quite different from that of a friend's, whose receiver was connected to an aerial at the opposite side of the town. Variation of lists of stations may happen as near as a mile between installations. The radio enthusiast on the south side of the hill will be deprived of listening to certain stations, which his friend on the north side is able to receive easily and consistently. Similarly, the receiver installed on the north side will be unresponsive to numerous stations enjoyed regularly by his equally unfortunate friend on the other side.

The radio touch

This rather suggests that the real way to discover the potentialities of a radio receiver lies in carefully going through its whole tuning range. It is neither practical nor reasonable to adopt the idea that any given station must be received because one of similar power is always to be received. It may happen that the radiation from a specific station may be diverted by what, in effect, is a very efficient screen. However, by careful tuning the performance of any one receiver should be equal to that of another, in so far as overall efficiency is concerned. And usually, it is found that the receiver with the good performance is operated by someone with the radio touch.

The envy of friends

In handling the receiver being described here, it is essential to maintain the tuning condensers in step. This recommendation becomes the more important should the selectivity of the receiver be advanced by the various methods suggested. It may be assumed by everyone that unless a careful method of tuning is adopted, very few distant stations will be received, if any at all. There should be no difficulty in this, as by the careful adjustment of the reaction condenser, a slightly audible hiss indicates that the two circuits are in resonance, or tuned to the same wavelength. An evening or two with the receiver to assist the owner in becoming familiar with its tuning characteristics will be sufficient to facilitate its operation to a degree of proficiency, which might well grow to be the envy of friends and acquaintances.

Using a gramophone pick-up

There are very few owners of radio receivers to-day who do not make use of the gramophone pick-up. It is quite a simple matter to connect such a device to the Mullard S.G.P. Master Three.

On every pick-up there are two terminals. One of these should be connected to the grid-bias battery into socket negative 3 to 4½ volts. The other terminal should be connected to terminal G of valve-holder V2. When it is desired to use this system of electrically reproducing gramophone records, the filament of the high-frequency valve should be switched out of circuit by means of the rheostat.

It should be noted that the two leads from the pick-up to the receiver must not run close to the speaker leads, otherwise serious trouble may arise from back-coupling, to be recognised by an unmistakable howl.

With the exception of the two connections named, no other alterations to the receiver are necessary, although, with a sensitive speaker, considerably more volume than is required may be obtained. In this event, a volume control in the form of a high resistance potentiometer should be placed across the pick-up.

A REPORT FROM NEWCASTLE

From D.B., Newcastle

" Having now completed the construction of the Mullard S.G.P. 3 Valve Receiver, I now tender you herewith the report-sheets of this receiver's construction and performance, which to the best of my knowledge are genuine and unbiassed affidavits, but as the space available on the report-sheets is somewhat limited I herein desire to express to you personally my more detailed opinions and views upon the receiver under discussion.

" Firstly, let me say that I trust the Reports are adequate and sufficient to suit your requirements, if not, I should be glad to make any further or additional report if needed.

"Terrific Volume"

" To say I am delighted with it is but a poor expression of what I really feel about it, for without the slightest hesitation I must say point blank that, it outclasses anything I have ever constructed in Radio Sets. *Never* have I had such terrific volume from a 3-valver even with two stages of L.F. amplification, and again *never* such undistorted volume. The tone of this receiver's production is as near perfection as I have ever attained with any type of set, or ever heard on *any* set as yet and I must tell you that I am about the hardest critic to please as ever tuned-in a set. I am fascinated with this receiver and cannot let it alone, it is a pleasure to handle it, and I never felt so satisfied with a Receiving Set before, and I must admit to you candidly and honestly that I am compelled to give this S.G.P. set the honour of first place over my cherished 4-valve Nelson P.M. Set, a set which was the first to give *me* satisfaction.

"Punch and power"

" I get 25 per cent. (at least) more volume from this 3-valve S.G.P. Set than I get from the aforesaid 4-valver, using four valves. The tone is richer and purer and more faithful than I have ever previously got from any set. This, together with the magnificent punch and power this set has got, makes it a very desirable possession. For a 3-valver it 'beats the band,' and there is not, in my humble opinion, anything on the market, either British or Continental, that can beat it. Understand, I speak from experience and with knowledge of most up-to-date practices in radio, for there is very little advancement made in wireless matters but that it is 'tried-out' by me sooner or later.

" To sum up in brief this receiver's advantages, it only needs be said that it is—A fine set, ridiculously easy to make and operate, and one capable of satisfying the most super-critical wireless fan that ever was, and its construction, following your detailed point-to-point wiring instructions and the blue print renders the job an easy one and need not deter even those who are absolutely ignorant of making sets, it is all 'cut-and-dried' and as easy as making Meccano models.

"Two evenings' work"

"I did not build it in an evening. I took two evenings to do the job, because I thought such high-class accessories were worthy of something better than a hook up or slip-shod treatment and this finished set is a picture as you will see later on by photographs of it.

" Although I took a protracted time for making this set, I say it candidly that the S.G.P. 3 Star could be completed in 6 or 7 hours in the ordinary way."

★ ★ ★

Report on Assembly

1. **Did you find the blueprint clear ?**

   Yes, and very easy to follow and understand in every detail.

2. **Did you find the instructions on Wiring Step-by-Step and Battery Leads clear ?**

   Yes, an absolute novice could not fail to wire up this receiver, all instructions are so definite and clear.

3. **Did you find the list of battery connections (low tension, high tension and grid bias) clear ? Which means to say, did you succeed in connecting up the receiver correctly the first time ?**

   Yes, and the lengths of all leads which you give are correct, no unsightly jumble or tangle whatever. I have not had to make one single alteration or adjustment after completing the receiver to your instructions and the receiver is now tuned in to Hilversum.

4. **Did you find it necessary for further information to be given at any stage during the construction of the receiver ? If so, where did you experience difficulty ?**

   None whatever, everything was so easy and simple to follow, and in my opinion easier than some of the so-called simple sets. No one could go wrong. The construction of this set makes Meccano a Draughtman's job in comparison. It is " dead " easy.

QUESTION AND ANSWER

Performance Test Report

What are your impressions of the following features :—

1. **SENSITIVITY—remarking on its distance capabilities.**

   One must actually handle this set before they would believe its marvellous distance-getting powers. I get more continentals than ever before, even when using a stage of neutralized H.F. and the volume is 25 per cent. more than I get with a 4-valve set I own and operate daily.

2. **RECEPTION — stating how you found the control of reaction.**

   Beautifully smooth over the entire range and capable of very fine adjustment of building up signal strength, from faint emissions to terrific volume.

3. **DESIGN—stating if the receiver appears attractive in your opinion.**

   A neater and more attractive or a more pleasing design it is difficult to imagine. As regards the layout, it leaves nothing to be desired and is in my opinion "Ne plus ultra."

4. **SELECTIVITY — remarking whether the local transmission could be tuned out easily.**

   Unusually selective local station (about 3 miles away) cut "dead" out in less than 10 degrees rotation of condenser dials. No over-lapping or faint signals in background at all.

5. **QUALITY—stating how reproduction compared with other receivers you have heard or owned.**

   This is revelation. It must be actually heard to be believed. I have never built in all my 25 years' experimental work a receiver giving better reproduction, and I have to-day learnt what quality of reproduction means.

6. **EASE OF OPERATION—remarking on the simplicity of tuning.**

   A child could operate this set. It eliminates all uncertainties of tuning, which, with this set practically becomes automatic. Freedom from threshold howl is very noticeable.

7. **RECTIFICATION — stating whether you preferred to operate the set with battery lead No. 7 connected to the first socket of the G.B. battery (leaky grid) or in socket 6 to 9-volts (Anode bend).**

   "Leaky Grid" preferred on account of its enhanced selectivity powers, but there is very little to choose between the two methods of rectification. Anode bend, in my opinion giving modified tone and a pleasing softness to the reproduction.

Editorial comment

The test report which we publish above is extremely interesting. Our correspondent has obviously had experience of receiver construction which has placed him in the position of wholeheartedly appreciating the merits of the Mullard S.G.P. Master Three Receiver.

He was sent a complete kit of parts. Very few instructions were given to him. These consisted merely of "Wiring Step by Step," Battery Lead Instructions, High tension tapping values and one or two notes regarding the mounting of the switch and the assembly of the screen. A Plan of Assembly, of course, was included with the kit.

His success is apparent to all who may care to read through the very interesting and inspiring letter which accompanied the two reports. It will be noted that in the amplified remarks contained in the letter, emphasis is given to the measure of volume, the degree of quality, its relative performance as compared with a four-valve receiver, and the simplicity of assembly and operation. Analysis of his experience with the receiver is very enlightening. Not one alteration to the wiring was necessary; every lead was found to be of the correct length. Even with only the limited data provided, a few hours assembly was rewarded with immediate success.

