MILLS SECTION

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SAIL CLAMPS

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History of SAIL CLAMPS

Sail clamps were often fitted to strengthen the sail stocks on mills equipped with iron canister windshafts.

A pair of sail clamps would be fitted to each stock. The clamps were stout lengths of good timber, sprung across the iron canister and shackled and bolted to the stock so as to brace it. The mid-length region of a stock is where it sees the greatest stress, both due to the weight of the sails and to wind loading.

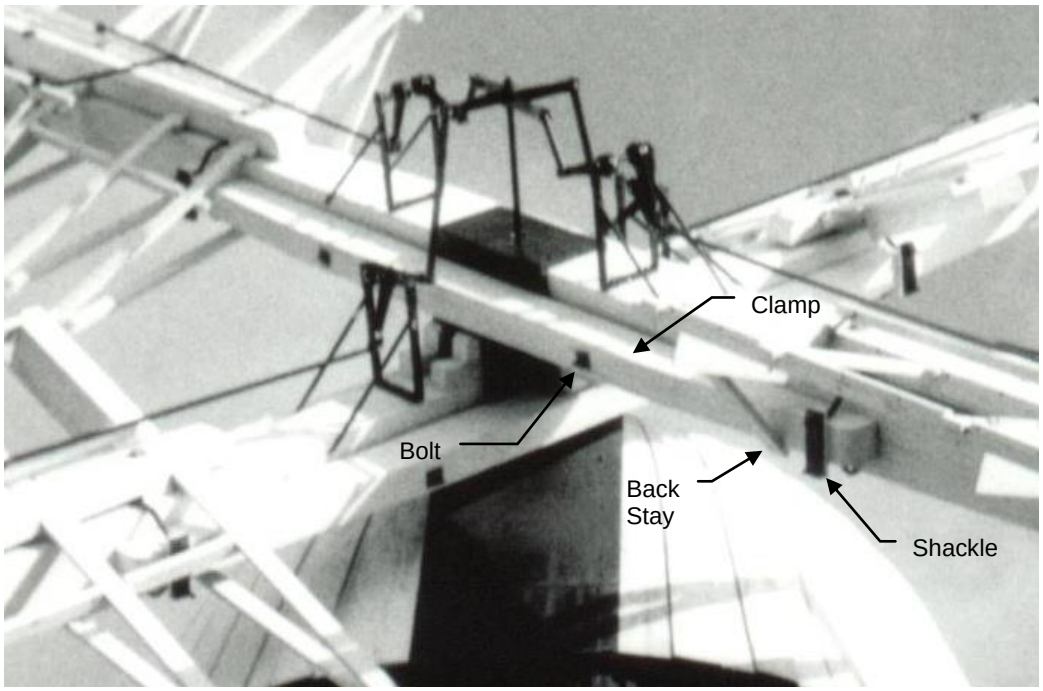

Figure 1. Sail Clamps fitted at Wicken Corn Mill, Cambridgeshire.

Of course there were many variants. On large mills the clamps might be very long, and were sometimes doubled up. Steel clamps have been used to good effect. On at least one occasion a third wooden clamp was fitted to a front stock, across the front of the windshaft canister, providing additional strength against wind loads.

At some windmills they were fitted from new. In other cases millers had clamps fitted as soon as they suspected a stock might be becoming tender. There is photographic evidence (for example at Berkswell Mill) that sail clamps were originally fitted in regions such as the West Midlands, where they are not now generally used.

Whilst a clear function of sail clamps is to assist the stock in resisting the weight of the sails, they can also assist in withstanding wind loading. The stresses due to this, especially sudden shocks in storms, can be comparable to those due to the sail weight alone. The clamp action is more complex against wind loading, but if tightly braced to the stock the clamps do significantly increase the ability to resist wind shocks. In addition, the bolts and shackles hold the clamps to the stocks in such a way as to increase the overall bending strength of the system and to reduce stress concentrations at the canister itself.

