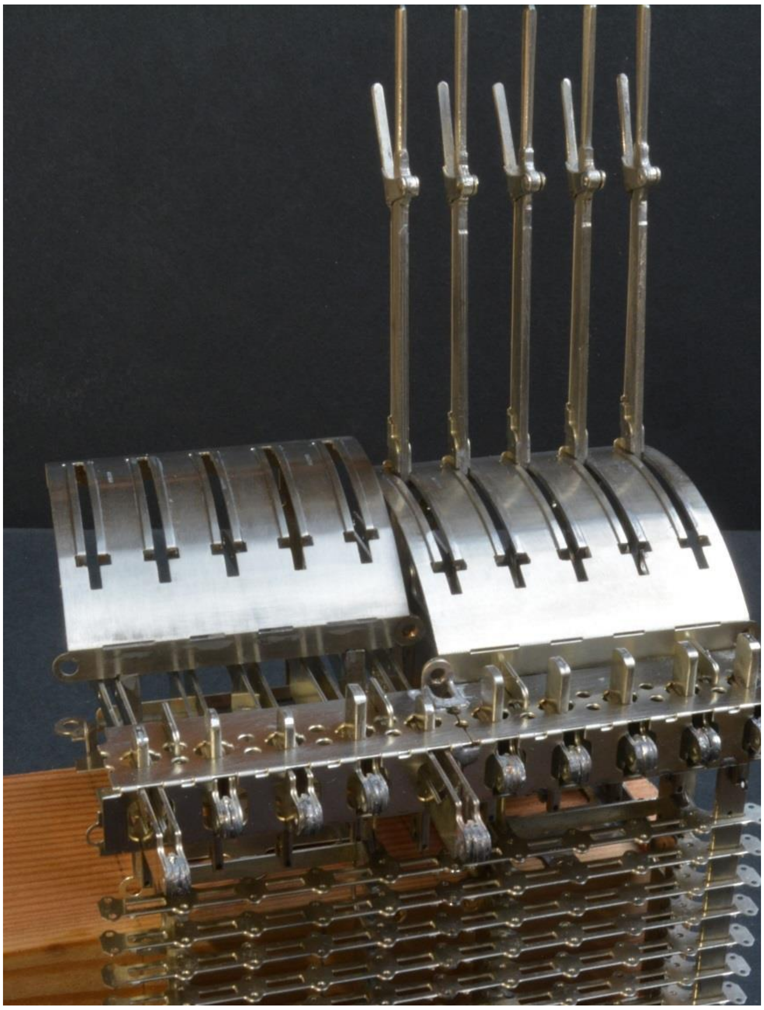
4 bar VT Interlocking
To fit the Scalefour Society
Mk II Lever Frame*

Assembly guidance notes

- **May also (with some additional work) be fitted to the previous SHAG design of frame**



A 10-lever frame being assembled with the optional mechanical locking

4 Bar VT Locking Assembly Guidance

General

The mechanical interlocking of lever frames is quite an involved technical subject which this assembly guide does not seek to address: rather, the builder is assumed to have a basic understanding of how locking works and is designed and sources are suggested to assist builders to this end. This guide therefore does not contain any guidance on the design of the interlocking and restricts itself purely to the building of the locking mechanism.

These guidance notes have been prepared to help builders avoid some non-obvious pitfalls. Although they may not represent the ultimate, the method described has been developed based on a fair bit of assembly experience and it is suggested that builders follow this method until they have built many frames and might thereby be in a position to spot improvements. The notes provide guidance on what might go wrong and how to minimize the risk whilst creating a result which is accurate and robust.

Metalwork

Success in making a smooth-functioning locking mechanism does depend of achieving a reasonable standard of finish and fit which in turn requires a reasonable standard of basic metal working skills, such as filing drilling and sawing. Moreover, there is a fair amount of it, and for the benefit of those less experienced in metalwork, guidance will be given. Most builders will have previous experience of "etched kits" though the gauge of the metal and the size of the parts in this make for quite a different set of challenges.

The locking mechanism is etched in 0.7mm thick nickel silver and the etch-cusp in metal of this thickness is quite prominent. Moreover, we are pushing the technology of etching to and beyond its limits in using it for this purpose. There are a number of important consequences arising from this as follows:-

1. Small-diameter holes have to be etched under-sized, and often, will not be completely etched-through on the frets. For this reason, such holes will require to be drilled-out to the correct size, and these notes will refer to these specifically.
2. Many working parts are intended to be soldered up to double thickness to provide the necessary strength and integrity and where possible, these are etched in pairs on the fret and should be cut out as a pair and folded up for soldering. It is important to ensure that such pairs of laminations are well cleaned, folded closely together without gaps and soldered properly. As a rule, such components should not be tinned as it will increase the thickness – rather, provided they are cleaned and well fluxed, the solder with be drawn between by capillary action.
3. A number of components require to be finished to a fairly accurate size and these are etched over-size and must be filed to the finished size. Accuracy and a good standard of finish are important to the success of the finished job and guidance will be given on how best to achieve this.

Tools

It is worth mentioning that there is a fair amount of repetitive metalwork and the functioning of the finished job will be much enhanced by a good standard of finish. It is suggested that this will be made much easier with good quality tools in good condition – this is particularly true of files and to this end, a good quality 6" or 8", cut 2 (very smooth) hand file in good condition, as well as a larger, coarser file for removal of excess solder will be found very helpful. (Note:- solder will not "clog" the file if it is regularly rubbed with French Chalk but should any clogging start to occur it should be dealt with by brushing out with File Card or "File Cleaning Brush") To get a good polish, fine emery boards (600, 1000 and 1200 grit) which can easily be made up at home or purchased from suppliers, are essential.

Other tools required

Soldering

Many parts are built up from laminations soldered together to create a metal thickness of 1.4mm and for this, a soldering iron of at least 50watts is required, plus a liquid flux, and solder. 179 degree silver-bearing solder is ideal, though 188 deg. will work well though its flow characteristics are much poorer. Higher melting point solders (including "lead-free") will be very difficult to use unless a gas torch is available as a heat source and any additional strength will not be of value. The use of such solder, and the use of acidic or resin paste fluxes which often leave a sticky residue is not recommended unless you are very experienced in how to get good results with them.

Holes

0.8, 1.2, 1,4mm drill bits plus a means of turning them both by hand and power along with a set of cutting broaches for such diameters. A drill press ("pillar drill") will be found very useful for drilling holes at 90 deg to the job, although it is not essential if care is taken with a hand drill.

One very particular task is to open out the Cap Wire holes to 0.8mm. With 108 of these to do tedium can be avoided by the purchase of a couple of 0.8mm "Long Series" drill bits. These are long enough to line-drill these holes after the frame has been assembled.

Taper broaches – 0.8, 1.2, and 1.6 dia (for opening the lever holes to take 1.4mm drive pins).

A pair of decent wire cutters

If using piano wire for the lever drive pins, an abrasive cutting disk plus a suitable mini drill will be needed. Also, to clean-up the cut ends, a grinding disc (thicker than a cutting disc and suitable to take side pressure will be needed. Eye protection suitable for such tools is essential.

Means of cutting the parts from the fret. A pair of micro-snips is the best tool for such thick metal, decent ones are pricey, but a cheap pair is adequate for this job.

Basic information

Outline description

This fret is designed to fit the recently redesigned 5-lever frame also sold by the Scalefour Society which is designed for the job. The previous version of this frame, which originated with the Shropshire and Herefordshire Area Group can also be utilized, though a degree of adaptation is required in this case.

The design of the locking is based on the Great Western Railway's 5-bar Vertical Tappet locking which is extremely compact and efficient, though to simplify the building, only 4 "bars" or bridles are utilized in the miniature version. Despite this, the compactness of the design has meant that a frame of 70 levers has been successfully locked within the capacity of the basic locking of 32 channels. The "real" railway used a whole variety of terminology to describe the various parts of the locking mechanism, but the diagram illustrates the terminology which will be used in this guide.

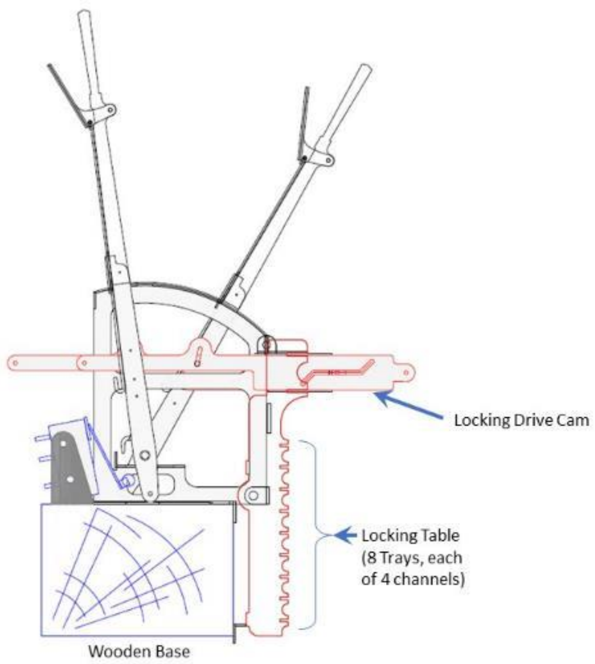
The locking embodies a number of design features as follows:-

- The interlocking can be fitted and removed from the lever frame at any time to allow for fault finding and correction. This also means that the lever frame and locking table can be built separately and assembled after all testing is complete. To this end, the design of a suitable assembly jig is suggested in this guide.
- The Tappets may be easily removed at any time for maintenance, adjustment, etc and this allows the Bridles – both front and back – also to be removed should this be necessary. Although it is hardly an easy job, this does mean that subsequent modifications to the layout can be accommodated without scrapping and rebuilding the frame.
- The design provides the capability to create all the mechanisms used on the prototype including releases, deadlocks, conditional locks, sequential locks, loose nibs, butts etc.

Capacity

The locking incorporates 8 trays each of four channels, thus at any point in the length of the frame, up to 32 individual bridles can be accommodated. In practice, this is sufficient to lock quite sizable frames – up to 60 or even 70 levers – but if this is not enough capacity for your needs, additional trays can be purchased to double the capacity. These are available to special order.