He refers to the reception of distant stations, reaction, design, selectivity, quality, and ease of operation in terms which prove that he has given the receiver as thorough a test as we ourselves. This gentleman clearly knows what he is talking about except when he refers to the matter of rectification. Here it will be observed that he remarks "leaky grid preferred," and he goes on to give his reason. This is an interesting point of view, as there is no question but that anode bend rectification definitely increases the selectivity of the receiver.

[concluded on page 30

SIGNPOSTS

THREE pages are devoted to the explanation of various points which may occur during the construction and operation of the Mullard S.G.P. Master Three Receiver. Whatever the degree of proficiency held by readers in the matter of receiver assembly and handling, a perusal of these "Signposts" will be of great assistance.

★ Mounting battery switch

Different from most receivers, it is important to mount the battery on-and-off switch correctly. Examination of the specified make shows that contact is made with the central spindle by means of two spring leaves or arms. When the switch is mounted into position, one of these leaves or arms comes nearer to the panel than the other. **Looking at the receiver from the front, this nearer leaf or arm should be on the left hand side of the spindle.**

Mounted in an opposite sense, that is with the longer leaf or arm to the right, the switching-off of the high-frequency valve will not be possible, with the result that the low-tension battery will quickly run down. This is due to the fact that, although the switch may be in the off position, as regards the second and third valves, in whatever position it may be—on or off—the H.F. valve will always have its filament in circuit. Should you use any make of switch other than that which is illustrated, make positively certain that it makes contact with the panel and functions electrically in exactly the same way as the one referred to in this paragraph.

★ Watch the rheostat

The rheostat also calls for one or two remarks. Reference to the Plan of Assembly shows that only one wire is connected to this component; this being number four. The other connection is made by means of the common earth return—the panel. **Therefore the spindle of the rheostat must make contact with the panel.** Here it is necessary to note whether this actually happens should you employ a make of rheostat other than that included in the list of parts.

★ Scrape away lacquer

When the screen is removed from its packing it will be found to be lacquered. **Where any connection is made to the screen, as is the case at points Sc. 1, Sc. 2, Sc. 3, and Sc. 4, every trace of lacquer must be removed to permit perfect electrical contact.** The lacquer may be removed by scraping away with the point of a pocket knife.

★ A useful refinement

A rather desirable refinement to the Mullard S.G.P. Master Three consists of the addition of 2 mfd. reservoir condensers shunted across low-tension and H.T. + 2 and H.T. + 3.

★ The flying leads

In this receiver there are two flying leads which, in the Wiring Step by Step, are numbered seventeen and twenty-seven respectively. With the high-frequency coil in its holder, Wire number twenty-seven carries high-tension current to the anode of the high-frequency valve. To most readers will occur the idea that, while inserting or removing this valve, should this lead fall into the receiver and short across the filament circuit during this operation, disaster will ensue. Remember, therefore, always to handle this lead with extreme circumspection. Similarly would become the state of affairs in the matter of Wire number seventeen.

★ Connecting the batteries

So great may be the excitement after the completion of the assembly to hear the new receiver operating, that one might be tempted to connect up the batteries in an irregular way. It will be realised that it is quite within possibility for the receiver to be switched on with the low-tension battery leads and the high-tension battery leads connected to their respective batteries but with the grid-bias leads unconnected. Should it happen—and it probably would—for one or other of the wander plugs at the end of the three grid-bias leads to be making contact with a high-tension wire inside the receiver, then trouble from a short-circuit across the filaments of the valves may be expected. **Adopt the policy of connecting up the grid-bias battery leads first of all,** leaving the low-tension and high-tension battery leads until this has been done. The grid-bias battery leads referred to are numbered six, seven and eight.

★ Condenser and leak holder

Special care should be taken correctly to screw into position the Mullard Combined Condenser and Leak Holder. **Viewing the receiver from the back of the panel the grid leak should be to the left.** Thus the terminals from which the short connecting strap is removed come at the back of the set. Fixed the other way round, connects the anode of the screened-grid valve to the grid-bias battery. Certainly a connection to avoid.

★ Worth remembering

It is always worth while cultivating the habit of disconnecting every high-tension battery lead from the high-tension battery before making any running adjustments to the receiver. It is not sufficient merely to disconnect the negative high-tension lead.

★ Terminal "X"

The fifth terminal, designated as "X" on the Plan of Assembly, is left free in the case of valve holder VI.

★ Insulating Wire No. 9

The metal screen surrounding the aerial stage of the Mullard S.G.P. Master Three is connected to negative low-tension. It is, therefore, to be advised that sistoflex, or any similar insulating sleeving, should cover Wire number nine, which is a low-tension positive wire. The flexible aerial lead wire, number twenty-six, might also be similarly treated where it passes through the side of the screen. A short circuit here would be equivalent to bridging the aerial and earth terminals of the receiver. The effect of this need not be stated. It is, for all that, a point worth watching.

★ Mounting tuning condensers

When mounting the tuning condensers on the panel be certain to place them in the right positions; these are easily discovered. The capacity of the aerial condenser is increased by the rotation of the control knob to the left; that of the high-frequency condenser by rotation to the right. With this system of control there is a right and wrong drum. That for the aerial condenser would be readily recognised, as an increase of capacity advances the dial readings. Should this not be the case, it may be assumed that the drums are attached to the wrong condensers.

The remedy suggests itself. While referring to the variable tuning condensers it is a point to bear in mind, that under no circumstances should they be mishandled, as plates touching will short the high-tension battery were this the mechanical condition of the H.F. condenser.

★ A rheostat point

The specified rheostat included in the list of parts has a resistance value of 50 ohms, which is correct for controlling the filaments of six and four volt Mullard P.M. Valves. The Mullard P.M. range of two volt valves will require a rheostat with a resistance value of 15 ohms. The makers specified in the list of parts have both values.

★ The art of tuning

Tuning is an art which practice makes perfect. But perfection is by no means essential to the successful operation of the Mullard S.G.P. Master Three. Endeavour to remember that there is no secret to discover or any trick of the trade to learn, in order to secure maximum results from the receiver. It often happens, however, that many a good receiver has been condemned unjustly, simply because a few minutes were not devoted to mastering the one or two characteristics of its tuning arrangements. Rotate the control knobs slowly and in step. Do not swing over from left to right hoping for the best, which, of course, is never realised by such unsympathetic movements.

Commence with the local station which will register up the two dials, and then rotate each knob in an opposite direction, with a final touch to each as soon as a station is heard. By the way, the reaction condenser (marked as "C3" on the Plan of Assembly) adds considerably to the ease of tuning, as it increases the sensitivity of the set. But do not fall into the way of tuning with the receiver in an oscillating condition. It results in hideous noises, to which every other member of the household would justly object. Maintain the receiver in a sensitive, not an oscillating state. This is reached with the reaction condenser so adjusted that a slight increase of capacity would take the set into oscillation. As the wavelength to which the receiver is tuned is increased, more reaction is necessary in order to keep the set at this useful point of sensitivity. Consider the reaction condenser a secondary volume control rather than a primary means of making the receiver oscillate.

★ A useful volume control

The rheostat is included in the design to allow a useful control of volume on the local station. It is a method greatly to be preferred over any variable resistances shunted across either the input or output circuit of the low-frequency stage.

★ Screening grid potential

If you have read the notes on the screened-grid valve, contained in "A Peep into our Notebook," it will have been made clear to you that the feature of this type of valve lies in its additional electrode, known as the screening grid. Here it is sufficient to point out that the correct functioning of this type of valve is largely governed by the relationship between the high-tension voltages applied to the screening grid and anode. Battery Lead No. 3 (H.T.+1), serves the former while Battery Lead No. 5 (H.T.+3), serves the latter.

Experiment proves that, while the actual voltage on H.T.+1 is not over critical, maximum efficiency from the valve is secured when it is adjusted fairly accurately. It is best to try various potentials round about the value given. Do not apply an excessive or lesser voltage than recommended outside a margin of six to seven and a half volts either side. The result of an incorrect potential on the screening grid, would be to reduce the effective amplification of the valve.

★ Switch-off first

It is imperative that the receiver should be switched-off before removing grid bias plugs from the grid bias battery. Similarly, when connecting up the receiver for the first time, make it the practice to connect all G.B. battery leads (Numbers 6, 7 and 8) before connecting H.T. battery leads (Numbers 1, 3, 4 and 5) to the high-tension battery or battery eliminator. Should these instructions be ignored by having the G.B. leads disconnected, the emissive properties of the valve filaments will be seriously impaired.