An incidental but important advantage of fitting sail clamps is that they prevent any axial movement of the sail stock through the windshaft canister. This means that the block nailed or screwed to the stock to locate it against the canister can be dispensed with. Such blocks, and their attendant screws, are a major source of rot located at the highest stress point of the stock, and are consequently a bad feature of some traditional designs. Major failures have been associated with this practice.

In view of the absolute importance of preventing serious accidents, all those responsible for windmills without sail clamps but with iron canister windshafts are strongly recommended to consider having them fitted. Apart from the likelihood that the clamps will reduce the chance of a breakage in the first place, they also make it extremely unlikely that the stock would fall to the ground, as has happened to un-clamped sails.

Practicalities

For both the primary functions, the clamps need to be tightly braced against the canister, and the ends of the clamps need to be pulled up tight against the stocks, thus transferring the load from the stocks by virtue of the clamps springiness. To resist wind loads, there needs to be a high friction force between the clamp and the canister walls, and the bolts holding the clamps close to the canister as well as the shackles need to be checked and tightened frequently.

The notch that locates the clamp round the canister needs to be shallower than the thickness of the canister wall. In this way not only is the clamp sprung against the stock by the end shackles, but also, importantly, there is an air gap between the stock and most of the clamp, preventing water from settling and promoting rot. For preference, the ends of the clamps should be sprung inwards by around 1in.

1.1 A Typical Design

Clamp design varies from mill to mill. Where clamps were fitted to the working mill, these should be copied, except in the very rare cases where the original design is grossly inadequate for the purpose.

Typically the clamps would be designed to run along the centre line of the stock, though this is not absolutely paramount, and the final location will often be determined by the poll end design. As a matter of good practice, it is advisable that the clamp be selected to be of the largest available section consistent with the canisters and the available timber.