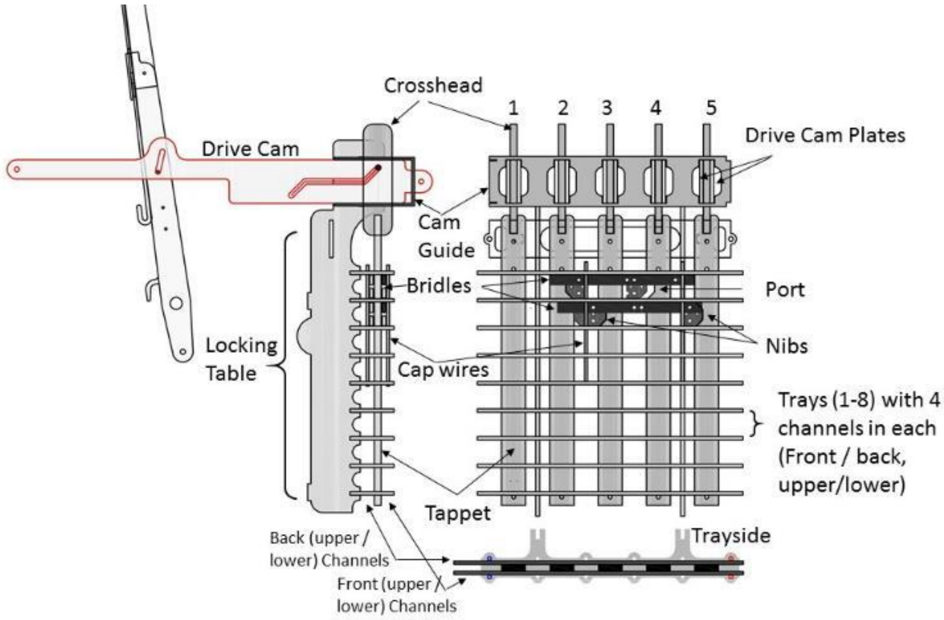
Arrangement of the frame



The diagram illustrates the lever frame with the locking attached. Note the use of a base (which may be made from wood) which supports the frame at a height suitable to give clearance for the locking. Dimensions for this are given in these notes. Wood is suggested as it allows the use of small woodscrews to attach the frame and the locking to give suitable support and for attaching the combined assembly to the layout (etc.).

The diagram shows also how the Locking Drive cams transfer the movement of the lever into a much reduced travel of the locking tappets by means of the shaped slot in the Cam Plates. Note that the tappets travel DOWNWARDS as the lever moves from Normal to Reverse. Also, the shapes of the cam is such that the first 5mm of lever travel impart 50% of the tappet's movement, the remainder resulting from the final 5mm of lever movement. This arrangement gives a very positive "lock" without necessitating an extended travel of the tappets thus greatly simplifying the design of the locking.

Locking arrangement and terminology.



This arrangement drawing illustrates the main components of the locking, and also the terminology which will be used to describe them. The individual railway and contracting companies used a variety of terms which were often inconsistent and those used here do not represent any particular practice from the full-size world.

Principle components

Locking table:-

The **Locking table** is the framework which holds everything together and comprises 8 **Trays** (numbered one to 8 from top to bottom) each capable of holding 4 locking **Channels**. Thus the entire **Table** can comprise up to 32 individual Channels – though it is unlikely all the 32 can be used at once in the same area of the table due to "Conflicts" between adjacent Trays, and the fact that some locks – for example conditional locks – take up some of the space in an adjacent tray.

Drive Cams:-

The Cams transmit the angular movement of the lever and translate it into a horizontal movement which not only provides the drive to the locking but the rear end can be used to provide a mechanical drive to "ground" equipment (points signals etc.). Each **Drive Cam** consists of two **Cam Plates** passing either side of the lever which are joined together at their fronts ends.

Crossheads:-

The **Crossheads** are constrained to move vertically and the by means of the **Drive Pin** which engages in the shaped slots in the **Cam plates**, transform the horizontal movement of the **Drive Cam** into a vertical movement to drive the **Tappets**

Tappets:-

The Tappets move vertically through a distance equal to the pitch of the Trays. By means of the **Ports** cut into them, they drive the horizontal components of the locking to provide the locking action. The Tappets are coupled to the Crossheads by means of removeable pins (for which 1/32" split pins can be used) allowing the Tappets to be disconnected and withdrawn during assembly or for maintenance (or modification…)

Nibs and **Bridles:-**

In this design of locking, all Nibs are "two way" – that is, they are formed with a 45 deg. Angle on both edges which engage in the Ports. This means that all nibs are identically shaped and any nib will fit into any port since they are also identically shaped. This simplifies the design and, more importantly the manufacture of the nibs and ports as the same template can be used for marking and shaping them all.

Nibs and **Bridles** combine to create the horizontal assemblies which communicate the locking action between the Tappets and therefore the levers. The **Nibs** are shaped to enter the Ports cut into the Tappets in such a way that the vertical movement in the **Tappet** is converted into an equal horizontal movement of the **Bridle**. There are several different designs of Nib for use in different situations. In particular, not all Nibs are affixed to bridles - these "**Loose Nibs"** are used (for example) to provide a lock or release between adjacent levers, or where they are driven by pins mounted on the bridles in such a way that two brindles can both drive the same nib, without the movement of one affecting the other. Up to four such bridles may act upon a single nib.

Cap Wires:-

The Cap Wires retain the Bridles and Nibs in place. It is by no means necessary to fit a Cap Wire in every location – it creates unnecessary friction without any benefit. Rather, the minimum number necessary to retain all the components securely is sufficient. Although the holes will accommodate wire up to 0.8mm diameter, smaller wire – say 0.5mm dia. will be found sufficient. During build and assembly, any number of "temporary" Cap Wires will be found useful.

Locking concepts – from the diagram above on Page 5

It is not intended in these notes for cover the design of the locking in detail, but a couple of examples of locks are show above to illustrate some important aspects.

The locks included in the diagram on page 5 are:-

- 2 Locks 4 (In the topmost tray - Tray 1)
- 2 Releases 3 and 5 (Tray 2)

In plain English therefore:

- Once 2 has been pulled, lever 4 is locked. If lever 4 is pulled, then lever 2 will be locked
- levers 3 and 5 are locked until lever 2 has been reversed, and once either 3 or 5 are pulled, lever 2 will remain back-locked until they are replaced.

The following important points should be noted:-

1. There is only a single Port cut in Tappet No 2. This port provides not only the 2 Locks 4 in Tray 1, but also, when lever 2 is reversed the SAME Port now provides the release for 4 and 5. This is an important design feature, which can be used to advantage where a single tappet provides both "Locks" and Releases" BUT it is important to note that this can give rise to "Conflicts" ie an unintended release can be created due to the presence of a lock in the tray above. Anyone modelling a real Great Western location, should be aware that this feature does not exist on the GW VT frames meaning that the prototype "Dog Chart" cannot simply be copied "as-is"!
2. Half of the 32 channels for locks are in the "Back" Channels ie to the rear of the tappets. This means that access to these is considerably more restricted by comparison with the "Front"

channels, and it is worth bearing this in mind when laying out the locking. That said, the tappets can easily be disconnected and removed at any time to allow access to the back-channel bridles.

Additional Materials required

- 0.7 and 0.8 mm dia straight N/S wire (for the capping irons – these are designed to be made from 0.8mm wire but where a lot of bridles are present in a particular part of the frame, 0.7mm wire may be substituted to provided additional clearance – see notes for details.)
- 1.2mm o.d. brass tube (i.d. not important) or rod.
- 1.4mm dia hard steel Piano Wire

Note: Piano Wire is extremely hard and cannot be worked with the usual hand tools - it must be cut using a carborundum cutting disc in a mini drill. It is also best soldered with a more active flux – concentrated Phosphoric Acid (Carr's "Brown") is very suitable and is very easy to use.

8BA bolts for attaching to the lever frame

1/32" split pins for attaching the bridles to the crossheads (one per lever)

Additionally, lengths of thinner wire which need not be straight and may be of any suitable material, will be found useful for temporary Cap Wires.

PLEASE NOTE:-

All 90 deg. folds are made with the Half-etched fold-line on the ***Inside***

180 Degree folds to the Tappets are made as described in these notes.

180Degree folds to the cam spacers are made with the Half-etched fold-line on the ***Inside.***

Terminology:-

Rear = side Away From the signalman. Front = side Towards the Signalman. Please refer to the General Arrangement Drawing for identification of the parts.

Building the Locking Table - Suggested build sequence

The first step is to make a long and a short tappet – see section 1 for details - as these will be used as assembly jigs to build the Locking Table

Then, build the main Locking Table, make the cam guide and tack this in place - see section 2.

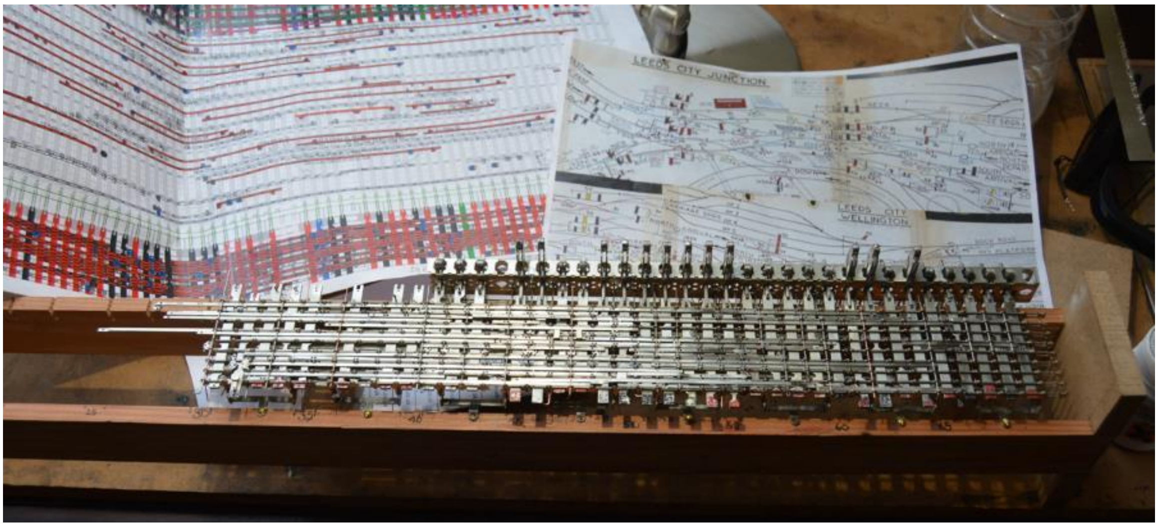
Next make the crossheads, and tappets, – sections 3 and 1 – and prepare the Cam Plates.

Assemble the Drive Cam - section 5 and test each tappet / cam for free operation. At this point, the 5 - lever section of locking should be temporarily attached to a lever frame section, the alignment fully checked and the cam guide may then be fully soldered up.