★ Inserting the coils

The coils for the Mullard S.G.P. Master Three Receiver are obtained in two kits, one for the long waves and the other for the short waves. Reference to the Plan of Assembly shows that there are two six-pin coil holders in the set, marked H 1 and H 2. The first named carries the aerial coil which is placed inside the metal screen, while the high-frequency or anode coil is inserted into the second. Do not omit to examine the makers' markings on the coils, as it is very easy to make the mistake of inserting the coils into the wrong six-pin coil bases. These remarks apply to both wavebands.

★ Operating on D.C. Mains

If it is desired to operate the Mullard S.G.P. Master Three Receiver from a D.C. mains supply unit, it will be necessary to sacrifice the advantage of the specified metal panel. The reason for this will become perfectly intelligible when it is remarked that with direct current supply one side of the mains is connected direct to the receiver. This being the case, to touch the metal panel with H.T. derived from D.C. mains might give the operator an unwholesome shock. To avoid this happening, it is important to substitute an ebonite panel for the aluminium make specified. The following additional connections, therefore, become essential.

Connect the top screw of right hand panel bracket to the left hand terminal on the rheostat R1.

Join the latter terminal also to the terminal on the end plate (moving vanes) of condenser C1, and continue the wire to the terminal on the end plate of condenser C2.

Connect the same terminal on the end plate of condenser C2 to that on the end plate of reaction condenser C3 (moving vanes).

Connect the end plate of condenser C3 to terminal F— on valve holder V3.

When these extra connections are made, but before connecting up the receiver to the aerial and earth or to the D.C. eliminator, insert into both the aerial lead and the earth lead a fixed condenser. In the former position a value of .01 mfd., while one having a value of 2 mfd., should be inserted in the earth lead. These components may be placed at the back of the screen. The .01 mfd. condenser would break into the aerial lead, numbered wire twenty-six, and the 2 mfd. condenser would break into wire numbered seven.

A Peep into our Note-Book

Since September, 1927, there has been much talk of screened-grid valves. The idea of a high-frequency valve possessing an amplification factor of two hundred fired the imagination of the radio public. The stands of exhibitors at the Radio Show in progress at this time, were besieged by crowds eager for information about them. It was certainly a sign that the public's interest in radio was by no manner of means dead. It seemed that the early days of broadcasting were being revived. . .

Behind the scenes

But new ideas take time to filter through into general use. In the case of the screened-grid valve, eighteen months have passed before it has become possible to release a practical, simple and efficient design. Readers will rightly presume that, behind the scenes, there has been much activity in the laboratory. They may also assume that the introduction of a such revolutionary type of valve as the screened-grid kept research engineers and technicians very much in an occupied state of mind. Radio valve production does not conclude with its invention. It is necessary to adapt the invention to practical production methods . . . machinery, to name only one. Then it has to be considered whether the final product of the machinery may be released on to the market . . . It is all a problem for the men behind the scenes . . .

We people concerned with the design of radio receivers for the radio public—both the experienced and the inexperienced sections of it— spend much of our time at the test bench, experimenting with this scheme, pursuing that idea, discarding here and adopting there, in order to arrive at the point where maximum efficiency will be obtained. This pursuit of knowledge is as interesting as it is imperative; it is as fascinating as it is important. And the screened-grid valve certainly provided us with an irresistible target upon which to direct thought, time and trouble.

The matter was one for endless thought, a never-ending expenditure of time and a constant source of trouble in the early days of its release. Every method of using the valve has been tried, and it is proposed briefly to outline here, a few of our impressions gained during these experiments.

The rated amplification

The screened-grid valve possessing such a high internal resistance, tuned-anode is the obvious coupling arrangement to use in the anode circuit; at least, it is the first arrangement which suggests itself. And it was with this system of intervalve coupling that our experiments commenced.

There is much in favour of this circuit when viewed from the angle of obtaining the greatest degree of amplification from the valve, or, more accurately, obtaining as much of the rated amplification of the valve as possible. Most of us know how really difficult it is to approach in practice anywhere near the rated amplification factor as published by the makers. This is the state of affairs for several reasons.

Under working conditions, the external impedance and the internal impedance of the valve have an important bearing upon one another. By the external impedance we mean the impedance of the inductance in the anode lead of the valve when a current is passing through it. By the internal impedance we mean the internal resistance in ohms of the valve given by the makers. In the case of the Mullard P.M.12 this figure is 230,000 ohms, while the Mullard P.M. 14 is also rated at 230,000 ohms. In practice, the rated amplification factor of the valve is most nearly secured when the working conditions are such that the external impedance is large compared with that of the valve. Therefore, the intention of the designer or experimenter would be to employ a circuit arrangement which produced this condition. The impedance of a tuned-anode circuit comprising such a coil as is included in the Mullard S.G.P. Master Three Receiver, would be in the neighbourhood of 120,000 ohms.

Experimental details

Experiments were commenced, however, with a coil of a much lower high-frequency resistance. It was intended to obtain as high an impedance in the anode circuit as possible and a number of coils were prepared with this object. Four-inch paxolin formers were used. The first series of coils were wound with Litzendraht (27-42) wire. These were found to have an H.F. resistance of 2.5 ohms. A second series of coils were also wound on four-inch paxolin formers but the wire was changed for the normal 28 gauge double-silk-covered wire. The ohmic resistance was measured at nine. A third series of coils were wound on the same sized formers but the astatic method of winding was used. Measurement of these coils showed them to have an ohmic resistance of sixteen.

It will be agreed that these three different types of coils offered a wide field for experiment, which, in fact they did, as we were kept very busy for some months trying out various schemes in order to employ the first mentioned range of coils. It will be explained later why it became necessary to use the last named after all.

The experimental sets

Two receivers were built for the experimental work—the first incorporating one stage of screened-grid high-frequency and the second, two stages of screened-grid high-frequency amplification.

Commencing with the last named first, it was discovered that with the most efficient coils—those having an ohmic resistance of 2.5—that the receiver was hopelessly uncontrollable. It was absolutely unstable from one end of the tuning range to the other. (It should be remarked here that all the early experiments were conducted on the broadcast waveband.)

At this point it must be noted that complete screening of the two H.F. stages and also of the detector stage had been adopted. There was, therefore, no chance of interaction between stages causing the serious trouble which was being encountered. Every precaution was thereupon taken to eliminate any interaction between grid and anode wires caused through hurried and careless wiring. Feed-back which may be caused by the close proximity of high-tension leads to high potential leads was overcome by the enclosure of the former in earthed lead covered cable.

In spite of these precautions—drastic as they were—the receiver continued to oscillate. There appeared no way of overcoming the instability by ordinary means. It was, therefore, decided to attempt neutralising the residual capacity of the screened-grid valve, in an endeavour to see whether or not a cure could be effected in this manner. The experiment was enlightening. Even neutralising proved ineffective.

Residual capacity

Instability under the conditions indicated above was due to the residual capacity of the valve, for it must be remembered that it is not possible for it to be entirely eliminated altogether. This capacity is very low; something in the neighbourhood of .5 mmfd. (.0000005 mfd.). It is sufficient, however, to make a two high-frequency screened-grid receiver very unstable except under certain definite conditions.

External impedance

The impedance of the external circuit with this type of coil (2.5 ohms) would be of the nature of 200,000 ohms at 300 metres; very useful indeed, did it but prove stable. That it caused instability definitely showed that the coil was too efficient. This fact was difficult to swallow.

The next experiments were conducted on the second series of coils, which it will be recalled possessed a resistance of nine ohms. The impedance here at 300 metres would be something like 125,000 ohms.

Here instability was also encountered, although not quite as serious as in the previous experiments but sufficient to make the receiver unworkable. Neutralising was again tried without much success. The third series of coils with an impedance of about 80,000 ohms at 300 metres was now tried and the receiver was found to be perfectly stable. Thus we were provided with something to start upon.

IMPORTANCE OF COIL EFFICIENCY

Amplification with two stages of screened-grid high-frequency was enormous. Lengthy tests of the receiver revealed the fact that it was not over stable but was poised at a very useful point where a slightly lower coil resistance would have sent the receiver " up in the air."

A practical receiver

The desire to use the most efficient of the three sets of coils was prompted by the realisation of the fact that the low H.F. resistance would not only give us the greatest amplification but a high degree of selectivity as well. It was unfortunate that it was necessary to discard the 2.5 ohm coils, as the use of the coils with a higher H.F. resistance, beside dropping the effective overall amplification of the stage, also decreased the selectivity of the receiver. At a later stage of the experiments, selectivity was improved by the use of a Litzendraht aerial coil.