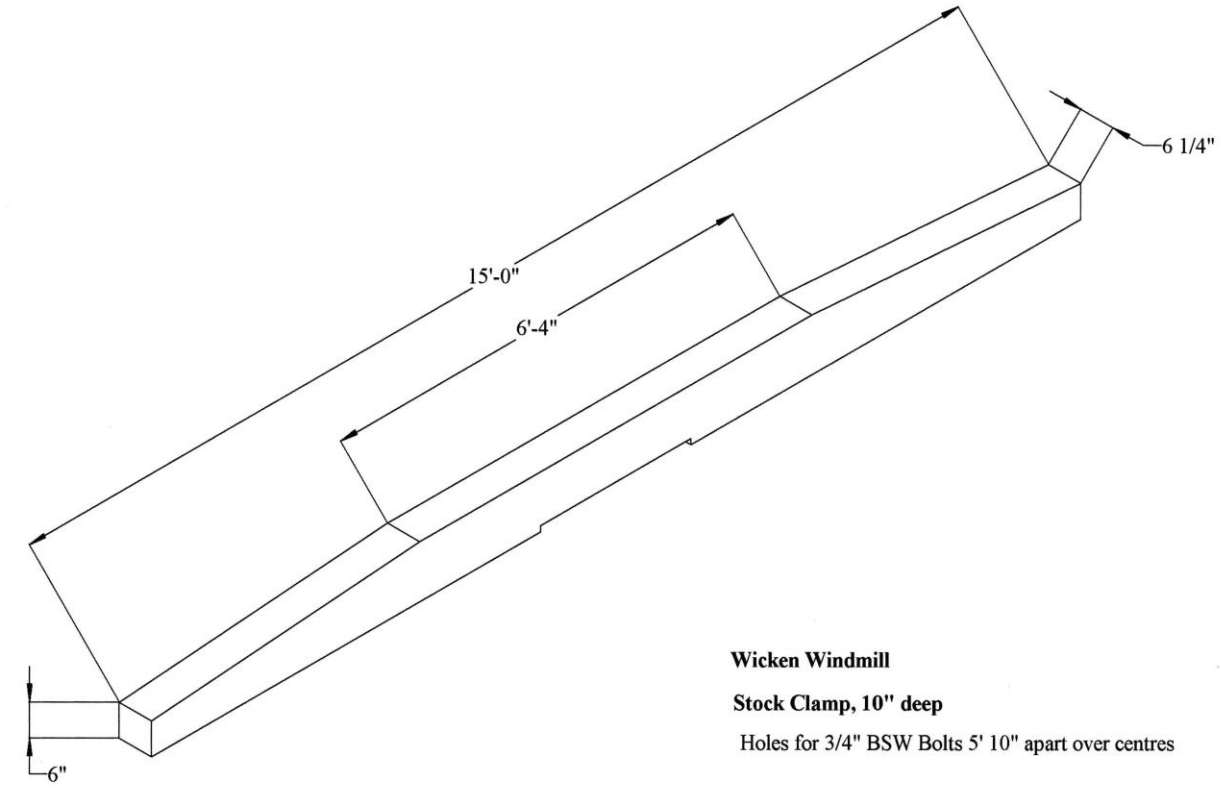

Fig.2 Typical Sail Clamp

It is advised that the stock should be a snug fit in the canister from side to side. From front to back the stock should be wedged up against one face of the canister.

It should be noted that the wind pressure on a particular sail varies as the sails rotate, tending to be significantly higher when the sail is at the top of its path. This variation in wind load effectively rocks the stock backwards and forwards in the canister, however imperceptibly, and can easily result in a gradual loosening of the canister wedges. A simple canister wedge restraint system is generally sufficient to counter this problem: the restraint's design should not impinge on the stocks.

A typical clamp design is shown in the sketches (fig.2 and 3), with the following overall specification:

Material: Slow grown Douglas Fir or Scotch Pine

Length: 15ft

Width: 6in

Depth: 10in

The clamp should be notched over the canister, sufficiently to locate the clamp, and importantly, the clamp should not be sprung excessively when clamped on to the stock.

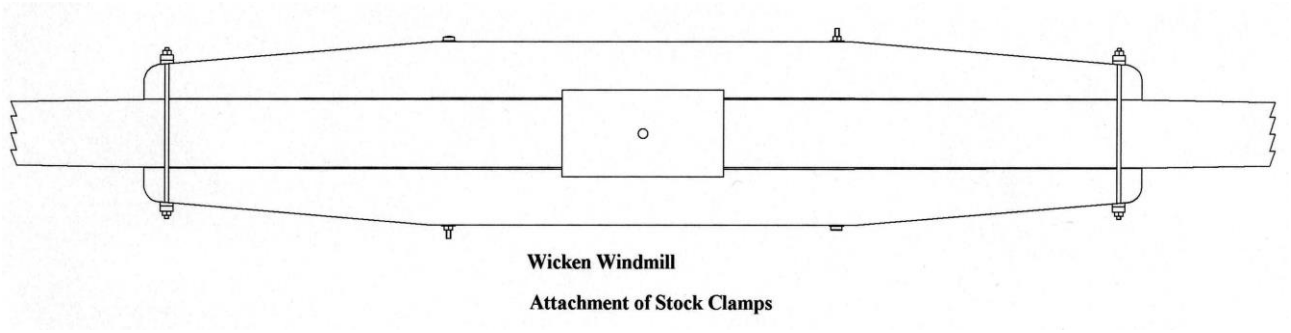

Fig.3 Sail Clamps as fitted

1.1.1 Fixings, per stock

Each fixing should hold both clamps on to the stock:

2 x 1in bolts or studs, approx 3ft long

2 x sets of shackles to hold the clamps at the ends NB In the photo there are wooden pads between the shackle plates and the clamps. These must be well painted. The pads have one face chamfered to accommodate the sloping face of the clamp.

1.1.2 Paint: general

Paint thoroughly, bearing in mind that the face between the clamp and the stock will be impossible to paint again without at least loosening off the clamp. Paint the bolt holes thoroughly: the bolts should again be a snug fit: they should not be a tight fit, but neither should they be sloppy. Preferably the steel bolts will be galvanised, and greased before fitting. This is in the interest of easier removal both to assist maintenance and replacement in the long term.