The locking table may then be removed from the lever frame and assembled with the other sections required to build up the full length of the frame, the locking components themselves made up, and the locking assembled and tested. It is recommended that every bridle assembly is tested in place as it is constructed in order that any tightness or unnecessary friction can be identified and rectified – it is far easier – for example – to slightly open out a port, or re-polish the bearing surfaces of a nib when they are dealt with one at a time as identifying the cause of stiffness when there are several locks on a tappet can be frustrating business.

Note on longer frames.

Whilst shorter frames – say up to 15/20 levers – are easy enough to handle without any great difficulty, beyond this point, things get more challenging and it is recommended that a simple wooden jig is made upon which the locking may be assembled, built and fully tested before fitting to the frame. For longer frames – say beyond 40/50 levers, not only is the use of a jig essential, but it is more convenient to build the locking up section by section for example by building the table for levers 1-20 and fully assembling this, making the longer bridles in – say - 25 lever lengths, with the end protruding so that once the next 20 lever section has been added, the bridles can be extended with an extra length. This enables testing to be carried out stage by stage, whilst reducing the problems of fitting and removing very lengthy bridles – which in the case of the rear set - can involve removing all the tappets… most of which will be locked… The photo shows a 70 Lever Locking Table, with levers 41-70 almost completed, a "temporary table" (without cams) for levers 31-40 is in place with the locking being added and also the bridles are ready for further extension as the table is extended.



1. Making the Tappets

The fret includes four "short" and one "long" Tappet – the sort ones are the correct length for use in a standard 8-tray locking table. The "long" tappet is actually two "short" tappets joined end to end. It is used as a jig for the assembly for the Locking Table frame after which it can be parted at the half etched marks to create two normal-length tappets. Thus, one spare tappet is created for every five levers sets. This might be useful in case of mistakes… If you are making a frame longer than five levers, it is worth making two long tappets as this assists the assembly process

Tappets are formed from a double-thicknesses of etch which are located in pairs on the fret. It will be seen that both layers of the tappet etches have half-etched markings to indicate the locations of the Ports for each Tray. There are three basic alternative ways go about making the Tappets – the first methods results in the half etched markings remaining exposed and on view which looks untidy and is less smooth in operation, but it requires a slightly lower lever of metal working skill than the other approaches. By contrast, the other two methods result in the half-etched port locations being hidden on the finished job, which not only looks better but results in smother operation.

For all three methods, the same basic metalwork is needed to get the tappets to size as follows:- clean the etch and remove from the fret, fold together and tack the two layers together according to your chosen approach (below) ensuring there are no gaps whatsoever between the two layers and taking care to ensure that the edges are perfectly aligned all round. Do not "tin" the layers first: but tack the two layers together whilst they are held tightly in contact with each other ensuring that they remain straight and flat. After fluxing well, the iron may be applied to re-heat the job causing the solder to run in between the layers. Additional solder may be introduced ensuring that the etch-cusps around the edges are well filled. Clean up the faces of the tappet to remove all excess solder and polish to a good finish, then clean up the edges by draw filing to the point where they are straight and level, then try the tappet in the slots in the tray sides in the fret – try several such slots to cater for any variation in etching across the fret. If necessary, the tappet can be reduced in width by removing an equal amount from each side. As soon as the tappet is a good clearance fit in the slots, bring the edges to a smooth and well-polished finish.

Alternative assembly methods

The three methods differ in how the ports are cut. The easiest approach therefore is to fold the Tappets etches so that the half etched guides are on the outside – thus avoiding the need to accurately mark-out the Ports. (Method 1). Alternatively, the ports may be marked and cut before the two halves are folded together – again, this enables the half-etched guide marks to be used – but there are twice as many cuts to make. (Method 2). The third method does not use the half-etched guide marks and the cut-outs for the ports must be marked by hand. To assist with this, and etched marking guide is provided which is used to scribe the Port locations. Anyone with reasonable skill in using a scriber and a piercing saw will have no difficulty with this method which creates a tidy result and offer the additional advantage that tappets may be mass-produced before being allocated to a specific lever number.

Method 1:-

Clean up the tappet etches with a glass-fibre brush and remove them as a back-to-back pair from the fret. Bend the pair together with the half-etch on the tags to the INSIDE such that the half etched port location remain visible. The required ports can now be identified from the design drawing and they may be cut out using a piercing saw with a fine blade and following the half-etched guide marks. The port sides should then be cleaned up using fine needle files until the half etched marks have disappeared and the full thickness of metal can be seen along the extent of the edges of the port. Finish to a good polish ensuring all file marks are removed. Mark the tappet by scribing its number on its front face. I also mark the tappet with the appropriate colour (red for signals, black for points etc) using an indelible marker to make them easier to identify.

Method 2:-

Clean up the tappet etches with a glass-fibre brush and remove them as a back-to-back pair from the fret. Mark each layer for the Port cutouts remembering that each will be a mirror image of the other. Cut out the Port openings with the piercing saw using the half-etched marks as a guide – there will be two cut outs for each Port. Clean up the cutouts to the maximum extent of the guide marks. Then fold the layers together with the half-etch on the tags to the OUTSIDE such that the half-etched port locations are hidden inside. Then proceed to solder and finish the tappets as described above.

Method 3

This method demands a slightly higher level of skill in marking out and cutting the Port-openings but results in a neat job whilst allowing a “mass production” approach to making the tappets which is very helpful for longer frames. Clean up the tappet etches with a glass-fibre brush and remove them as a back-to-back pair from the fret. Then fold the layers together with the half-etch on the tags to the OUTSIDE such that the half etched port locations are hidden inside. Then proceed to solder and finish the tappets as described above. Open out the three holes in the Tappet to a clearance on 0.8mm Obviously, the tappets need not be identified to a particular lever at this stage, so may be built in bulk up to this point.

To cut the Ports: the marking jig provided should be prepared by opening out the two holes to 0.8mm dia. Cut 2 lengths of 0.8mm wire (say about 20mm long) and insert each into the holes from the face-side (the one with the etched tray numbers) so that about 3mm protrudes through. Solder in place so that the wires are exactly perpendicular to the jig. Cut off the excess length from the face side. These two wires are inserted into the corresponding holes in the tappet to be marked out to provide an accurate location for the jig. To mark out, the prepared tappet should first be coated in marking fluid (indelible felt pen) at each position where a Port is required. The marking jig is located in the holes, flat against the face of the tappet. Using a sharp scriber, mark round the required Port openings, then remove the marking jig. Cut out the Ports using a piercing saw with 4/0 blade which will, to some extent follow the solder-filled half-etched marks inside the Tappet. Clean out the saw-cuts using a square needle file – hold it at 45 deg. for each of the sides. Don’t be tempted to use a triangular file – you will not achieve a 45 deg. result! Needless to say, the marking jig is not suitable for use as a filing jig… Test the resulting cut-out frequently with the gauge provided and also by re-fitting the marking jig to ensure the location is not drifting. The gauge should be a close fit in the cut-out which must however be deep enough that there is no trace of “rocking” of the gauge in the cutout.

2. The main frame

General points

Clearly accuracy in building the Main Frame is key to success and where possible, self-jigging has been used to assist in this. Nonetheless, it is vitally important to ensure that right angle bends really are 90 degrees, that straight components have had the sheet curl removed etc. Please pay special attention to such aspects as indicated below.

Cap Wire holes

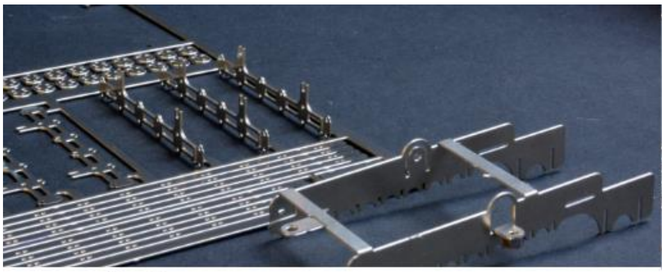
Each tray side incorporates a dozen holes through which the Cap Wires will eventually be fitted. Because of the etching process, these will require opening out to 0.8mm and because there are 9 tray sides, that equates to 108 holes to open out per five lever unit of locking. Clearly, one way is to do them individually whilst the fret is "in the flat". However, a less tedious method is available in the form of "Long Series" drills which are long enough to line-drill all 9 trays at once after the frame has been assembled. Such drills can be purchased at ridiculously cheap prices from the internet and the purchase of a couple will help preserve sanity.

Assembling the main frame

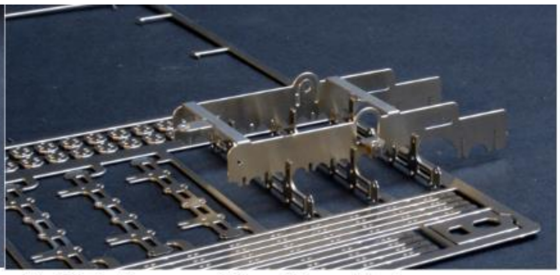
Examine the fret carefully; you will notice that there is a slight curl across the width of the sheet. This is due to the fact that the material is supplied in coil form and despite the best efforts of the etchers to remove the resultant distortion, the act of etching the metal will inevitably cause the curl to re-appear to at least some degree. The sheet has been laid out in such a way that many of the components (bridles, tappets etc) are not affected. The main frame parts however will be, and it is essential that this curl is removed from each of the components. In assembling the main frame it is also essential that all right angle bends really are at right angles – the use of an engineer's square or a vee block is essential, as is the use of a pair of folding bars or a smooth-jawed vice.

Remove the Main Frame from the etch, sight along its length in the direction of the curl and very carefully straighten to remove the curl taking care not to introduce any kinks at the weaker areas of the part. Bend up each of the sides to exactly 90 degrees and sight across the two rear members to ensure that there is no twist in the frame. When completely satisfied that the geometry is accurate, reinforce the four folds with a fillet of solder. Fold out the two fixing brackets from the frame sides to 90 degrees. These are used for securing the locking table to the lever frame with the screw entering from the rear (lever frame) side and are etched to the tapping size for 8BA and therefore may be tapped out or alternatively, may be opened out to clearance size and a nut soldered to the front face. On longer frames, it is by no means necessary to use all the fixing holes – between 1 in 2 and 1 in 4 will be sufficient depending on the length of the frame.