A practical receiver was built using standard binocular coils along the lines indicated by the experiments. It was a splendid set from the point of view of range and volume. Without the use of a wavetrap, however, it was possible to hear both the London and the 5 GB transmissions while the set was tuned into Langenberg. The test aerial was within two and a half miles of 2 LO.

It was revealed to us very clearly that the efficiency of the screened-grid receiver depended as much upon coil design as anything else. In a way, some disappointment was experienced, that rather less efficient coils than the most efficient had to be used, although under the conditions in which the receiver operated so well, the only problem was really one of selectivity. But one would expect this trouble when operating the receiver so close to a powerful broadcast station as 2 LO as two and a half miles.

Coil details

Details of the astatic winding used are familiar to most but here they are should any reader wish to know. The four-inch paxolin former carried seventy turns of 28 gauge D.S.C. Starting from one end, thirty-five turns were wound on, where the wire was anchored. A further thirty-five turns were then wound on in an opposite direction.

During the course of these experiments, the effect of neutralising was tried. The method adopted was by taking a lead from the anode of the valve to a small neutralising condenser, the other terminal of which was connected to the bottom end of a small winding (six or so turns) connected to the bottom end of the tuning coil. The arrangement did not function very well.

Tuned-anode preferred

For almost all of the experiments referred to above the tuned-grid method of coupling was employed. Thus the bottom end of the coil was at low potential while the top end was joined to the grid. So far as the efficiency of this circuit over tuned-anode is considered, experiment shows that the latter is to be preferred. There is, however, the losses introduced by the H.F. choke in the tuned-grid method to take into account. As a matter of fact, this particular component has a considerable effect upon the efficiency of the method, and for this reason the straight tuned-anode method is to be preferred, in that there is no risk of losses due to this cause being introduced. The two circuits otherwise operate identically.

On a powerful receiver of the type being discussed, the losses due to the H.F. chokes might not be noticeable, but this is certainly not the case with the single H.F. screened-grid receiver as will be shown later in these notes.

Assembly advantage

From the constructional point of view, one might favour the tuned-grid method, as it enables the moving vanes of the tuning condensers to be connected to earth—a feature not possible with tuned-anode, unless the system adopted in the Mullard S.G.P. Master Three is followed.

Coming now to the single H.F. screened-grid receivers which are naturally of more interest, in view of the publication of the Mullard S.G.P. Master Three, the results of our experiments were much along the same lines as those of the 2 H.F. receiver investigation. For example, coil efficiency here, as well as there, plays a large part in the behaviour of the set. With an anode coil of high efficiency—such as a Litz wound coil—instability is almost inevitable. If one is lucky enough to gain stability, it is almost certain that the receiver will be very tricky to operate. But under average conditions it was found that stability was still maintained with a Litz coil in the aerial.

As a matter of interest, four receivers of this type were tested during the course of one evening, that is to say, over a matter of three hours. Two of these sets were commercially made; the other two were experimental receivers of the home assembly type. On the same aerial and adjusted to best working conditions, each of the receivers mentioned gave more or less similar results. There was something to choose between them whether considering selectivity, volume, reaction effects, range or quality.

Circuit variations

The circuit arrangements of each varied. One brought the H.T. supply to the anode of the H.F. valve to the centre point of the anode coil; another had the plate of the H.F. valve connected to the centre point of the coil; the third followed the tuned-anode system while the fourth embodied tuned-grid—all variations of the tuned-anode. Tapping schemes, as were found in the first two, obviously were attempts to gain a comparatively high degree of selectivity. It was difficult to say whether or not the doubtful gain in selectivity really compensated for the loss in amplification, which results when the impedance of the external circuit is reduced by tapping along the anode coil.

Facts about selectivity

The problem of selectivity very close to a powerful broadcast station is scarcely to be overcome by tapping either down or up the coil. It seems that it is best done at the aerial end, where alternative aerial taps permit of either a selective or a moderately selective adjustment at will, according to the conditions and time of reception. When the local station is operating and it is desired to receive certain distant stations through the local's transmission, then one would naturally make use of the more selective tapping.

On the other hand, at such times as the local station is inactive, the availability of a less selective tap is something to be desired, if the receiver is to be of the greatest service. It would be blinding ourselves to the true facts if we did not agree that selectivity pushed to the limit decidedly impairs quality. We must not omit to bear in mind that at close quarters to a broadcast station, it is not possible to press selectivity to the utmost limit without impairing the performance of the receiver from this point of view. To expect what is usually termed "knife-edge" selectivity within a mile or two of a broadcast station, is to expect that which is impossible, unless, of course, one is willing to sacrifice quality and signal strength. There is, then, an economic limit to which selectivity may be advanced. It must be accepted. It must be realised and appreciated. Even the frame aerial is not selective enough for some people. But this is really taking things a little too far, as nothing could be more selective than a frame aerial. However, it does not satisfy some.

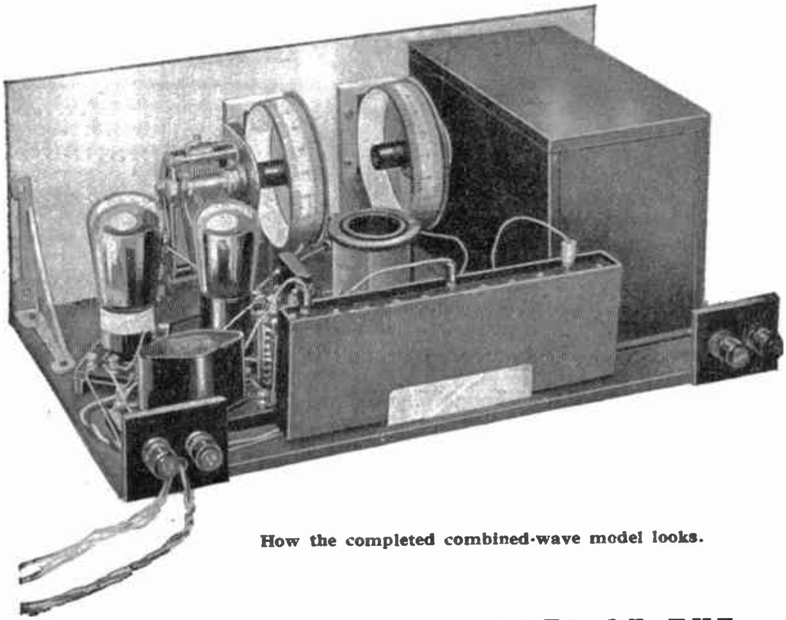
Let us see things as they really are. Let us have quality first and then advance selectivity up to the point—but not one hair breadth more—where quality is still retained. Let us have signal strength up to the point where we are able to listen to a varied choice of distant stations; but we should not press selectivity up to the point where it deprives us of signal strength to take away the pleasure of listening to this good choice of programmes. For this is really what happens when the degree of selectivity is advanced beyond the economic limit dictated by the power of the receiver.

An *impasse*

An unnaturally and excessively high degree of selectivity may cut down the interference from the local station and add three or four more stations to your treasured log. It is comparatively easy to do this. In point of fact it is remarkably easy, so simple in fact that we are rather inclined to do it disregarding that it is at the expense of volume on the rest of the stations. Consider the true state of affairs. Is it preferable to enjoy really good programmes from twenty stations with a moderate or economic degree of selectivity or to insist upon an uneconomic degree of selectivity, simply to add five or more stations to your list and to lower the signal strength of the other twenty? It is an interesting *impasse*.

Screening grid voltage

The fact that the potenial on the screening grid of the screened-grid valve is rather on the critical side is confirmed by some recent experimental work using a mains supply unit with variable tappings. With an incorrect value—either too high or too low—the screened-grid valve is rendered inoperative. Working under incorrect conditions, distant stations will not be received. Nor will the reception of the local be up to standard. It will be distorted as well as weak in strength. Therefore, in the event of your receiver appearing on the insensitive side, try a little experimenting with this particular tapping value.



How the completed combined-wave model looks.

THE COMBINED-WAVE MODEL OF THE MULLARD S.G.P. MASTER THREE

Wiring modifications

With the exception of combined-wave coils, there is no essential alteration in the combined-wave model. The panel has two additional holes, one drilled immediately below that through which passes the mounting bush of the battery on and off switch, and the other immediately below the rheostat control knob. These extra holes are necessary for the switching arms of the combined wave coils. Apart from this, there is no other modification required in order to gain the utility of combined waves. A certain percentage of the listening public prefer not to change coils when reception on the alternative waveband is desired. Speaking for ourselves, we do not find any objection, although there is a degree of trouble attached to it. But this we are quite willing to experience, as there are many things in favour of the interchangeable system.