Traditional paints (using Lead Carbonate pigments) had a strong fungicidal property. Such paints are now banned, and replacements use Titanium Dioxide pigments which are not fungicidal and which are also vulnerable to UV light. It is recommended that Linseed oil based paints should be used as these are porous and allow water to evaporate more readily. Alkyd based paints form an impervious coating, which sooner or later traps water underneath it, leading to rapid decay. It is also recommended to treat the bare timber with a fungicide before painting to make good the lack of this feature. One way of doing this is to dilute an intial coating of linseed oil with 1/4 oil based wood preservative.

1.1.3 Fitting the Clamps

Sail clamps tend to be unwieldy and awkward to fit. The suggested approach is as follows:

- Lock the sails in position if possible, with the relevant stock vertical.
- Hoist the 1st clamp into position, hanging vertically
- From the storm hatch push the 1st clamp bolt through the clamp, and on through the bolt hole in the stock so that a few inches of the bolt's free end appear.
- Hoist the 2nd clamp in position.
- Push the bolt through, fit washer and screw on the first nut lightly. The pair of clamps should house over the canister.
- Unlock the sails. Rotate the stock through 180°. Lock the sails again if possible.
- If necessary fit spanish windlass around upper part of clamps and around the stock, to pull the 'free ends' of the clamps together sufficiently. Fit 2nd clamp bolt through one clamp. (It may be desirable to fit and partially tighten the Spanish windlass before the 180° rotation is complete.)
- Lever clamp until the bolt lines up with the stock. Push through.
- Lever 2nd clamp till the bolt will pass through. Fit washer and nut.
- Tighten clamp nuts.

After the sail frames are in place the clamp shackles can be fitted by millwrights standing on the sails. *The clamps should only touch the stock in the vicinity of the shackles.* If necessary thin wooden pads, well painted, can be fitted between the clamp and the stock at the shackle location. The clamps should not be tightened down on to the stock at the clamp bolts. There should normally be an air gap between the clamp and stock at this position.