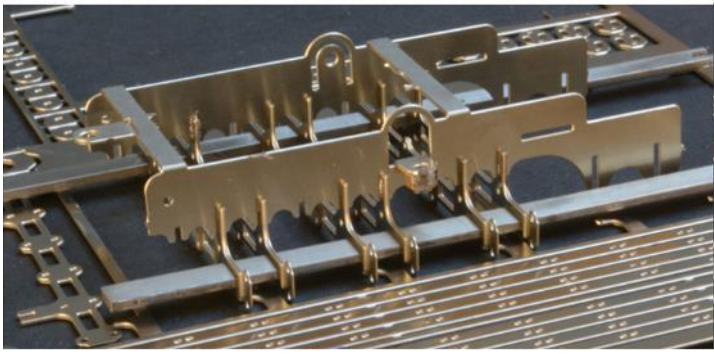
Next, assemble the Main Frame to the Tray sides. DO NOT REMOVE THE TRAY SIDES FROM THE FRET. With the fret positioned on the bench so that the tray-sides are to the right side nearest you, bend up each of the group of three tray sides on your right to exactly 90 degrees. Sight along the length of each trays side and carefully remove any sheet curl or twist. The main frame can now be positioned over this group of three tray-sides as shown below and firmly pressed down to ensure it is fully seated in place. Once happy that a good and accurate fit has been achieved, the main frame may now be soldered at each of the junctions. Turn the fret over and use a pair of face cutters to release the assembly from the fret. This process is now repeated for each of the other two groups of three tray sides – use the previously prepared long tappet through the tappet holes to check for any misalignment before soldering.



1. **Tray-sides bent up**



2. **Main Frame positioned for soldering**

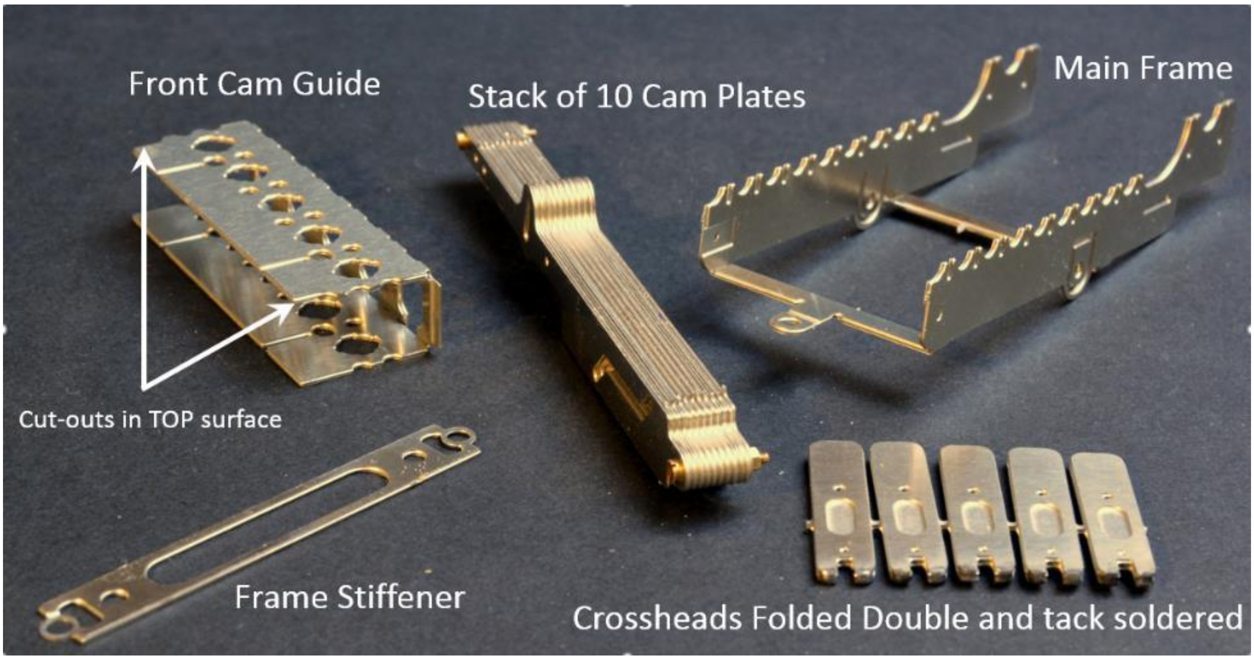


3. **Using a Long Tappet to check for alignment of second and third set**

4. **Using face cutters from rear to remove from fret**

Fitting the Front Cam Guide

The geometry of the Front Cam Guide is crucial to the satisfactory working of the frame and special care should be taken to ensure this.



Clean up and remove the Front Cam Guide from the fret, and clean up the remains of the tags from each side (remembering that these sides must fit closely together on a frame longer than 5 levers). Very carefully bend up the top and bottom flanges to EXACTLY 90 degrees. Note that despite the relieving slots, there will be a tendency for the ends of the Guide to distort during bending. This can be minimized by the use of bending bars or a smooth -jawed vice for at least the first bend. Should any distortion occur, deal with it before proceeding. Once completely satisfied that both bends are at right angles and that there is no twist at all along the length of the guide, reinforce the folds with a minimum of solder applied from the outside ensuring that no solder at all strays on to the working (inside) surfaces of the guide.

Identify the top face of the Cam Guide by the half U-shaped cut-outs in the sides at the rear edges. These are to accommodate the Locating Brackets by which adjacent locking units are joined and fixed to the lever frame.

With the top face correctly oriented, fit the Cam Guide to the previously assembled main frame by interlocking the pairs of slots and push the guide fully home – it should be a fairly easy fit. If any binding is evident, locate and deal with the cause. Note that the guide is correctly located when its rear face is completely flush with the rear face of the corresponding part of the main frame. Therefore, accuracy of assembly can be assured by pushing the rear face of both items against a suitable straight edge. ONLY TACK SOLDER the Guide to the Main Frame at this stage. Final soldering of these components should be left until the final assemble of the Locking to the Lever frame as any slight misalignment of the units can be corrected at that stage.

Test the alignment at this stage by using a long tappet through each of the tappet locations – it should fit very freely through the longitudinal slot in the Cam Guide without any hint of binding. Check to ensure that the tappet runs exactly in the centre of the Cam Guide slots. Find and eliminate the cause of any binding, stiffness or misalignment.

Frame Stiffener

Clean up the Frame Stiffener and remove it from the fret. Remove the remains of the tags by carefully draw filing the upper and lower edges. Very carefully check the two side of the main frame for perfect straightness – once the frame stiffener is soldered in place there will be no further opportunity to make further corrections.

Identify the right and left sides of the frame stiffener by reference to the half-etched locating holes at either end – the orientation of those on the stiffener must match those on the Cam Guide. Thus, the hole with its half-etch facing you should go to the right viewed from the front of the locking table.

Locate the Frame Stiffener in its slots in the sides of the Main Frame and position it so that the semi-circular ends of the main cutout are exactly aligned with the inside faces of the side frames. Tack solder one end only, then thoroughly check the whole frame for straightness and squareness, and check the location of the stiffener. When fully satisfied, solder in position.

Cap Wire holes.

With the frame fully assembled, now is the time to drill out the Cap Wire holes to 0.8mm using a "Long Series" drill bit. Some tips for those who have not used such a thing previously. Firstly, do not put the drill into a power tool and switch on – the drill bit will "whip" uncontrollably resulting in breakage a possible injury. Rather, the drill bit should first be carefully located in the first locking tray into a hole previously opened out with a normal length drill bit. Secondly, and obviously, take care not to unnecessarily bend the drill bit in use – in fact they are more flexible than seems feasible – but only to a limit…

3. Crossheads.

The crossheads work vertically in the front cam guide to convert the full-stroke horizontal movement of the cams into the restricted vertical movement of the tappets. The drive pin which accomplishes this function is subject to a fair amount of work and is best made from 1.4mm dia. hard piano wire.

Preparing the crossheads

Clean up then remove all five crossheads from the fret as a single piece, then fold them all over together through 180 degrees with the half-etched fold to the OUTSIDE. Clamp the laminations tightly together, then tack solder the ends of each crosshead to hold the folds in place. Doing the cams as a block of five helps to ensure that each cam stays in alignment. Open out the larger holes to 1.3mm and the smaller ones to 0.8mm. Separate each cam, and after checking for good alignment of the laminations, flux well, then run solder between the laminations. Clean any solder off the side faces of the cams, then bolt them together as a stack of five using a 12BA bolt and nut with a piece of 0.8mm wire through the smaller hole, cutting this off flush with the faces of the stack.

The Crossheads are etched over size and now it is necessary to file them accurately to size as follows:-

Grip the stack of five Crossheads in a smooth jawed vice and file the edges of stack until the etch cusps have just disappeared. Observe progress with each stroke of the file to ensure that metal is being removed uniformly across both width and length – you might find it necessary to turn the job end for end half way through to counteract any tendency towards uneven filing. Repeat this for the other side and also remove the etch cusps from the top and bottom of the cams. Take great care to ensure that the same amount of metal is removed from both sides. If you have a micrometer, or a Vernier caliper, then check the width you have achieved at both ends and across the width. The target at this stage is 6.5mm. Now separate the stack of Crossheads and drawfile the edges to remove all file marks, polish the faces to a high finish and remove the corner edges between the sides and faces. Finish to a decent polish – obviously, as the sides are a sliding fit, a good finish is essential – but note that the crosshead is not yet fully finished to size – there remains approx. 0.5mm to be removed from each side depending on the degree of etch on the sheet – so some degree of fitting is needed.

Find the narrowest of the Crossheads – use your “mike” or Vernier, but if you do not possess such, then check both ends of each of the Crossheads in one of the slots in the cam guide. They should not fit at this stage, but you are likely to find that one of the cams is nearer to fitting than the others – you have now found the narrowest Crosshead. Take your narrowest Crosshead and try its narrowest end in each of the cam guide slots – again, you have now found the widest slot, but still at this stage it should be a pretty tight fit. Now polish up the sides and edges of your narrowest Crosshead ensuring that there are no burrs of roughness of any kind, that the edges are slightly radiused and that it is perfectly uniform in width along its length. Now the brutal bit:- take this Crosshead and “force” it into the slots in the Cam Plates. Common sense check – it should be a “tight” but not a “drive” fit. If it is not going in with reasonable push, remove a file-stroke or two more metal from the Crosshead – DO NOT open out the cam guide slots with a file. After working it back and forth several times it will become an easier fit – doing this compresses the etch cusps on the cam guide to create a better bearing surface. Repeat this for all five slots. Now finish polish each Crosshead to an easy sliding fit in the cam guide slots – you have achieved the result when the Crossheads will fall out under their own weight without any rattle.

Now we have to fit the drive pins – which involves slightly spoiling our good finish… Take a length of 1.4mm hard piano wire and polish it to a perfectly clean finish using fine (1000 grit) carborundum / emery paper. ("wet or Dry") and carefully de-burr the end using a mini grinding wheel.

Open out the holes in the crosshead to a good fit on the wire. Grip the wire in the vice with about 10mm protruding and mount a Crosshead on the wire such that about 1.5 – 2mm of wire protrudes. Apply an active liquid flux (Note:- concentrated Phosphoric acid such as Carr's "Brown" works best – this is sometimes described as "nasty stuff" but it is not – you will find that it spits and fizzes much less than "normal" Phosphoric acid flux - though sensible eye protection is still needed - but it does leave an oily residue which will wash off with water – but dry the steel carefully or it may rust. And this flux makes a tricky job like soldering Piano wire very easy indeed.