The pros and cons

One therefore has to weigh up the advantage of combined waves against the ability to secure the advantage of an increased degree of selectivity with the highest degree of amplification. As we have explained elsewhere in this issue, the intention is to employ as highly efficient coils as is possible. The combined arrangement is slightly less efficient than the interchangeable system, coils for the latter having a slightly lower high-frequency resistance than the coils for the former system. In this circumstance, coils with a low H.F. resistance not only give greater selectivity and the opportunity to adjust selectivity to suit individual cases, but also improved amplification.

Detailed instructions

Many are willing, however, to sacrifice, shall we say the last ounce of efficiency for the utility of combined waves.

And it is to them that the assembly, wiring and operating details of a combined wave model are directed.

Omitting reference to the extra holes required for the arms operating the switches of the combined-wave coils, the panel is the same. It carries similar components—a similar make of variable tuning condenser, reaction condenser, battery on and off switch and rheostat. It is attached to the baseboard just as it is in the case of the interchangeable coil model.

With regard to the baseboard, all components with the exception of the coils are

[*concluded on page 29.*

WIRING STEP BY STEP FOR C.W. MODEL

FOR the convenience of readers who are constructing this model, we are printing here the full point-to-point instructions. It thus becomes possible to wire-up the receiver without making numerous cross references. This is rather important, as it would be so easy to make a wrong connection otherwise. Builders should bear in mind that all rigid wires must be kept as short as possible, as any long and tortuous wires may give rise to trouble quite apart from rendering the receiver rather unsightly.

Wire No. 1.—Connect nearer terminal on condenser C6 to terminal S on valve holder V1.

Wire No. 2.—Connect further terminal on condenser C6 by a round head wood screw Sc. 1 to the base of the screen.

Wire No. 3.—Connect this same screw Sc.1 to terminal 5 on coil holder H1.

Wire No. 4.—Connect terminal F— on valve holder V1 to the right hand terminal on resistance R1.

Wire No. 5.—Connect terminal F (fixed vanes) on condenser C1 to terminal 4 on coil holder H1.

Wire No. 6.—Connect terminal 4 on coil holder H1 to terminal G on valve holder V1.

Now fix the sides of the screen box in position.

Wire No. 7.—Connect terminal E on T.S.1 to fixing screw Sc.2.

Wire No. 8.—Connect nearer screw of right hand panel bracket to screw Sc.3.

Wire No. 9.—Connect terminal F+ on valve holder V1 to terminal F+ on valve holder V2. A short length of sleeving must be slipped over the wire before fitting in order to prevent contact between the wire and screen.

Wire No. 10.—Connect terminal F+ on valve holder V2 to terminal F+ on valve holder V3.

Wire No. 11.—Connect terminal F— on valve holder V3 to terminal F— on valve holder V2.

Wire No. 12.—Connect terminal F— on valve holder V2 to bottom terminal on switch S.

Wire No. 13.—Connect right hand terminal on condenser C5 to fixing screw Sc.4.

Wire No. 14.—Connect terminal 6 on coil holder H2 to left hand terminal on Condenser C5.

Wire No. 15.—Connect left hand terminal condenser C5 to terminal L.S.+ on T.S.2.

Wire No. 16.—Connect terminal L.S.+ to terminal X on valve holder V3.

Wire No. 17.—Take a piece of wire about 4 inches long, place over it a piece of sleeving and connect one end to terminal X on valve holder V3.

The other end of this wire is connected to the terminal on the cap of the Pentone valve V3.

Wire No. 18.—Connect terminal 2 on coil holder H2 to further terminal on H.F. choke H.F.C.

Wire No. 19.—Connect further terminal on H.F. choke H.F.C. to terminal P on valve holder V2.

Wire No. 20.—Connect terminal G on transformer T1 to terminal G on valve holder V3.

Wire No. 21.—Connect terminal A on transformer T1 to nearer terminal on H.F. choke H.F.C.

Wire No. 22.—Connect terminal F (fixed vanes) on condenser C2 to further right hand terminal of combined grid leak and condenser holder and thence to terminal 4 on coil holder H1.

Wire No. 23.—Connect terminal F (fixed vanes) on condenser C3 to terminal 3 on coil holder H2.

Wire No. 24.—Connect terminal G on valve holder V2 to the nearer right hand terminal of combined grid leak and condenser holder.

NOTE.—Remove connecting strap from combined grid leak and condenser holder.

Wire No. 25.—Connect terminal P on valve holder V3, to terminal L.S.—on T.S.2.

Wire No. 26.—Bare the ends of a 6 inch length of insulated flexible. Pass the flex through the lower right hand corner of the screening box connecting one end to terminal A on T.S.1 and the other end to terminal 1 on coil holder H1.

Wire No. 27.—Take a 6 inch length of insulated flexible wire, bare the ends and connect one end to terminal 4 on coil holder H2, **and the other end to the anode terminal of screened grid valve VI.**

DIAL CALIBRATIONS FOR C.W. MODEL

BELOW we are printing a complete list of dial readings which are almost invaluable during the preliminary testing of the receiver. While the readings given for the H.F. condenser—the second column—are more or less constant, those for the aerial condenser—the first column—will vary in accordance with the self-capacity of the aerial system to which the receiver is connected.

Long waves. (Switch arm out.)

Wave-length.	Station.	C.1.	C.2.
1849.6	Huizen	**86**	**86**
1748.2	Radio Paris	**78**	**75**
1653.1	Zeesen	**75**	**70**
1566.6	Daventry 5XX.	**68**	**64**
1488.8	Paris (Eiffel Tower)	**64**	**60**
1342.6	Motala	**52**	**48**
1155.3	Kalundborg	**46**	**40**
1073	Hilversum	**38**	**31**

Short waves. (Switch arm in.)

543.5	Budapest	**99**	**96**
539.2	Munich	**92**	**94.5**
520.1	Vienna	**89**	**92**
512	Brussels	**88**	**91**
504	Milan (Italy)	**86**	**89.5**
496.2	Oslo (Norway)	**85**	**88**
489.5	Zurich	**88**	**87**
482.3	Daventry (5GB)	**83**	**85**
475.6	Berlin (Witzleben)	**81.5**	**84**
473	Lyons PTT	**81**	**83.5**
462	Langenberg	**80**	**82**
448.9	Paris PTT	**78**	**80**
443.4	Rome (IRO) (Italy)	**76**	**79**
438	Stockholm (Sweden)	**75**	**78**
432	Brunn	**74**	**77**
427.7	Madrid (EAJ7)	**73**	**76**
422	Frankfurt (Germany)	**72**	**75**
415.8	Katowice (Poland)	**71**	**74**
411	Dublin (2RN)	**69**	**72**
406.3	Berne (Switzerland) }	**68.5**	**71.5**
405	San Sebastian }		
401	Glasgow (5SC)	**67**	**71**
400.4	Madrid EAJ2	**66.5**	**70.5**
396.3	Plymouth (5PY)	**65**	**68**
392	Hamburg	**64**	**67**
382	Toulouse (Radio)	**63**	**66**
378.3	Manchester (2ZY)	**62.5**	**65.5**
374	Stuttgart	**62**	**65**
362.3	Leipzig (Germany)	**61**	**63.5**
358.9	London (2LO)	**60**	**62**
354	Graz	**59**	**60**
349.8	Barcelona EAJ1	**57**	**59**
346.9	Goteborg (Sweden)	**56.5**	**58.5**
343.2	Prague	**56**	**58**
339.3	Copenhagen	**55**	**57**
336.3	Huizen	**54.5**	**56**
330	Bremen	**53**	**54**
326.6	Gleiwitz	**50**	**53.5**
323.2	Cardiff (5WA)	**50**	**53**
320.1	Breslau (Germany)	**50**	**52**
311	Aberdeen (2BD)	**49**	**49**
311	Marseilles (PTT)	**49.5**	**49.5**
302.6	Belfast (2BE)	**47**	**48**
294.1	{ Dundee (2DE), Liverpool (6LV), Stoke (6ST), Swansea (5SX) }	**44**	**45**
291.5	Lyons	**43**	**44**
288.5	{ Bournemouth, Hull 6KH, Bradford 2LS, Edinburgh 2EH }	**42**	**43**
283.1	{ Magdeburg, Stettin, Berlin, East }	**41**	**42**
280.5	Konigsberg	**40**	**41**
276.7	Turin	**38**	**40**
273.1	Kaiserslautern	**36**	**38**
270.4	Sheffield (6FL)	**35**	**37**
267	Munster (Germany)	**34**	**36**
263.3	Cologne (Germany)	**33**	**35**
260.8	Horby (Sweden)	**31**	**33**
258.9	Leeds (2LS)	**30**	**32**
250	Kiel	**29**	**30**
249	Cassel	**28**	**26**
243.9	Newcastle (5NO)	**19**	**20**
200	Metres	**4**	**9**

