Construction Continued

(Continued from page 14.)

It was then found that instead of chokes wire-bound resistances could be used. These are much cheaper than chokes, and fulfil not only the same function of preventing back-coupling and giving results equivalent to a separate battery for each valve, but also provide a means of evenly exhausting the whole B accumulator. And it is claimed that with this system "motor-boating" cannot occur, and the amplification is as great as in the case of feeding each plate from a separate B battery.

EVERY receiver with audio stages fed from the same B battery is liable to produce a change in waveform and amplification characteristic due to interaction, of which interesting curves have been published taken by means of the oscillograph, a piece of apparatus that traces out and records the form of either high or low-frequency waves. One of these curves shows the audio wave of high amplitude, and running through the centre is a high-frequency ripple that should not be there, and which would cause a shrill whistle in the loud-speaker.

LOW-FREQUENCY oscillation is a fault that is difficult to remedy, especially as it is sometimes evident as an oscillation above audibility which creates an unpleasant form of distortion. The principle of interposing suitable resistances in each plate lead is of some importance, and when properly appreciated is likely to become widely adopted. A variable resistance included in series will allow of fine adjustment, much as is the practice upon B eliminators in which there is not a continuous resistance (potential divider) with tappings, extending from positive to negative.

R.F. VERSUS A.F.

QUITE likely a large number of listeners have an idea that audio amplification gives a greater increase than radio amplification per stage. But this conception probably arises from the fact that almost every receiver incorporates one or two stages of audio amplification. This, for the reason that audio is so easily added, and its effect assured with minimum trouble. Nevertheless, it is a fact that R.F. amplification gives the greater increase in signals. The power into the loudspeaker is proportional to the square of the voltage on the grid of the power tube and the output of the detector is proportional to the square of the voltage on its grid. Voltage on the grid, it should be explained, means signal voltage only, and is in no way connected with battery voltage.

WHEN the A.F. amplification is multiplied by 10, for example, the power into the loudspeaker is 100 times greater, but when the R.F. amplification is multiplied by 10, the detector output is 100 times greater and the power into the loudspeaker is 10,000 times greater. The following table shows the comparative increase produced by the two methods of amplification:—

Added Amplification	Increase in Speaker. R.F.	A.F.
2	16	4
5	625	25
10	10,000	100
20	160,000	400
50	6,250,000	2500

But in spite of these figures, the audio side of a receiver forms a handy means of building up large output after detection, so that the detector is not called upon to carry heavy volume as would be the case with only one or no audio stages. A single audio stage is sometimes adopted in order to avoid troublesome, unwanted interstage couplings causing loss of quality.

IN CONCLUSION.

IT is scarcely safe to mention "distortion" nowadays, for after an article such as the above has appeared, one or two letters are sure to arrive from individuals who erroneously take it as an attempt to lay the blame for all distortion upon every receiver. Such an idea is far from the intention of the writer at all times, and it is his firm resolve to continue with these articles so long as they appear to be helpful to a majority of constructors. One individual classed them as contentious matter that should be excluded from the paper! In constructional writing the question of how the signals arrive at the aerial, and the condition in which they arrive has little bearing on the case. The constructor builds and improves his receiver so that signals will be as efficiently handled as possible, so that the quality of good signals will be preserved, and the bad quality of others not made any worse than necessary.

A Chat on Crystal Chemistry

HOW CHEMICAL COMPOSITIONS INFLUENCE RECTIFICATION

WHEN one begins to consider the number of different forms of crystalline minerals which exist in various quarters of the world, one is often struck by the relatively small proportion of these naturally occurring minerals which are of any practical use for the purpose of radio rectification.

Apart from its crystalline nature and physical form, therefore, it follows from the above observation that a mineral, to be an efficient rectifier, must possess another quality, that of partial electrical conduction. A crystal of rock salt or of quartz (silica) is a tolerably good insulator, and it is also a non-rectifier. A diamond is also a non-conductor and a non-rectifier, but, at the same time, it forms an extremely well-defined crystal.

At the other end of the scale we find substances which are very good conductors of electricity, but which, at the same time, do not possess any rectifying powers. Such materials may be looked for among all the true metals, their alloys, and one or two of their pseudo-metallic compounds.

WELL-KNOWN GROUP OF CRYSTALS.

IT will thus be evident that a crystalline substance must be intermediate in character between a conductor and a non-conductor if it is to be used as a rectifier of R.F. currents, and, in fact, practically all of the mineral rectifiers which have been found to be of any use at all conform to the above provision.