Now apply a soldering iron to the edge of the crosshead adjacent to the wire and hold it there until the solder begins to sweat and continue to hold it there until a bead of solder appears round the wire – if necessary, encourage it by touching some solder to the joint. Once the bead has appeared, allow the assembly to cool and test the result for strength. If the joint fails, the most likely cause is dirt contamination – remove the wire and re polish it. It must be bright and shiny.

Now part the completed crosshead from the rest of the wire leaving about 2mm protruding using a cutting disc in a mini drill taking all appropriate safety precautions. Deburr both resulting ends of with a mini grinding wheel. Working in this way ensures a good joint and should result in a minimum of "damage" to your previous good finish – just remove any excess solder from the edges and the faces of the Crosshead and re-polish with a very fine emery board. Test-fit the crosshead in the slot in the cam guide to ensure the drive pin is not over-length and that all excess solder has been removed.

Finally, clean out the slot in the bottom of the Crosshead to remove the worst of the etch cusp, check that the 0.8mm hole is clear of solder, and test fit the Crosshead to a Tappet – it should be an easy clearance fit with no tendency to bind. Try a 1/32" split pin in the holes in the Crosshead and Tappets again checking that no binding has been introduced.

Notice that there is also a cross hole through this slot which is formed from 2 half-etched grooves on the inside faces of the crosshead etch. This can be used as an optional additional fastening between the crosshead and Tappet when the frame is finally assembled and tested. If you do want to use this facility, assemble the Tappet to the Crosshead and push a piece of 0.8mm wire into this hole – it should be a push fit in the cross head but a clearance fit in the Tappet to ensure that it will not fall out but does not cause the tappet to bind in the Crosshead. Having designed this facility, I have never had cause to make use of it…

Finally, after you have prepared your Cam Plates, you should try the Crosshead Drive Pin in the slot of the cam plates to ensure that the bead of solder securing the pin is not impeding free movement – clean up the fillet otherwise.

4. Drive Cams

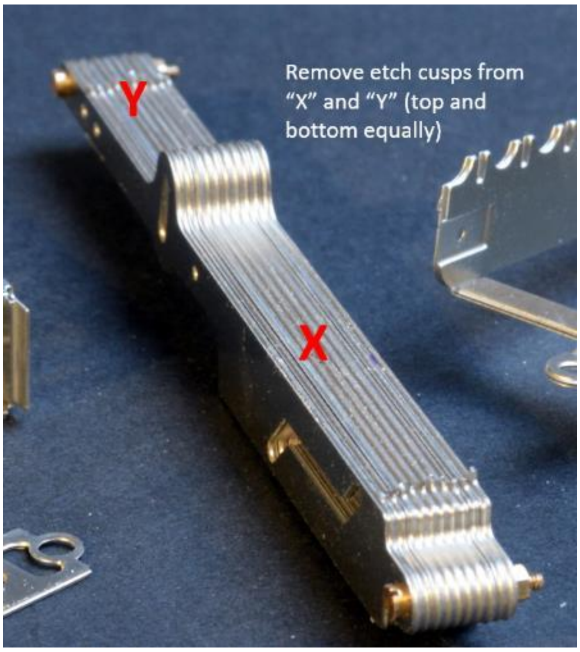
The Cam Plates work in pairs either side of the lever and crosshead, with spacer pieces to hold them in the correct alignment and position. At the initial assembly stage, just a single spacer is fitted at the front end of the cam, leaving the rear end of the cam open to be fitted round the lever on the final assembly of the locking table to the frame. The spacers can be fitted using 12BA nuts and bolts – this method having the advantage that it allows the cams to be disassembled at any stage. However, this rarely proves necessary and therefore it is quite acceptable to solder the spacers in place.

Preparing the Cam Plates.

The Cam Plates are etched slightly over size to enable the etch cusps to be removed to create a decent bearing surface. To accomplish this, it is best to treat all the cams in bulk as follows.

Drill out the holes at the outer ends of the Cam Plates to 1.3mm diameter, then remove the Cam Plates from the fret.

Stack all ten Cam Plates and bolt the stack together using a 12BA bolt and nut through each of the end holes. Clamp the stack in the vice and carefully file down the etch cusps from the areas shown below, taking care to remove metal uniformly across the length and width of the filed areas.



Test progress frequently by trying the stack of Cam Plates in the cam guide in the locking tray frame. The final size has been reached when the cams are an easy sliding fit with the minimum of rattle (about 9.75mm). Whilst the Cam Plates are still in the stack, insert a piece of 1.4mm dia. piano wire into the cam slot: depending on the degree of etching of that particular sheet, it may be a stiff or and easy fit, and if there is any stiffness, the wire should be vigorously worked back and forward until it becomes an easy fit. Under no circumstances be tempted to open this slot out with a file. Repeat this for the lever drive pin slot

Unbolt the stack of Cam Plates but retain adjacent plates in pairs. Very carefully deburr and polish the filed edges to the cams. Beware that in this condition, the Cam Plates are quite weak across the diagonal of the cam slot – take care not to apply sideways pressure which may distort them.

To assemble the Cam Plates.

Firstly, prepare two simple jigs to assist the assembly process. Remove a cam spacer (there are plenty of spares) from the fret and carefully fold it through 180 deg. with the half etched fold to the INSIDE, ensuring that the two layers are in perfect contact. Take care to ensure that the two halves are exactly aligned with each other, then open the holes out to a good fit on a piece of 1.2mm OD brass tube or wire. Solder a length of this material into the hole such that about 2mm is left protruding. Take great care to get the wire square to the spacer. Cut the wire off again leaving about 2mm for the spigot on either side of the spacer.

Remove the three components of the Front Alignment jig from the Fret and use a piece of 1.4mm OD brass wire (or tube) to clean out the slots in the two side pieces – again, these might be a more or less tight fit, but work the wire until it becomes an easy fit. Open out the two holes in the centre piece to a good fit on the wire and solder two short lengths in place taking care to ensure they are perpendicular. The centre piece needs thickening slightly to create a clearance between the cam and the crosshead and this is easily done by sticking a piece of PVC insulating or masking tape to both sides of the centre piece – the jig does not get hot during the soldering so such material is quite suitable.

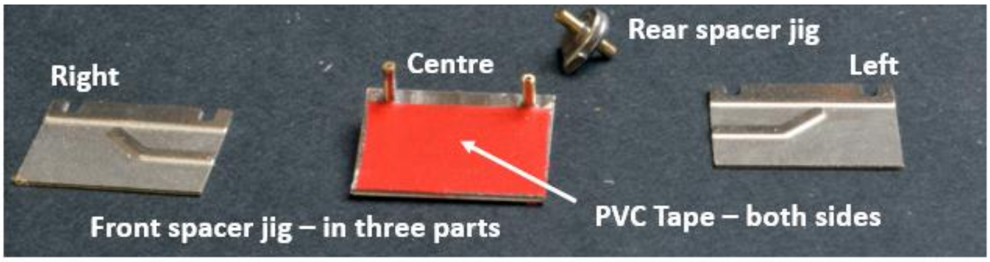
Clean up five cam spacers and remove them from the fret, fold them through 180 degrees – note the half etch on the hinges goes to the INSIDE. Squeeze the two layers together and check that the two holes are in good alignment then open out the holes to a clearance on your 1.4mm OD wire or tube. If you are SOLDERING the cams, open out the holes in the front end of the cams similarly.

Take a pair of Cam Plates (these should be cams plates which were next to each other in the stack) and check that they are a fully free fit in the rear cam guide and that they do not bind on the crosshead drive pin.

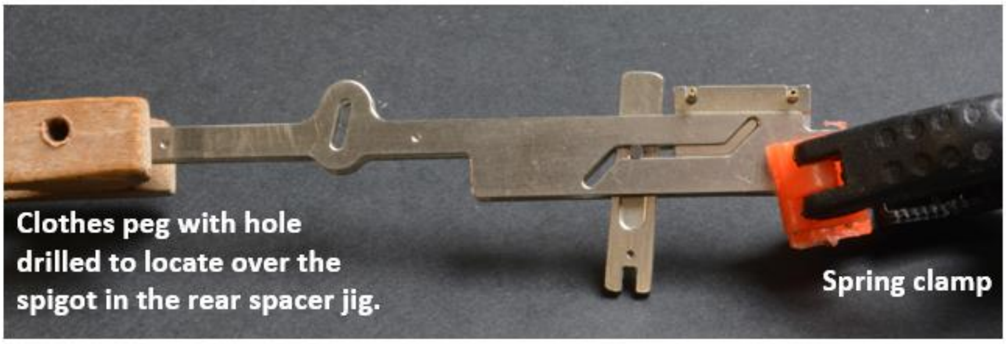
Take previously prepared crosshead and insert it into the appropriate slot in the cam guide. Ensure that it is free-moving along its whole length without any hint of binding or stickiness – it should easily fall out under its own weight. Insert a Cam Plate to one side of the crosshead, locating its front end in the cut-out in the front of the cam guide. Position the crosshead such that the drive pin engages in the cam slot at the extreme and of its “normal” travel – ie the crosshead is in its highest position. Insert a second Cam Plate and similarly engage the slot with the drive pin. With the Cam Plates snugly against the sides of the crosshead, work the Cam Plates through the guide slot to the “Reversed” position. (builders possessing three hands are at an advantage for this step). Locate the rear-end assembly jig in the holes at the rear of the Cam Plates. A wooden clothes peg with a hole drilled across the jaws to accommodate the spigot in the jig can then be used to clamp the assembly. Assemble the 3 parts of the front alignment jig and, with the Cam Plates in the “reversed” position, inset the alignment jig between the Cam Plates taking care to ensure that it is correctly located in the cam slot and clamp it in place – a spring clamp (as illustrated) may be used, or alternatively, a pair of parallel jaw pliers will work. Do not use anything which cannot exert an even grip (for example a normal pair of pliers) as it will result in the two cams plates being out of parallel.

Check that the two Cam Plates are properly aligned and insert a spacer between the front of Cam Plates adjacent to the front alignment jig (note:- if it seems to foul the jig causing it not go far enough in, this might be because the spacer was folded the wrong way leaving the half-etched fold hinges protruding). Insert a length of 1.4mm wire/tube and check that everything aligns squarely.