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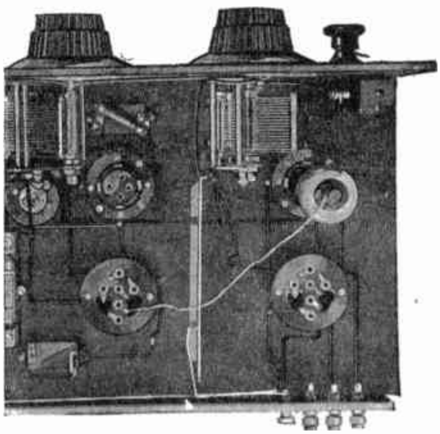
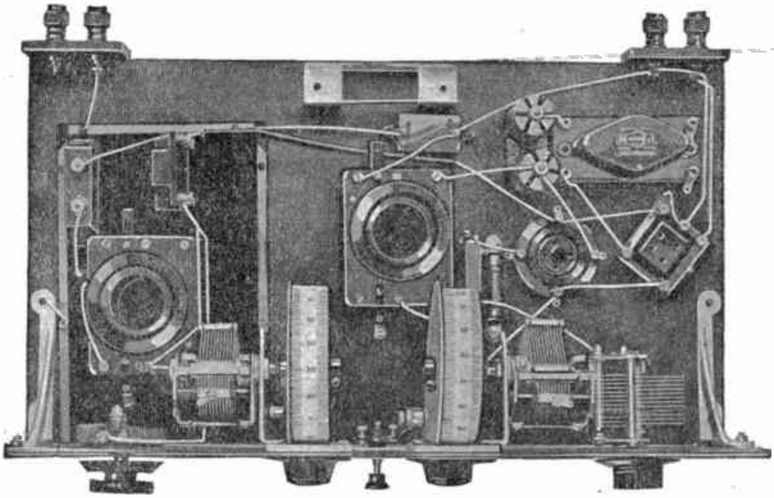


AN illustration of a reader's Mullard Nelson P.M. de Luxe converted to use a Mullard Screened-grid Valve.

PREPARING BATTERY LEADS



AN illustration of the combined-wave model, which, in conjunction with the "Wiring Step by Step," makes the assembly of the receiver an easy undertaking, even for those without any technical experience whatever. The disposition of the coils is clearly shown. They should be fixed to the baseboard in the manner described in the text.

★ ★ ★

Battery Lead No. 1.—Take a piece of black flex about a yard in length. Bare each end, attaching to one a black wander plug. (H.T.—). About 12 inches from this same end, remove the braid and rubber insulation at which point attach a black spade (L.T.—). The other end of the flex is connected to the top terminal on switch S. The black spade is placed under the negative terminal of the L.T. (wet) accumulator, and the black wander plug is inserted into the negative socket of the dry H.T. battery.

Battery Lead No. 2.—Bare the ends of a piece of red flex about 2 feet long and connect a red spade (L.T.+) at one end; connect the other end to F+ on valve holder V3 and place the red spade under the + terminal of the L.T. (wet) accumulator.

Battery Lead No. 3.—Take a piece of red flex about 1 yard long and bare both ends. Thread one end through the left hand lower corner of the screen box and connect to terminal S on valve holder V1. To the other end fix a red wander plug (H.T.+1).

Battery Lead No. 4.—Take a piece of red flex about 2 feet long, bare both ends and connect one end to terminal +H.T. on transformer T1. The other end is fitted with a red wander plug (H.T.+2).

Battery Lead No. 5.—2 feet length of red flex is similarly treated and one end connected to terminal L.S.+ on T.S.2. The other end is fitted with a red wander plug (H.T.+3).

Battery Lead No. 6.—Take about 9 inches of red flexible wire, bare the ends and connect one end to the screen box by means of screw Sc. 4. At the other end fit a red wander plug (G.B.+).

Battery Lead No. 7.—Take a 9 inch length of black flexible wire and bare the ends. Connect one end to the further left hand terminal on the combined grid leak and condenser holder (R2). To the other end fit a black wander plug (G.B.1).

Battery Lead No. 8.—Bare the ends of 12 inch length of black insulated flex and connect one end to terminal —G.B. on transformer T1; to the other end fit a black wander plug (G.B.2).

ESSENTIAL INFORMATION

Essential Components for the Combined-wave Model

THE following list of components for the combined wave model is identical with that of the Mullard S.G.P. Master Three Receiver described in the Supplement to this issue apart from the substitution of combined wave for the interchangeable coils.

1 Table Cabinet (Kabilok) (W. T. Lock), or
1 Transportable Cabinet de Luxe (Kabilok) (W. T. Lock).
1 Baseboard.
1 Aluminium Panel (Ready drilled to carry tuning condensers, switch, reaction condenser, rheostat and panel brackets) (Colvern), or
1 Ebonite Panel (Becol) 18″×7″, for D.C. mains operation.
1 Pair of Logarithmic variable tuning condensers (each .0005 mfd.) (J.B.).
2 Drum tuning dials (one right and one left) (J.B.).
1 Reaction condenser (Bébé .0003 mfd.) (Cyldon).
1 Filament rheostat (50 ohms) (Sovereign).
1 Filament battery switch (with terminals) (Benjamin).
1 Combined wave aerial coil (S.G.P. Master Three) (Colvern or Gent).
1 Combined wave anode coil (S.G.P. Master Three) (Colvern or Gent).
2 Valveholders (Type HV) (Junit).
1 Valveholder with terminals (anti-microphonic) (Pye or W.B.).
1 Combined condenser (.0003 mfd.) and grid leak (2 megohms) (Mullard).
1 High-frequency choke (Climax).
1 L.F. transformer (Mullard "Permacore").
2 Terminal mounts (Junit).
4 Terminals (A., E., LS–., LS+.) (Belling-Lee).
1 G.B. Battery clip (Lisenin).
1 Pair panel brackets (Burne-Jones).
1 Metal screen (S.G.P. Master Three) (Colvern).
1 Fixed condenser (.01 mfd.) (Mullard).
1 Mansbridge type condenser (.25 mfd.) (T.C.C.).
2 Spade terminals (one red and one black) (Lisenin).
7 Wander plugs (four red and three black) (Lisenin).
3 Radio receiving valves (Mullard).
1 Set of Master Three connecting links (Junit).
Quantity of red and black flex.
11 ¾″ No. 4; 21 ⅜″ No. 4 round head wood screws.

Specified Mullard P.M. Radio Valves

With two volt low tension accumulator:

V.1. Screened-grid high-frequency amplifying valve—Mullard P.M.12.
V.2. Special Detector—Mullard P.M.2D.X.
V.3. Pentone low-frequency amplifying valve—P.M.22.

With four volt low tension accumulator:

V.1. Screened-grid high-frequency amplifying valve—Mullard P.M.14.
V.2. Special detector—Mullard P.M.4D.X.
V.3. Pentone low-frequency amplifying valve—Mullard P.M.24.

Suggested Accessories

1 Speaker (Type H.) (Mullard) or
1 Speaker Unit (for de luxe cabinet) (Mullard).
1 2 volt or 4 volt low tension accumulator (Exide).
1 H.T. supply unit (Mullard) or
1 Super capacity high tension battery (Types 924-120 volt or 1206-100 volt) (Siemens).
1 G.B. battery (16 volts) (Type G.3) (Siemens).

Grid Bias Values

G.B.+ (Battery Lead No. 6.) Connect to G.B.1½; this is the second socket at the positive end of the G.B. battery.

G.B.1 (Battery Lead No. 7.) For leaky-grid rectification connect to G.B.+; this is the first socket at the positive end of the G.B. battery. For anode-bend rectification connect to G.B. 6 to 9 volts negative, according to anode voltage, remarks concerning which are given below.

G.B.2 (Battery Lead No. 8.) 9 to 15 volts negative. Extreme care should always be exercised when adjusting grid bias values.

High Tension Values*

H.T.+1 (Battery Lead No. 3) feeding screening grid of screened-grid valve V.1. With 100 volts positive applied to H.T.+3:—66 volts positive; with 120 volts positive applied to H.T.+3:—75 volts positive; with 150 volts positive applied to H.T.+:—80 to 90 volts positive.

H.T.+2 (Battery Lead No. 4) feeding anode of detector valve V.2.