There are a few rectifying materials which are elementary in nature. That is to say, they are composed entirely of a material which cannot be split up into any simpler forms of matter by the ordinary means of chemical analysis. Such rectifiers are Silicon, Tellurium, Arsenic, and Graphite. The first three of this list are in nature and general characteristics half-way between a metal and a non-metal, and they are generally referred to as "metalloids." With the exception of graphite, which is a good conductor, these elementary rectifying substances are poor conductors. They offer considerable resistance to the passage of direct current, but yet they are capable of producing good rectification.

The other rectifying minerals which are in use for wireless purposes are almost entirely confined to the sulphide and oxide class of chemical compounds, although there are a few other rectifiers besides these which can be used satisfactorily, and which we will deal with later on in this article.

The sulphides of metals form the most widely-used class of mineral rectifiers. If you have a piece of crystal whose composition is unknown to you, you may wager quite a considerable amount that it is composed of a metallic sulphide. Of course, it may not have such a composition, but the chances are that it will contain sulphur in some form or other.

A sulphide, of course, is a compound which is formed by the direct union of sulphur and a metal. Thus, for instance, if we heat a few pieces of scrap copper to redness and then throw a quantity of flowers of sulphur over the metal, combination between the two elements will take place. The metal will glow almost to white-heat, and a blackish mass of copper sulphide will remain.

A LIST of the sulphide rectifiers which are used for wireless purposes will be seen in Table I. It will be seen that Galena, the basic material of all the proprietary "ites," is included in the category of sulphide rectifiers.

Now, just as sulphur can combine with metals to form sulphides, tellurium and arsenic are able to enter into a similar combination with metals with the formation of tellurides and arsenides. Many of these latter compounds behave as efficient rectifiers, Hessite, a telluride of silver, is about the best-known mineral of this class, and Niccolite, or nickel arsenide, is another example of this category of minerals.

From the table it will also be seen that the "pyrites" minerals are all sulphides. Some of them are complex sulphides containing more than one kind of metal in their composition. Thus it will be seen that whilst galena, molybdenite, and iron pyrites contain only one metal, minerals such as copper pyrites, Bornite, and Bournonite contain two or three different metals in each case.

It is interesting to note that Argentite, a sulphide of silver very similar in general type of composition to galena, is, to all intents and purposes, a complete non-rectifier, but, nevertheless, when a small proportion of this mineral is fused with galena it is able to increase the sensitive properties of the latter mineral. Most samples of argentite have a very much lower electrical resistance than galena, and probably this fact may account in some way for their non-rectifying properties.

THE OXIDE GROUP.

PASSING on to the oxide group of minerals which are able to act as radio rectifiers, we notice from Table II that the most important member of the group is the well-known Zincite, which can be used in combination with so many other rectifying minerals.

Zincite is a naturally occurring oxide of zinc, and its ruby-red colour is imparted to it by the existence of slight traces of manganese compounds in the mineral. This trace of manganese in the mineral seems to have a lot to do with the efficiency of its recitfying powers, for zincite which has been devoid of such impurities is found to be a poor rectifier.

Mineral.	Chemical Composition.	
Galena	Lead sulphide	Single sulphides. Galena forms the basis of most proprietary crystals.
Molybdenite ..	Molybdenum sulphide	
Covelitte	Copper sulphide	
Stibnite	Antimony sulphide	
Iron pyrites ..	Iron sulphide	
Copper pyrites	Sulphide of iron and copper	Complex or mixed sulphides
Bornite	Sulphide of iron and copper	
Bournonite ..	Sulphide of copper, antimony, and lead	
Mispickel ...	Sulphide of iron and arsenic	
Tin pyrites ...	Sulphide of copper, iron, and tin	

Table I.—The above table indicates the composition of most of the sulphide group of mineral rectifiers. Note that these minerals can be further divided into "single" and "mixed" sulphides.

METALLIC RECTIFIERS.

IRON and copper oxides have been used experimentally as rectifiers of R.F. currents under the names of Magnetite and Cuprite respectively, but owing to the varying sensitivities of different samples of these minerals they are not used with any frequency in general amateur work.

A number of oxide rectifiers which do not give very good rectification under ordinary conditions can have their rectifying powers very much increased by the application of a small local potential across the rectifying contact. Such mineral rectifiers include the two oxides of manganese, Manganite and Pyrolusite; Cassiterite, an oxide of tin; Anatase, or titanium oxide; and one or two other similar compounds.