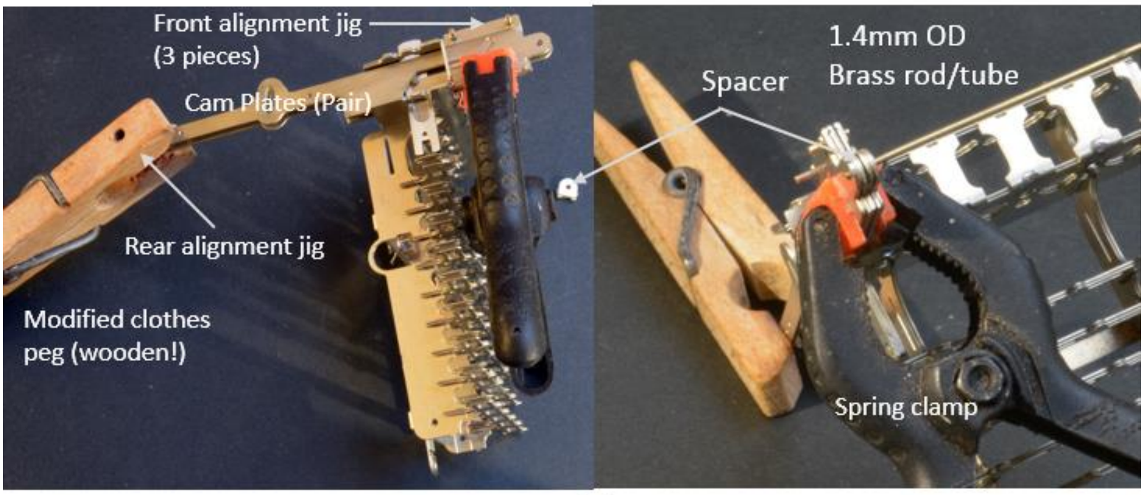
Cams may be assembled by either bolting or soldering the rear spacer in place – bolting has the advantage that the job can be dissembled at any time, though it costs more, and runs the slight risk that the bolts may come loose in service. Soldering is easy and cheap but is much harder to undo if things do not go to plan. You may therefore wish to bolt your first few levers worth of cams until you are familiar with the job after which you will have the confidence to solder. Ultimately neither method makes the job of fitting the locking to the levers any easier…



Cam Assembly Jigs



Cam Assembly Jigs – principle of use.



Cam Soldering

IF SOLDERING the cams:- Tack-solder the cams to the spacer, remove the rear alignment jig (slide the centre piece out first then the two outer pieces will drop out). Leave the rear jig and its clamp in place, and test for free movement of the cam throughout its whole length. If there is any binding, which a few movements fail to clear, it will be because the two cam halves are not fully aligned – find and eliminate the cause, then fully solder the spacer. Cut off the excess of wire/tube in the rear spacer hole.

If BOLTING the cams:- the cams and spacer are bolted using a 12BA bolt and nut – there is sufficient clearance in the holes to allow a slight adjustment of the Cam Plates in the event of any tightness when tested. Note:- when the frame has been fully assembled and tested, the tightness of these nuts should be checked and it is worth locking them with Loctite ThreadLock or with varnish to prevent them working loose in use. Alternatively, once the operation of the finished job is proven, the spacers may be soldered up and the nuts and bolts removed for re-use elsewhere.

The rear spacer jig may now be removed. Repeat for the remaining cams.

5. Nibs and Bridles

General

Obviously, the nibs and bridles are the heart of the locking and inevitably, making the nibs and assembling them accurately to the bridles demands a bit of metalworking and requires to be done to a decent standard - Please note that there are PLENTY of spare nibs and bridles in the fret – use this facility to practice their manufacture to gain a decent level of skills – once you have made a few dozen nibs, you will find it quite easy and quick, but PRACTICE is the only route to this point. Do not worry if you end up with a lot in the scrap bin – you will not run out of nibs or bridles!!

Principles and geometry

The bridles are supplied in lengths of 5, 10, 15 and 25 levers and of course, may be cut-down or joined together as required to make any length. When joining bridles a "half lap" joint is provided which includes etched holes which, when aligned, will maintain geometry across the joint. The bridles are provided with holes which allow the nibs to be attached in the correct location using wire dowels – those in the 5-lever-long bridles are etched through, whilst in longer bridles they are half-etched to maintain strength and rigidity.

Making the Nibs

Note:- successful locking comes down to the quality of manufacture of the nibs and their associated ports both requiring a reasonable standard of accuracy of shape and high degree of polish to the finish to minimize friction. Thus, given their small size , making the nibs requires a degree of skill which comes from practice – there are plenty of spares provided on the fret so it is suggested that these are used for practice to get a grasp of the process and acquire the experience needed to make them to the required standard – don't be afraid to throw away any sub-standard efforts

The nibs are etched slightly over-sized to allow the etch cusp to be removed and the working surfaces finished to a high standard of polish. It is essential that the filing process maintains the edges at right angle to the faces of the nibs and also maintains the geometry. To assist with this, the fret includes a couple of templates etched to the shape of the nibs. These jigs should be removed from the fret, doubled-up and soldered together. In use, it should be noted that these templates do NOT provide a test of the SIZE of the nibs – they only indicate the shape – thus, a finished nib will easily pass through the hole in the template with a comfortable space all around. This allows the shape to be constantly tested against the template as the nib approaches its finished size. The nib will be the correct size when the etch cusp has JUST been fully removed.

Nibs are supplied as a double-thickness etch folded together. Carefully clean all the nibs whilst still in the fret then remove them carefully, leaving a minimum of tag on the nib, then fold the two layers together. The fold can be made either way, but best is to fold with the half etch on the inside – it will "go tight" half way round but can be squeezed close with pliers. Doing it this way locates the two halves more accurately together – but always check that they are perfectly aligned and tightly closed together – use a piece of wire, a drill shank or a tapered broach as a temporary alignment tool and tack-solder the corners. Remove the alignment tool then run solder between the two layers ensuring that the etch cusps are well filled with solder. The nibs now require filing to size and the use of a smooth jawed vice will be found very helpful. Also, for finished a pair of parallel jaw pliers will allow the nibs to be gripped yet easily manipulated. File the nibs very carefully observing progress with every file stroke to ensure that the etch cusps are being removed uniformly – it literally requires only two or three strokes of a very smooth file.   Finish to a very high polish using fine emery sticks to the edges and faces.

Nib Guidance.

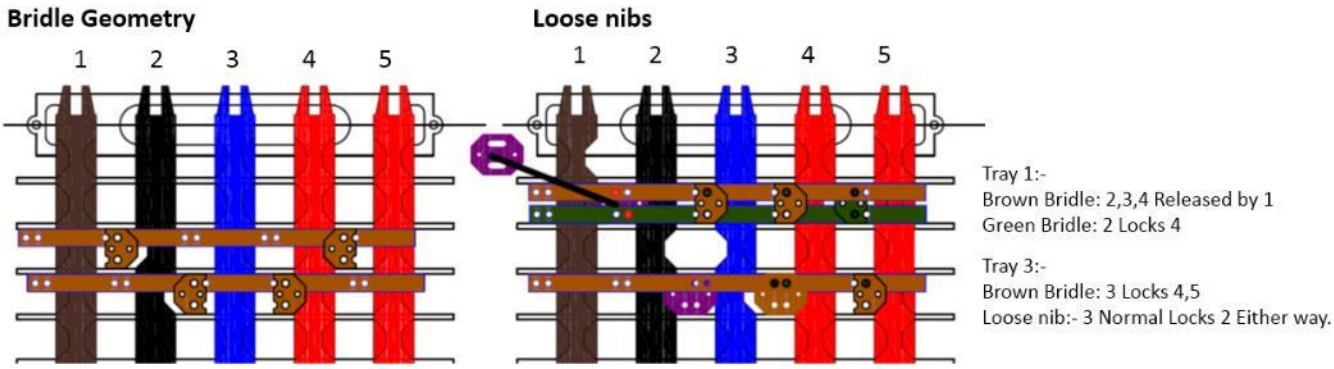
In the case of skeleton nibs and of loose nibs, it is important to ensure that the nib is adequately supported against the pressure of the tappet being moved whilst locked. Usually this can be accomplished by attaching a sort length of “orphan” bridle (ie it has no function other than to support and guide the nib) but that is not possible when other bridles occupy the same tray. In this case, the nib can be stabilized by using the adjacent bridles for guidance. To this end, all nibs are provided with a pair of holes along their mid-line into which short lengths of wire can be soldered. These will need to be 0.7mm in diameter as this is the minimum diameter of whole which can be etched however, the sliding edges of the wires should be reduced to about 0.5mm by use of a smooth file.

Use of guide wires to support loose nibs and adjacent bridles (note the double-ended nib with a short length of “orphan” bridle attached)

Assembling a bridle.

Geometry.

It will be seen that the bridles are provided with pairs of holes set at the tappet pitch along their whole length. These allow the nibs to be accurately dowelled to the bridles by opening-out the holes in the nibs and the bridles to 1mm diameter and using a short piece of 1mm dia. wire as a dowel. The geometry is such that the hole nearest to the tappet corresponds to the full hole in a nib as shown below:-



The function of these two bridles is identical (2 Locks 4) but their mode of action differs. Notice the geometry of the dowel holes in the bridles – it is the hole in the bridle adjacent to the tappet which locates the full hole in the nib.

This set-up illustrates two different uses of “loose nibs” (coloured purple). In tray one, the loose nib is driven by means of the two pins coloured red. Thus, both bridles act on the nib and vice versa, but there is no connection between the bridles. In tray 3, the Bridle and the loose nib are not connected in any way.

Required length

Generally, a bridle only requires to be long enough to reach between its end-most nibs. However, it is often prudent to extend the bridle so that it extends above the tappet on which the end nib acts in order to provide additional support. Clearly, care must be taken that adjacent bridles do not interfere with each other creating a false lock through an inadvertent “butt” ie a lock arising when one bridle pushes another end on. Such locks can be useful but only when the design functionality requires them.

Clearly, very short bridles require some care to ensure that the nibs are adequately supported and guided and in such cases a degree of extension of the bridles will be required – see example below.

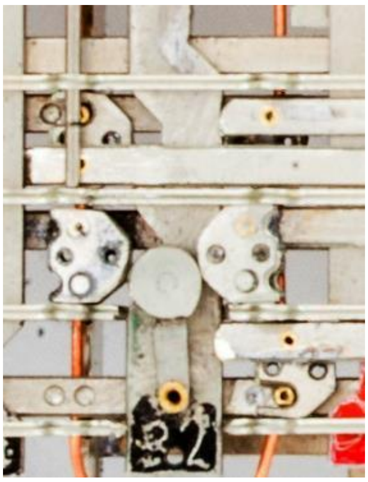
Double-ended nibs

Where a lock or release is required between adjacent tappets a “bridle of zero length” may be used and the fret provides double-ended nibs for use in this situation. According to the design need, these may be attached to a bridle to drive other nibs, or may be “loose” where no other lock is needed. In this latter case, means will be required to ensure that adequate guidance is provided as described above.