With Battery Lead No. 7 connected to 1½ volts positive of G.B. battery:—60 volts positive; thus connected rectification is obtained by the leaky-grid system. With Battery Lead No. 7 connected to 6 to 9 volts negative of G.B. Battery:—90 to 120 volts positive. (Anode bend rectification.)

H.T.+3 (Battery Lead No. 5) feeding the anode of the screened-grid valve V.1, the anode of the Pentone V.3 and also the screening high potential grid of the Pentone V.3:—100 to 150 volts positive.

*For a receiver of the type described, the use of a P.M. H.T. Supply Unit is recommended wherever possible. Quite apart from the fact that a constant supply is always available and that the frequent renewal of high tension batteries is done away with, really useful voltages are obtainable. For the Mullard S.G.P. Master Three, Battery Lead No. 3 (H.T. + 1) would be taken to Tapping No. 2; Battery Lead No. 4 (H.T.+2) would also be connected to No. 2, while Battery Lead No. 5 (H.T. + 3) would be taken to Tapping No. 4 of the H.T. Supply Unit. Grid Bias values in this case would be Battery Lead No. 7 (G.B.1) in socket 7½ volts (anode bend) or + (leaky grid), and Battery Lead No. 8 (G.B. 2) in socket 12 volts.

* * *

MANY readers with a Mullard Super-power Valve in their possession may appreciate the following points, in the event of wishing to make use of it in the output stage of the Mullard S.G.P. Master Three.

With a two-volt accumulator;

For V3 ... a Mullard P.M. 252

With a four-volt accumulator;

For V3 ... a Mullard P.M. 254

With a six-volt accumulator;

For V3 ... a Mullard P.M. 256

The employment of either of these valves does away with the necessity for the flying lead (Wire No. 17). Battery Lead number 5 (H.T.+3) is connected as for the Mullard Pentone. Battery Lead number 8 (G.B. 2) with 150 volts high tension requires to be connected to 22 volts negative. In this case it will be necessary to connect in series with the specified grid-bias battery an additional 9 volt G.B. battery.

Converting the Mullard Nelson P.M. de Luxe to utilise a Mullard Screened-grid Valve.

Numerous readers have requested us from time to time to give them instructions to convert this very popular Mullard receiver to embody a Mullard P.M. Screened-grid Valve. As originally published in the September (1927) issue of "Radio for the Million," the high-frequency stage was designed round a three-electrode Mullard P.M. valve. It was neutralised.

Its popularity may be gathered from the fact that there are thousands still in use to-day. We might go as far as to say that, as many as were built are still in use, for in actuality it would be very difficult indeed to design a more efficient receiver in its class.

Small wonder that possessors of this popular receiver are rather intrigued with the idea of improving its performance by the use of a screened-grid valve in the high-frequency stage. The following alterations to the wiring become necessary.

Point to point alterations

Delete wire No. 18.

Connect wire No. 14 to terminal No. 5 of coil-holder H2 instead of terminal No. 4 (Terminal No. 5 is left free).

Remove neutralising condenser C5; also wire No. 24 and wire No. 21.

Connect flexible wire from anode terminal of screened-grid valve to terminal No. 3 of coil-holder H2.

Disconnect wire No. 17 from terminal A3 and join to terminal H.T. + 2.

Connect static screen to wire No. 2.

Six inches from the left-hand edge of the baseboard, looking at the receiver from the front, a static screen divides the high-frequency stage from the succeeding detector and low-frequency stages. This screen may be cut from a piece of 22 gauge sheet copper. The illustration on page 25 conveys the idea. This screen is 6¼ ins. from front to back and 6 ins. from the baseboard to the top. When purchasing the metal allow an extra half-an-inch on each of these measurements. The bottom edge and the front edge should be turned at right angles to allow the screen to be rigidly fixed to the baseboard.

A small hole should be drilled in this screen through which to pass the flexible lead from the anode of the screened-grid valve. It is advised that this hole be bushed with a short piece of ebonite tube, or alternatively that the lead be covered with insulating sleeving, as any short circuit between this flexible lead and the screen, will result in the valves being damaged by the high tension thus put across the filaments.

It will be noted that the high-tension supply to the anode of the S.G. valve is by means of the lead from H.T.+ 1. The feed for the screen is by means of H.T.+ 2. This latter should be connected to 80 volts positive approximately, while H.T. + 1—the former—should be taken to 120 to 150 volts positive. Bear in mind that the high-tension must not be excessive for H.T. + 2. Its value is rather on the critical side if maximum results are to be obtained from the receiver. With a value too high or too low the valve becomes inoperative.

Combined-wave model concluded from page 23.

positioned as they are in the interchangeable coil model. There should be no difficulty, therefore, in assembling the receiver, if as much use as possible is made of the Plan of Assembly. The placing of the coils is made clear by the illustrations accompanying these notes.

The aerial coil is fixed into position with terminals numbered six, one and two to the back, leaving terminals numbered three, four and five nearer the panel.

Terminal No. 4 is taken to the fixed vanes of variable condenser C1 and to the grid of the screened-grid valve V1.

Terminal No. 5 is connected to the base of the metal screen.

Terminal No. 3 is left free.

Terminals Nos. six, one and two are aerial tappings.

The high-frequency or anode coil is placed with terminals numbered six, one and two at the back, and with terminals numbered three, four and five nearer the panel.

Terminal No. 3 is connected to the fixed vanes of the reaction condenser C3.

Terminal No. 4 is taken to the fixed vanes of the variable condenser C2.

Terminal No. 5 is left free.

Terminal No. 2 is connected to the further terminal of the H.F. choke, H.F.C.

Terminal No. 1 is left free.

Terminal No. 6 is connected to the left hand terminal on fixed condenser C5.

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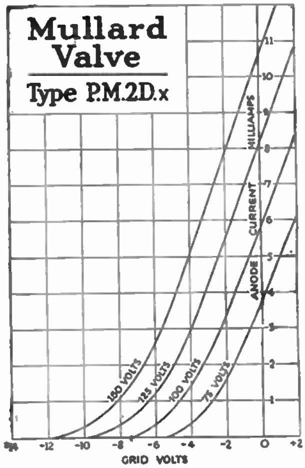
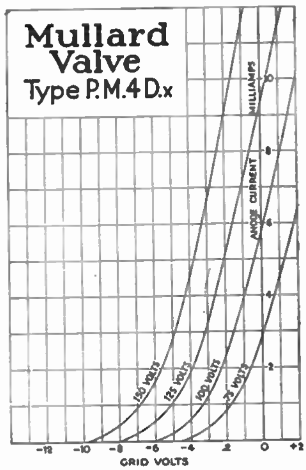


Max. Filament Voltage	...	2.0 volts.
Filament Current ...	...	0.25 amp.
Max. Anode Voltage	...	150 volts.
*Anode Impedance...	...	10,700 ohms.
*Amplification Factor	...	13.5
*Mutual Conductance	...	1.25 mA/Volt

*At Anode Volts 100, Grid Volts Zero.



Max. Filament Voltage	...	4.0 volts.
Filament Current ...	...	0.1 amp.
Max. Anode Voltage	...	150 volts.
*Anode Impedence...	...	7,500 ohms.
*Amplification Factor	...	15
*Mutual Conductance	...	2.0 mA/Volt.

* At Anode Volts 100, Grid Volts Zero.

Newcastle Test Report concluded from page 15

The leaky-grid method introduces considerable damping into the circuit, which directly affects selectivity. All damping on the H.F. side affects the performance of a receiver whether it is due to H.F. resistance in coils or to the small positive grid current present with leaky-grid rectification. These losses flatten the tuning curve, making it more difficult to cut out unwanted transmissions. That this particular correspondent did not find anode bend preferable on the score of selectivity may have been due to insufficient high tension voltage on H.T.+ 2 or to an incorrect choice of grid bias value on G.B. 1. For example, sixty miles from 5XX it is possible with anode bend to receive Eiffel Tower without interference from the British long wave station. Reversion to leaky-grid proved that it was a less selective arrangement, as it was then not possible to separate these two nearby and powerful transmissions.

There is much less damping with anode bend. It very often happens that a receiver is stable with leaky grid but decidedly unstable with anode bend; proof positive. Mark the point, that it is a little tricky to handle at first, precisely for the reason that it is a more selective system. Therefore persevere with it.