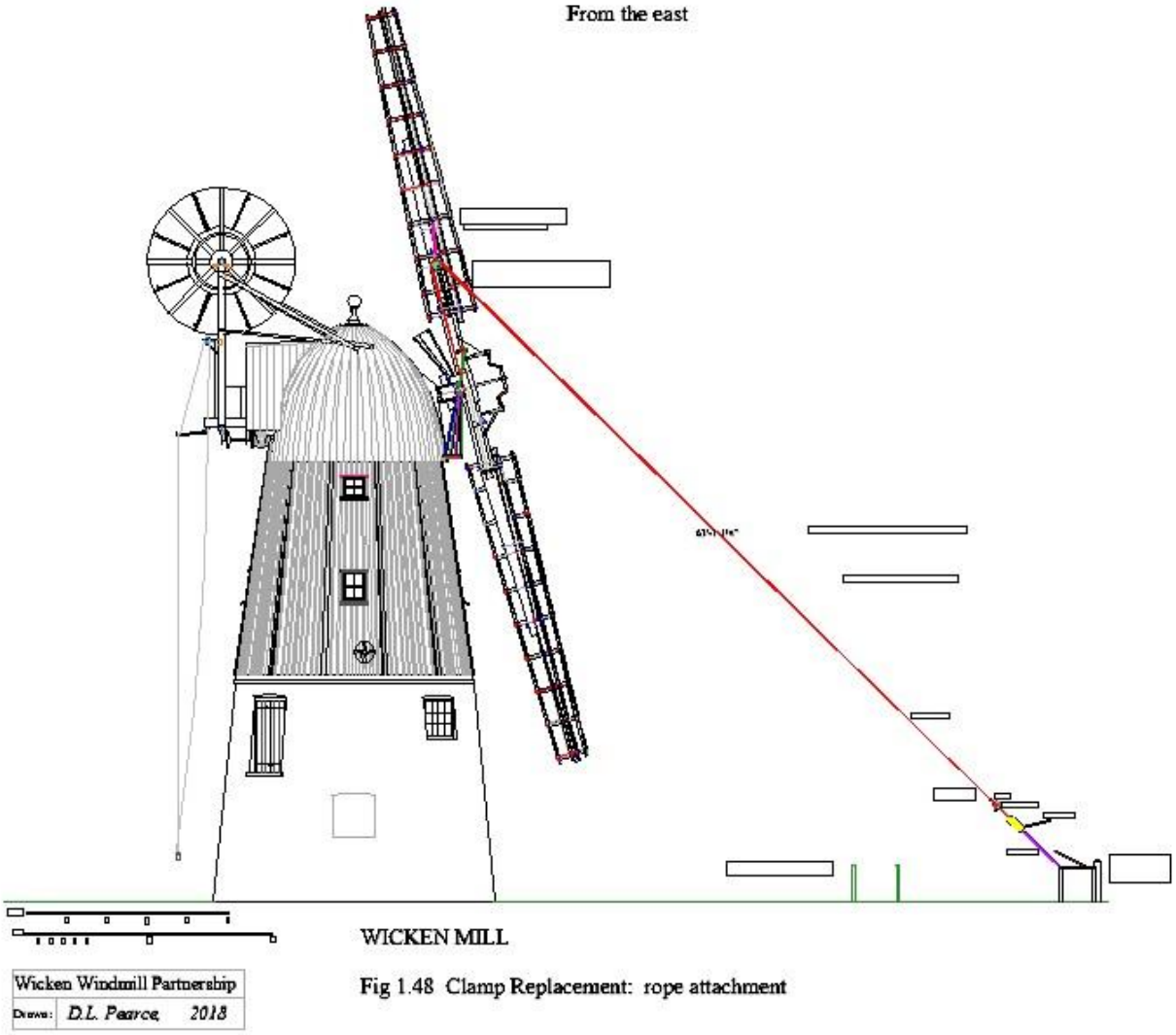

Fig 1.48 Clamp Replacement: rope attachment

N.B. The above instructions apply to traditional fitting of a pair of sails and clamps. Where a crane is to be employed there is great attraction to lifting the stock, top sail and pair of clamps (held by one through bolt) in one go, and dropping the stock through the canister from above. This method requires a millwright to be stationed inside the storm hatch, ready to ensure that the two clamps settle properly around the canister. This method of clamp fitting by-passes the first five steps of the traditional method.

1.2 Design Variation

There is considerable design variation in practice:

- the timber should be 'springy', that is capable of withstanding being sprung in place for the design life of the sails.
- The clamps can be markedly longer. On the driving side of a sail this is likely to require that the clamp is notched to allow free passage of the sail bars: care should be taken to avoid 'stress raisers' in the clamp. Also there should be an air gap between the sail bar and the clamp.
- On the leading side of the sail the back stays are likely to require fitting to the clamp rather than the stock.
- The clamps can be doubled up to give extra strength and support to the stock.
- It would be better for long term survivability if additional shackles were used instead of the retaining bolts. However the characteristic unwieldiness of the clamps makes this difficult to achieve.
- Some mills used a second set of bolts instead of shackles.

Repairs and Maintenance

Unless damage to clamps is superficial, they should be replaced rather than repaired. The whole point of a clamp is to relieve the stock of its load, and making a major repair consistent with this function is extremely difficult to do. The stocks are far more valuable and difficult to replace, so that it makes much more sense to put new clamps on as soon as they show signs of rot.

Clamps and Stocks should be inspected thoroughly annually. Any apertures, cracks or crevices should be treated with wood preservative using a spray, and turning the sails as necessary to allow the liquid to enter the holes under gravity. The stock wedges must be checked for integrity and tightness, and replaced and/or tightened.

Every five years, the clamps should be removed and repaired and repainted on the ground. The exposed areas of the stocks can be treated at the same time.

MILLS SECTION

Key Points

1.3 Must Do's

- Fit clamps to stocks passing through a metal canister
- Obtain high quality wood – these are structural components. Growth rings should be <3mm wide, density of the order of 500 kg/m^3
- Thoroughly preserve and paint all surfaces including internal ones

1.4 Must Avoid

- Alkyd based paints

1.5 Materials and Advice

For help with finding millwrights and suppliers of materials or for further advice see the SPAB website http://www.spab.org.uk/advice/ or ring 020 7456 0916

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