Skeleton Nibs.

Where independent locks are required on adjacent tappets, there is not enough space to fit two full nibs. For this situation “skeleton” nibs are provided as illustrated. These nibs do not of themselves provided adequate resistance against the movement of the tappets when locked, and therefore means of guidance must be provided – in this case by using a Bridle Spacer (a “blind” nib) beyond the tappet the only function of which is to provide guidance to the bridle.

Special locks



By using a bit of animal cunning, all kinds of special locks can be created including lifting tappet sequential locks, butts, sliding butts and whilst a description of each of these is beyond the scope of this guide, reference to prototype information will usually help. Once common form of “special lock is however provided for on the fret – the “conditional lock” – and this is provided by means of a swinging loose piece as illustrated.

Testing a lock.

It is self-evident that when a locking table has been assembled from a large number of individual bridles, testing it and eliminating issues can be a complex business and for this reason it is important that each individual bridle is tested as it is made.

Therefore, as each bridle is completed, it, along with its associated tappets should be temporarily assembled into the locking table and each tappet in turn tested to ensure that:-

- the locks function as designed
- the locks are not unduly "tight" – ie cause drag on the tappets even when they are supposed to be free – bearing in mind that such affects can be cumulative as further locks are added to a tappet
- that locks are not too "slack" – note that a degree of slackness is not a problem (better that than too tight) but if excessive, such slackness can allow a lock to be forced.
- They operate smoothly and without friction – if any stiffness or binding is detected as a tappet moves a bridle, the most likely cause is poor surface finish on the angled faces of the tappets or the ports. Such things must be identified and eliminated if the ultimate performance of the locking is not to be compromised.

IMPORTANT NOTE:- when testing the locking without the lever frame fitted, it is essential to ensure that the tappets are fully normal / reverse as appropriate. It is very easy for the tappets to be slightly out of position as there is nothing to "hold" them in place. Even a slight error in this regard will give a false lock.

6. Assembly

Fitting the tappets to the crossheads.

As the tappets are completed they should be trial-fitted to their crossheads. Slide the tappets up through the locking trays and check that they enter freely into the cutouts in the crossheads. Ease the slots in the crosshead with a needle file if necessary. Clean out the holes through the crosshead and through the tappet to an easy clearance fit on a piece of 0.8mm wire. The joint between crosshead and tappet must be easily disconnected as it will be frequently necessary to fit and remove tappets as the locking table is built up. Whilst this can be achieved using a piece of 0.8mm wire, the best way is to use 1/32" split pins as shown. These are available online or at shows from Eileens Emporium.

Joining the Locking Table units

Assuming you are making a lever frame of more than 5 levers, it will be necessary to joint the 5-lever units of locking table and in the case of "long" frames this clearly needs to be done with a degree of accuracy if the geometry is not to be compromised. To assist with this, each 5 lever unit should be carefully checked to ensure that the tray sides are straight without any bow and that the main frame members are straight thus ensuring that the tray sides are all vertically above each other. Adjacent units may now be united taking care that the half-etched ends to the tray sides and the rear Cam guide are coming together properly. Two lengths of N/S straight wire may now be pushed up through the capping wire holes at the junction of the to units. In theory, this wire should be 0.8mm in diameter, however it is likely that the holes will be slightly oversize from the etching process with the result that you may find that 0.9mm dia. wire is a better fit. This wire will serve to maintain the 10mm lever pitch between the adjacent units. Now carefully check the alignment of the adjacent Front Cam Guides and use a straight edge to ensure that they are perfectly aligned in the vertical and horizontal plain. TACK solder together (definition of "tack":- strong enough to hold the job together temporarily, weak enough to break apart WITHOUT the application of the soldering iron if needed).

Now go back to the tray sides and check that the wires are accurately locating them in alignment, pinch the two half etched layers tightly together, then tack solder (without soldering the wires in…). Repeat this at each tray side joint front and back. Now remove the cap wires. Check that the holes in the adjacent Frame Stiffeners are correctly aligned and are fitting closely together, then tack solder them. Thoroughly check the alignment, locate and deal with any discrepancies and once fully satisfied, complete the soldering of the Front Cam Guides and Frame Stiffeners then sweat each tray side joint together using a minimum of solder ensuring that they do not spring even slightly apart. A locating bracket (from the lever frame fret) may now be soldered over the joint as shown in the adjacent photograph.

Clean up each tray side joint to ensure that it is no thicker than the rest of the tray side.

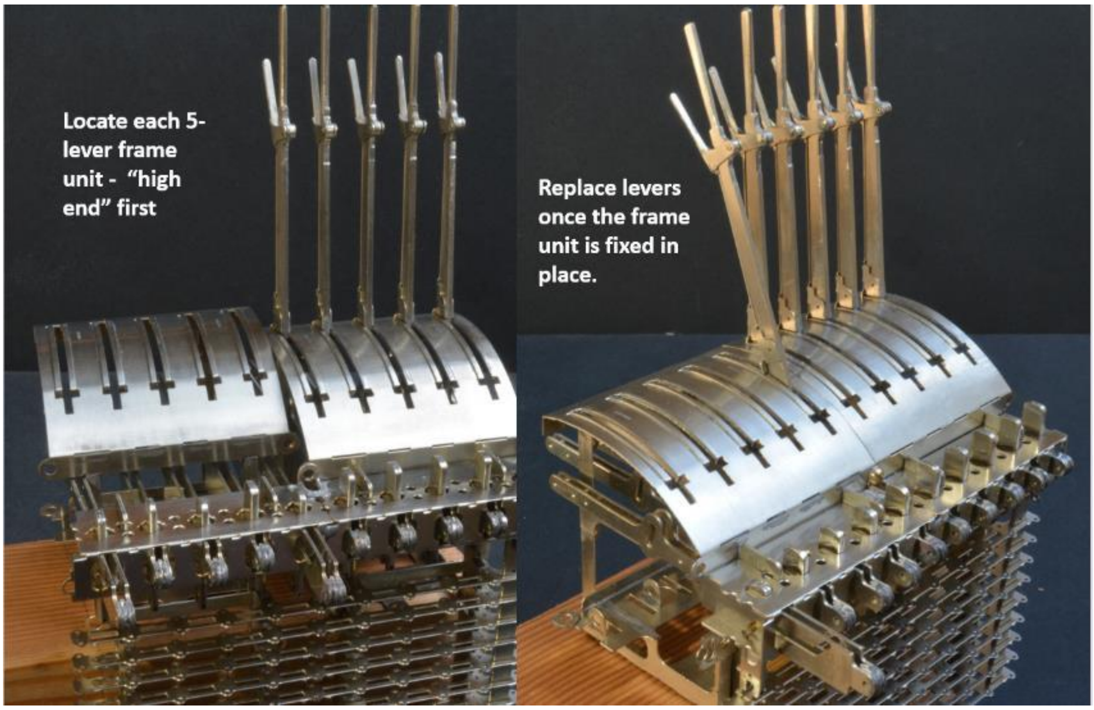
7. Assembling the Locking Table to the Lever Frame

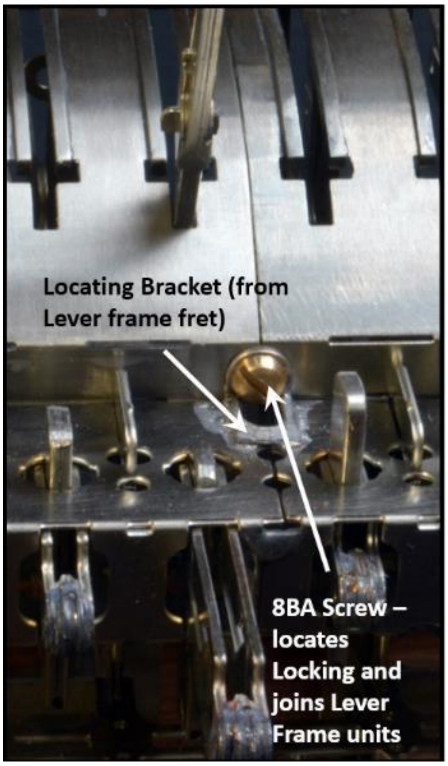
Particularly with longer frames, uniting the locking to the lever frame units can be a tedious job, but the design of the system seeks to minimize the difficulty. Since getting the locking right is the trickiest job, the first step is therefore building up the locking table as a unit, fit all the tappets, bridles and capping wires and fully test the locking "on the bench", if necessary using a suitable jig as described.

The lever frame itself should now be split down into its 5-lever units and the levers removed. This is actually a good stage at which to paint the levers and the frames as this is a much easier jib when the levers are not in the frames…

The fully tested locking table should now be carefully removed from the jig and the Main Frame of the right-hand most lever frame unit assembled to the Locking Table ensuring that the Cam Plates go in the right place relative to the frame. Fit the 8BA retaining screws to the captive nuts. Replace the levers, starting the highest number (right hand) one first. The Cam Plates will need to be prised aside to allow the Locking Drive Pin to enter between them. As the set of five levers is completed, the Pivot Rod is slid into the Pivot Plate bearing holes, through the levers and its retaining wire replaced. (See the lever frame instructions to remind yourself of the details on this.) The Rear Guide

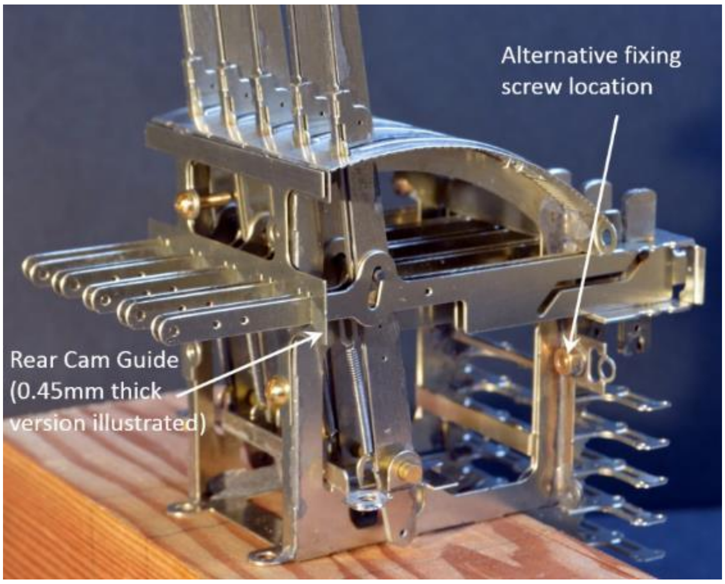
Plate (see also below) may now be fixed to the rear of the Main Frame using 8BA screws into the tapped holes in the Lever Frame. The result should now be tested for smooth working. All should be fine, but if there is a tendency to binding, the alignment of the Front Guide may need adjustment. Therefore, once the whole frame has been completed, this should be checked – remember that the Front Cam Guide was only tacked in place when the Locking Table Frame was assembled. A slight re-alignment may be needed to improve the free working and once all is working well along the whole length of the frame the fixing of the front guide can be made more secure – it is not necessary to blather a load of solder everywhere to achieve this.