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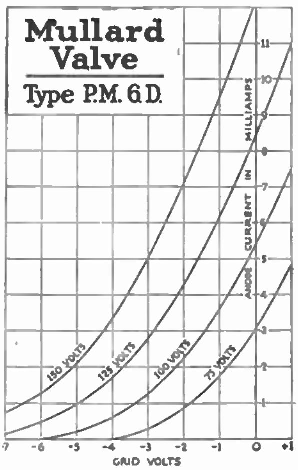
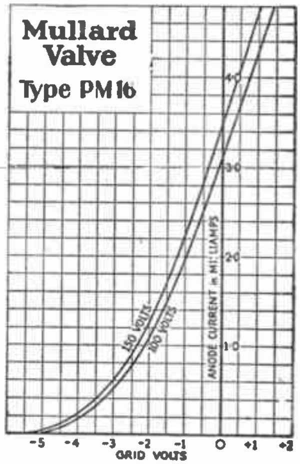


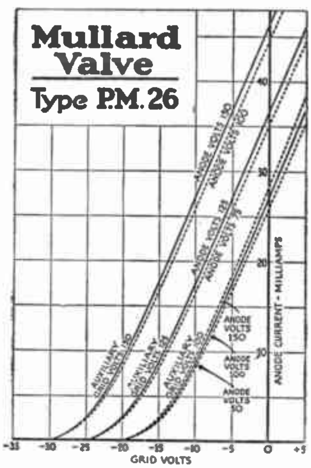
Max. Filament Voltage	...	6.0 volts.
Filament Current ...	...	0.1 amp.
Max. Anode Voltage	...	150 volts.
*Anode Impedance ...	...	9,000 ohms.
*Amplification Factor...	...	18
*Mutual Conductance...	...	2.0 mA/Volt.

* At Anode Volts 100, Grid Volts Zero.



Max. Filament Voltage	...	6.0 volts.
Filament Current ...	...	0.075 amp.
Max. Anode Voltage	...	150 volts.
Screen Volts	...	75 volts.
*Anode Impedance ...		200,000 ohms.
*Amplification Factor...	...	200
*Mutual Conductance...	...	1.0 mA/Volt.

* At Anode Volts 100, Screen Volts 75, Grid Volts Zero.



Max. Filament Voltage	...	6.0 volts.
Filament Current ...	...	0.17 amp.
Max. Anode Voltage	...	150 volts.
Auxiliary Grid Voltage	...	As HT+
*Anode Impedance ...	...	25,000 ohms.
*Amplification Factor...	...	50
*Mutual Conductance...	...	2.0 mA/Volt.

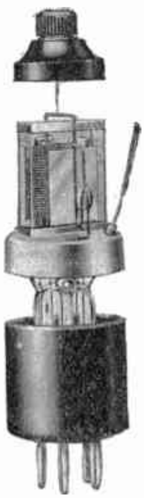
* At Anode Volts 100, Grid Volts Zero.

THE MULLARD P.M. SCREENED-GRID HIGH-FREQUENCY VALVE

VERY great interest has been centred upon the screened-grid valve for the past year or more by those radio enthusiasts who wish their radio sets to keep apace with modern valve development. Much has been said about this type of valve and with much enthusiasm. It will be seen that these valves have very high amplification factors and very high anode impedances.

High anode impedance

As the designers of valves increased the amplification factors, it was found that the impedance did not rise in proportion. A valve with an amplification factor of 20 say, could have an impedance round about 30,000. Double this amplification factor and the impedance will have increased to 100,000. As the amplification was increased higher, it was found that the impedance rose still higher.



It was discovered that by interposing a second grid between the normal grid and the anode and maintaining this at a fairly high steady potential, the impedance of the valve could be kept within workable limits and the amplification factor greatly increased.

This extra electrode also has the advantage of minimising the capacity feed-back which usually exists between the input and output circuits of a valve.

The actual amplification to be gained from the valve depends upon the ratio of the anode circuit effective impedance of the anode circuit to the internal resistance of the valve. With the recommended arrangement of tuned-anode, it is possible to design the anode circuit to have an impedance of 125,000 ohms, and it may be said that the higher the impedance in the anode circuit the more efficient the system.

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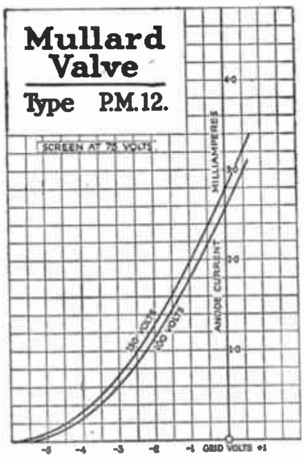
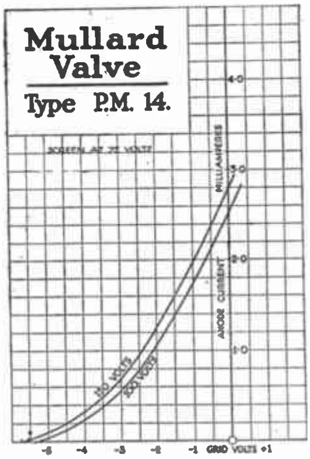


Max. Filament Voltage ...	...	2.0
Filament Current (amps.)	...	0.15
Max. Anode Voltage ...	...	150
Positive Screen Voltage	...	75
*Anode Impedance (ohms)	...	230,000
*Amplification Factor ...	...	200
*Mutual Conductance ...	...	0.87

*At Anode Volts 100, Screen Volts 75, Grid Volts Zero.



Max. Filament Voltage	...	4.0
Filament Current (amps.)	...	0.075
Max. Anode Voltage ...	...	150
Positive Screen Voltage	...	75
*Anode Impedance (ohms)	...	230,000
*Amplification Factor ...	...	200
*Mutual Conductance ...	...	0.87

*At Anode Volts 100, Screen Volts 75, Grid Volts Zero.

THE MULLARD P.M. PENTONE VALVE

THE Pentone is a development of the screened-grid valve. In this latter valve we had four electrodes—a filament, a control grid, an anode and a screening grid. The third grid in the Pentone is to prevent the screening grid robbing the anode of its current at periods when, during voltage swings, the plate potential will fall below the steady screened-grid potential. Under such conditions the current of the screen would rise at the expense of the plate current. The interposition of the third grid, or more correctly, the fifth electrode, avoids this and allows the screening grid to be maintained at a high steady potential to give a high anode current without the plate being robbed of its current.

Were these electrodes connected together internally, we should have a very peculiar arrangement, which certainly would not function as it is intended to do. The amplification factor of the valve would drop and in a way we should then have something very similar to a three-electrode valve with super-power valve characteristics. *The same voltage should be fed to the auxiliary grid as to anode.*

It is essentially a small input valve. Its high magnification provides the large output. With the normal high-tension current available, let us suggest 100 volts, its grid base is 12 volts. Operating with the same H.T., the grid base of a P.M.2 is 15. This suggests that it is not practical to use a Mullard P.M. Pentone Valve in a two stage low-frequency amplifier. It cannot be used in the first L.F. stage owing to its output characteristics. It is not suitable for use in the second L.F. stage owing to its limited grid swing, being essentially a valve for use in a single stage L.F. amplifier.

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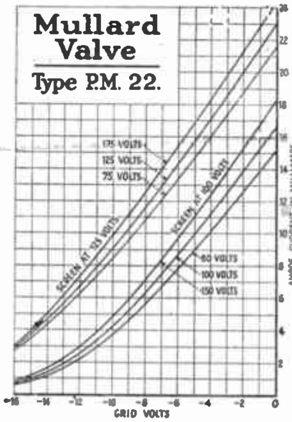
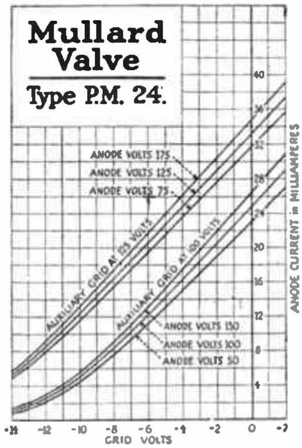


Max. Filament Voltage	...	2.0 volts.
Filament current ...	...	0.3 amp.
Max. Anode Voltage	...	150 volts.
Auxiliary Grid Voltage	...	As H.T. +
*Anode Impedance...	...	62,500 ohms.
*Amplification Factor	...	82
*Mutual Conductance	...	1.3 mA/Volts

*At Anode Volts 100, Grid Volts Zero, Auxiliary Grid Volts 100.



Max. Filament Voltage	...	4.0 volts.
Filament Current ...	...	0.15 amp.
Max. Anode Voltage	...	150 volts.
Auxiliary Grid Voltage	...	As H.T. +
*Anode Impedance...	...	28,600 ohms.
*Amplification Factor	...	62
*Mutual Conductance	...	2.3 mA/Volts

*At Anode Volts 100, Grid Volts Zero, Auxiliary Grid Volts 100.

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THE RADIO OWNER'S MAGAZINE

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