It is the rectifying nature of many metallic oxides which is often responsible for rectification at the point

Mineral.	Chemical Composition.
Zincite	Zinc oxide (containing traces of manganese).
Magnetite .	Iron oxide (magnetic).
Cuprite	Copper oxide.
Cassiterite .	Tin oxide.
Anatase ...	Titanium oxide.
Brookite ...	
Pyrolusite .	Manganese (di)oxide.
Tellurite ..	Tellurium oxide.
Ilmenite ...	Oxide of iron and titanium.

Table II.—Indicating the composition of a number of materials which may be included in the oxide category of rectifiers. A large number of other metallic oxides will produce rectification, but only when they are present in very thin films on the surface of their constituent metals. The above, however, are able to rectify in their mass condition.

of contact of two metals. For instance, if a strip of clean metallic copper is placed for a minute or two in the flame of a spirit lamp and then withdrawn and allowed to cool, its surface will be covered with a film of tarnish consisting, for the most part, of oxide of copper. Such a strip of copper will give good rectification when an extremely light contact is made with it either with an ordinary fine cat's-whisker or with a fragment of zincite. A few experiments of this nature, using different varieties of metals and alloys, will be of interest to the amateur should he be keen on the fascinating subject of crystal rectification. An explanation similar to the one given above accounts for the often surprising phenomenon of "rectification by means of the crystal cup alone." In these cases, the crystal cup has become slightly tarnished, and its film of oxide has such a physical form that it is able to display strong rectifying properties.

The last type of rectifier which we have to deal with in our brief survey of the chemistry of crystals is the compound carborundum. Carborundum has the honour of being the first rectifier to be employed for any practical purposes in radio reception, and its use in this direction dates back to the year 1906, when it was brought into service by General Dunwoody, of the United States Army.

Carborundum is really a compound of two elements, carbon and silicon, both of which are rectifiers. The substance is thus silicon carbide, or, as some prefer to call it, a carbon silicide. Both names, however, mean the same thing.

Carborundum and also silicon are the only commonly used rectifying materials which are not found in Nature, and which have to be produced artificially. Carborundum, as is well known, requires a local potential for its proper functioning, but, all the same, it can be used without the application of such a potential if the material is of good rectifying quality to begin with.

ORGANIC CRYSTALS.

THE whole range of mineral rectifying substances may thus be divided up into a few classes: the elementary class, the sulphide class, and the oxide class. Apart from a few exceptions to this classification, such as carborundum (silicon carbide) and one or two other little-known materials, all the crystal rectifying substances are contained in the above categories.

Experiments have been made with a view to producing well-defined crystals of an organic nature which contain metallic atoms in their composition and which would be suitable for rectifying purposes. Such experiments appear to have proved fruitless up to the present time, but they represent an interesting line of research, and doubtless, at some future date, they may provide the crystallographer and scientist generally with much interesting data of a theoretical and a practically applicable nature.

THE LISTENERS' GUIDE

SPECIAL INTEREST TO CONSTRUCTORS

CONSTRUCTORS and experimenters will find the "Listeners' Guide" extremely handy for general reference for lists of New Zealand, Australian, American and Canadian stations, with power and wave-lengths, short-wave stations, and a wide range of other information.

Of special interest to constructors there is a list of practically all valves on the New Zealand market, showing at a glance their main characteristics and the positions in the set for which each valve is best suited. There is also a table giving the necessary grid-bias for any valve likely to be used in audio stages.

ANOTHER useful list is that of rectifying valves that are sold without the stipulation that the purchaser must be in possession of the charger for which they are designed. Valves for B battery eliminators and A battery charging are also included, full particulars of all the rectifiers being given.

OTHER tables include winding of solenoids for given wave-length; turns for spider-web coils to tune with condensers of different capacities; turns for secondary coils tuned with condensers of various capacities; tables for making fixed mica condensers of capacities from .5 mfd. down to .00015; wire tables; list of amateur transmitters, etc.

CONSTRUCTIVE articles include crystal receivers, with the "R.R." Selective Crystal Receiver, which so many constructors have found highly successful, and which makes a highly effective wave-trap. Then there are two amplifiers for the crystal, a one- and a two-valve.

The ever-popular four-valve Browning-Drake is fully dealt with, including the amplifying for which inquiries are coming to hand in connection with the two R.F. tuning unit. The "Record" short-wave receiver is fully described, both as a complete shielded three-valve receiver, and as a one-valve "converter" or "adapter," which can be plugged into the detector socket of any broadcast receiver and thus use the audio amplifier to increase the volume of the short-wave reception.

Other information includes the Government regulations relating to wireless listeners, a handy glossary of radio terms, etc.

The "Guide" can be obtained from your dealer for 2s. 6d., or 2s. 9d. posted from the "Record" office.