Now add the frame of the next 5-lever unit ensuring that two pivot plates locate correctly together. Please remember that the geometry of the design is such that these frame units will ONLY assemble right to left (high numbers first). Once correctly in place, secure with an 8BA screw through the Pivot Plate joint and also through the locating bracket on the Front Cam Guide of the locking into the nut on rear of the quadrant plate. Now replace the levers in the second unit.

Repeat this process for the remaining units.



Choice of Rear Guide Plate

The Rear Cam Guide Plate is fixed to the rear of the lever frame using 8BA screws. There are two alternative plates supplied for this – one on the Lever Frame fret (etched in 0.45mm N/S) and one on the Locking Fret (in 0.7mm N/S). It will be seen that the two designs differ slightly in the way the holes to take the Cam Plates are arranged. The choice of which to use is decided by the how the Cam Plates are ultimately going to be utilized – for example, if a mechanical drive to the ground equipment (points, signals…). Thus, if the ends of the Cam Plates are to be permanently joined, then the 0.7mm Rear Guide allows for this whilst allowing the Rear Guide Plate to be removed. If however, the Cam Plates are not going to be joined in any way, the 0.45mm version will provide better location and guidance.

Once the locking and lever frame have been united, the levers should be checked for free movement and any source of stiffness located and dealt with.

Once the levers and frame have been painted, the locking may be lubricated with light machine oil, clock oil or horological grease and this will of course further reduce friction but should not be relied upon to correct stiffness due to poor fitting.

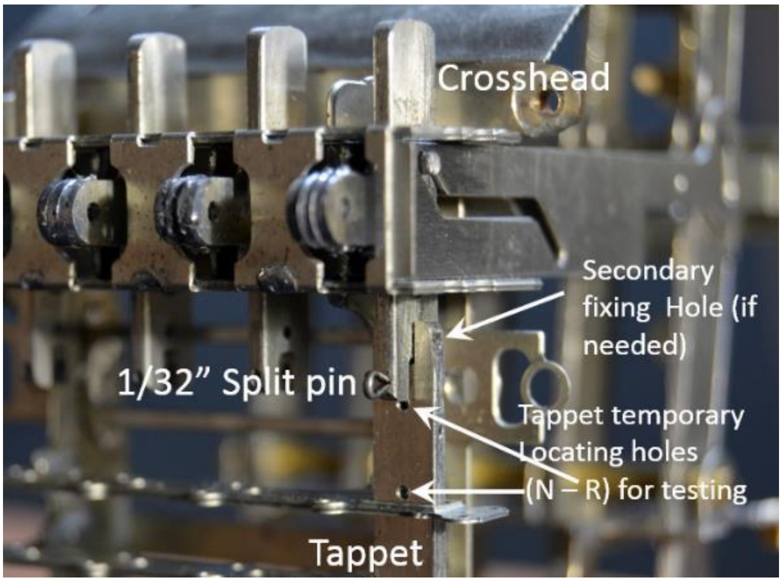
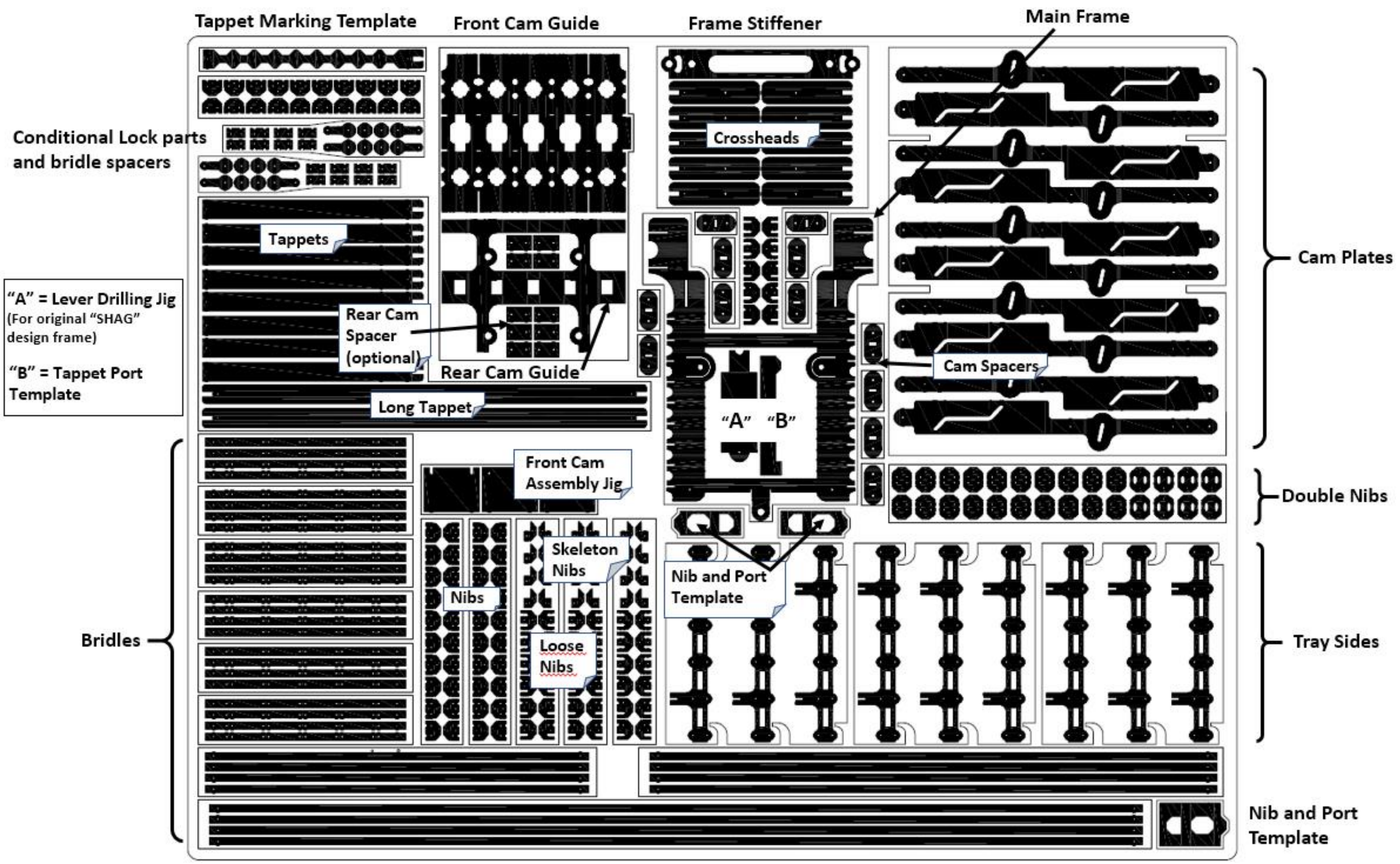


Photo showing the use of 1/32" Split pins for joining the Tappets to the Crossheads. Once everything is proven, additional security can, if necessary, be obtained by fitting 0.8mm N/S wire through the cross holes.

Note:- in the photograph, two additional holes can be seen in the tappet – one immediately above the top Tray-Side and the other just below the Crosshead. These allow the Tappet to be held in the "Normal" position (lower hole) or "Reverse" position (upper hole) even if the Tappet is disconnected from the Crosshead, or the lever frame is not attached – to make use of this, just insert a temporary piece of 0.8mm dia. wire into the appropriate hole and move tappet so that the wire bears against the topmost Tray Side. This facility can be very useful when building or testing the locking because without the levers attached, it will be found that the Tappets tend to drop away from the Normal Position under their own weight – even if the crossheads are connected - causing frustrating "false" locks.


Tappet Marking Template
Front Cam Guide
Frame Stiffener
Main Frame
Conditional Lock parts and bridle spacers
Crossheads
Cam Plates
Tappets
"A" = Lever Drilling Jig
(For original "SHAG" design frame)
"B" = Tappet Port Template
Rear Cam Spacer (optional)
Rear Cam Guide
Cam Spacers
Long Tappet
"A" "B"
Front Cam Assembly Jig
Double Nibs
Skeleton Nibs
Nibs
Nib and Port Template
Loose Nibs
Bridles
Tray Sides
Nib and Port Template

8. Fitting locking to a Mk1 (SHAG) lever frame

Although it is considerably more difficult to do, it is possible to lock the locking to a Mk1 (SHAG) lever frame and this might be useful to lock an existing frame. To do this, the existing frame will need to be completely disassembled as the levers will need to be drilled to fit the locking drive pin.

Drilling the levers for the drive pins.

The locking fret includes a drilling template ("A" on the illustration of the fret). The flanges on this should be bent up to right angles and this will enable the template to fit snugly on a lever. Fit a temporary length of 3/32" od tube into the pivot hole in the lever and locate the cutout at the bottom of the template this. Use the hole at the top of the template to locate the centre of the drive pin. Mark with a centre pop then drill out to 1.35mm and open then hole to a tight fit on the 1.4mm piano wire. Fit the drive pin as previously described.

Fitting the locking to the frame.

The original frame design does not explicitly provide a location for the locking table. However, it is possible to overcome this as follows:-

Firstly, re-assemble the lever frame and then locate the locking table roughly in position, threading the cam plates either side of the levers. Work the cam plates round the drive pins on each lever in turn until the frame and locking are in their correct relative positions. Temporarily clamp the locking table to the lever frame. Now work the levers normal and reverse to check the exact location of the locking which gives perfect travel of the cam plates to the fully normal and fully reversed positions. You should find that the Frame Stiffener plate comes quite close to the rear face of the lever frame but it is most likely that a degree of packing is necessary to achieve the perfect position and – because the design of the frame does not guarantee a consistent accuracy of build, the amount of packing needed may well vary along the length of the frame. Once the packings have been arranged, tack solder everything in place. Similarly, tack solder the rear guide plates in place on the rear face of the lever frame.

Fully test the locking and identify the causes of any stiffness – it is quite likely that in different parts of the frame the tappets will not be going fully N or R with the movement of the lever and adjustment of the packing spacers will be necessary to correct this.

Once the best possible result has been achieved, everything should be soldered up solid, but this is an irreversible step!!