

Crystal Grinding for the Novice G.J.Bennett G3DNF

Why use crystals for the HF and LF bands? Many have asked themselves this question and decided not to. Crystals made to order were never cheap and the supply of surplus ones for the amateur bands has dried up. Anyway, it is now so easy to build a rock steady VFO that the advantage of crystal control may not be so apparent.

However, there are circumstances in which crystals are better than a VFO. For portable or /A operation the use of crystals avoids the need to carry a crystal calibrator. The easiest way to get started with CW on the amateur bands is by building a CO/PA transmitter.

Although there is no longer a good supply of surplus crystals for the amateur bands, there are still plenty of cheap "useless frequency" crystals available outside the amateur bands and it is possible to make use of some of these by regrinding them. This is often shrugged off as "too difficult" or "time consuming". In fact, very little practice is needed to master the basic skills required. It is the purpose of this article to pass on to the beginner as much information as is needed to make the first attempt. The writer cannot claim to have superior knowledge or skill, except that gained the hard way, by experience. Like most basic skills, it is easier to show than to convey in writing, but let's see what can be done.

First, it is obvious that crystals mounted in hermetically sealed cans are not suitable for grinding. The old styles of mounting (in use up to the fifties) such as FT243, 10X and 10XJ permit the removal of the crystal plate. In these mountings the crystal is sandwiched between two metal plates, each of which has a raised area at the corners (for square or rectangular plate) or around the edge (circular plate) see Fig 1. N.B. Some of the later HF crystals in the 10X guise are actually constructed like the hermetically sealed types, with electrodes plated onto the quartz plate. These should be avoided; they are much lighter in weight than the usual 10X package.

For a beginner, the best plan is to start with a fairly large, easily handled plate. Typically this should be a 10X type with a frequency of about 3000KHz, for regrinding to the 80 metre band. Such a crystal will be about one inch square and one sixteenth of an inch thick.

The equipment needed is as follows:-

- Carborundum Powder (two grades - see note below)
- Paper Tissues (toilet, kitchen or handkerchief types)
- Saucer or shallow dish, and a glass plate
- Screwdriver
- Test Oscillator (see Fig 2)
- Amateur band or general coverage receiver
- Tube of Toothpaste
- Add water, patience, and off we go...!

Using a test oscillator, check that the crystal oscillates and note the frequency. Some old crystals are inactive but in most cases this can be cured. Open up the crystal holder over a tray or cloth, so as not to lose the parts. Withdraw or unscrew the spring tensioner and gently tip out the metal plates and quartz sandwich onto a tissue. Examine all parts for traces of dirt or corrosion.

To clean the quartz and metal plates, rub them gently between the finger and thumb with a little toothpaste and water. Rinse well with water, blot with a tissue, allow to dry in warm air and re-assemble. Check the frequency and activity again. This treatment will often make a "dead" crystal come to life again. Note that

toothpaste (the white kind) is used instead of carbon tetrachloride which is toxic and less effective as a general cleaning agent where plain dirt, as distinct from grease, is concerned. Avoid fingering the quartz plate during the drying and re-assembly. Hold it by the corners, between finger and thumb, or use plastic tweezers (see Fig 3).

Two types of carborundum powder are required for this operation. Fine grit (often referred to as carborundum flour) and medium grit. Both are easily obtainable in small quantities by purchasing a beginners' rock polishing kit. This will contain a few pieces of rock (real rock!) and four tubs of powder (coarse, medium, fine and polishing powder). These kits can be bought for less than £1 at many hobbies shops. Only the medium and fine carborundum will be required.

Place the glass plate on a steady table. Put some water in the saucer and stand it near the plate. Sprinkle a good pinch of medium carborundum in the centre of the plate and add a few drops of water, enough to make the powder swim but do not drown it. Work the paste out to a patch about three inches wide with the finger before placing the crystal on it.

Throughout the grinding, use a steady pace and even pressure. Never grind for too long without shifting the area of pressure on the crystal. Remember the aim is to obtain perfectly plane and parallel faces. Use the tips of the index and middle fingers to apply the pressure when dealing with the larger crystals such as the LF 10X types.

The first few strokes will break down the grit a great deal, so just give a couple of rubs, clockwise, with the finger tips on the diagonal AC (see Fig 4). Next, reverse the direction and give a couple of strokes anti-clockwise. Now turn the crystal through 90°, shifting it to the diagonal BD. Repeat two strokes each way and turn another 90° and repeat, turn again and repeat, until the crystal has had a total of 16 rubs, evenly distributed on one side. Now turn the crystal over and repeat the above procedure. Rinse the crystal in the saucer, wash it well in running water, then allow surplus water to drain off, while holding it by its corner (Fig 3). Carefully blot with a tissue then dry it in warm air or under a lamp.

Remount the crystal into the holder and check the frequency. It may not have moved far, but the change should be measurable. The grinding can now continue using more strokes, say ten each way. The only way to judge is to measure the result. Never let the grinding bed become too dry. Add more grit as required. If too much water is added it slows down the cutting rate of the paste. Keep the grinding track well distributed over the glass plate by working the tracks in overlapping circles (Fig 5). The grinding process also removes glass from the surface; avoiding local wear will improve the chances of a properly ground crystal.

Check the progress at intervals and take care not to overshoot the target frequency. When the crystal approaches the target, say 3400 for a target of 3500, stop using medium grit. Wash the plate clean and turn it over. Use the fresh surface to continue grinding with fine carborundum. The cutting rate will be slower, but easier to control. As the target frequency is approached, check more often. With practice, it is possible to grind to within 1KHz or better.

The grinding of a crystal from 6500 to 7000KHz is also feasible. Such crystals are only about half the size of the example described above; it following that the grinding of the thin quartz requires more care. Use only fine grade powder and apply pressure with the tip of the forefinger. The final stages are tricky, as a single rub can make a difference of 1KHz. It is a matter of fact that the grinding of a crystal causes microscopic surface damage, which can affect long-term stability. For this reason commercial crystals are etched to the final frequency after grinding. Etching entails the use of dangerous chemicals and should not be undertaken lightly. Even without etching, crystals which have been ground are quite

satisfactory for amateur use. Occasionally, a crystal ground to a spot frequency "settles down" after a few months to a slightly different frequency (say 1KHz in 7000). This is unlikely to be a matter of concern in a CO/PA transmitter but, for a filter or SSB oscillator, it must be etched to final frequency and that is a different story.

If reasonable care is taken over grinding, the chances of success are high. A crystal that fails to perk after grinding can often be restored by the "toothpaste treatment", but little can be done for badly ground or scratched crystals which fail to oscillate or behave properly. Corrective grinding is difficult and is likely to take the crystal out of the target band. It is far better not to spoil the crystal in the grinding; the temptation to hurry must be resisted.

The first attempt will take longer than the rest. With practice, several crystals can be ground in an evening. Forget any ideas of relaxing after such a performance by doing a bit of snappy CW. Your hand will feel as though it has been through the wringer! A more domestic hazard can arise through sloppy disposal of waste carborundum. It can play havoc with the glaze on a wash basin if traces are left for someone else to clean off. Pouring it through a waste disposal unit will also prove expensive.

The economically minded can recover some of the carborundum by washing the spent paste, but the stuff is so cheap that it is hardly worthwhile. In any event, at all costs keep the grades of grit separate. If the fine grade becomes even slightly contaminated with the coarse it will be ruined. When it is intended to grind several crystals it is better to grind them all with the coarse grit first, then transfer to the fine grit.

