OXFORD DIOCESAN GUILD OF CHURCH BELL RINGERS

Educational Leaflet

No. 4

BELFRY CARE AND MAINTENANCE

ACKNOWLEDGMENTS

The Education Sub-Committee of the Oxford Diocesan Guild wishes to thank Mr Ranald W. M. Clouston, B.Sc.(ENG), C.ENG.,F.S.A., Honorary Technical Adviser to the Suffolk Guild of Ringers, for permission to produce this leaflet which is a slightly shortened version of that which he produced for the Suffolk Guild.

The original leaflet, referred to above, was extended and amended by John Davidge for the Towers and Belfries Committee of the Oxford Diocesan Guild in March 2010.

The Towers and Belfries committee wish to express their grateful thanks to Mr N. Balshaw for permission to reproduce his diagrams showing a bell in the "up" and the "down" position and to the Towers and Belfries Committee of the Central Council for permission to use material from their maintenance booklet, on which the Maintenance Schedule is based.

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BELFRY CARE AND MAINTENANCE

These notes are not intended to cover every aspect of this work, but it is hoped that they will be found useful. The Towers and Bells Handbook published by the Central Council can be referred to for greater detail.

1. THE FITTINGS

1.1 HEADSTOCKS

These are the most vulnerable fittings and require close attention. Timber (normally elm) headstocks should be treated with an anti-woodworm/rot fluid such as Low Odour FLX F/1 (see separate note). Wykamol Plus, Rentokil or Cuprinol would also be suitable Headstocks should be checked regularly for splits and other cracks which should be examined and, if necessary additional clamps made to maintain the strength of the headstock. If there are major splits in a headstock then it is worth seeking professional advice.

Some headstocks consist of two beams placed one on top of the other with a horizontal join between them. This is acceptable provided the securing ironwork is kept tight.

Mild steel (fabricated) headstocks generally give little trouble. Cast iron headstocks can sometimes fail because the core was eccentric or because the stay has been too strong and the bell has been 'bumped' excessively. The metalwork should be wire brushed and painted at intervals; examine regularly for cracks.

1.2 SECURING IRONWORK

Bells without canons. Keep bolts tight. Loose bolts can often be identified by the fact that the paint film between the nut and the headstock has cracked, or there is a slight film of red rust around the nut. If the bolt is really loose there may even be a polished area around the nut. If all the bolts are loose so that the bell can move on the headstock the same symptoms may be visible at the junction between the crown of the bell and its headstock. Whilst the order of tightening bolts is not as important as with a bell having canons, it is worth observing.

Bells with canons.

The bell must be square on its headstock. If necessary, tighten the nuts diagonally as on a car cylinder head. Fit lock nuts or spring washers, to ensure nuts remain tight. If the straps are moving as the bell is rung, even if only by a very small amount, rust “weeps” will be visible, indicating that tightening is required.

The older type of fixing using nailed straps and wedge bolts requires special treatment. The former can be tightened with small hard wood wedges glued and driven between canons and headstocks and new wedges can be made and fitted for the latter but the resulting strength must be carefully assessed and it is probably better to obtain professional advice first .

Never ring a bell if it is loose on its headstock.

1.3 GUDGEON PINS

Metal Headstocks

Gudgeon pins in fabricated mild steel headstocks are unlikely to cause trouble. Gudgeon pins in cast iron headstocks can, because the metals are dissimilar. Gudgeon pins are fixed into a cast iron headstock in three main ways: -

1. By being cast into it
2. By being drawn into a taper and riveted on the inside of the headstock arm
3. By being drawn into a taper and secured in the taper by a nut on the inside of the headstock arm

A loose gudgeon secured by a taper can often be identified from the standard signs of movement on the inside of the headstock arm; sometimes oil from the bearings works its way along the taper and exudes on the inside of the headstock arm. A loose gudgeon normally results in a "thump" as the bell is rung and if one is suspected the clapper can be tied and the bell rung to check. Cast-in and riveted gudgeons will require professional repair; if caught early enough, the nut on the third type of fixing can be tightened to draw the gudgeon back into the taper. It should then be checked again as outlined above. All gudgeons should be checked regularly; in the case of the taper fixings, early action can avoid the need to replace the headstock.

Timber Headstocks

There are a number of varieties of gudgeons:-

(1) Driven in and hooped
(2) Recessed, hooped and single bolted (Strap)
(3) Plate type with two U-bolts or four bolts
(4) Hoop type

Of these, types (3) and (4) are best. Plain bearings are not self-aligning so gudgeon pins must remain in accurate alignment as the bell swings by ensuring that the securing bolts are kept tight. When gudgeon pins are worn there is a risk of them shearing; refer to the section on bearings. Some gudgeon pins fitted by Gillett and Johnston circa 1954 had shoulders on them which form stress raisers and they fail by fatigue. The design was defective and they may need to be replaced professionally.

1. 4 BEARINGS

Ball

Ball bearings are normally spherically mounted and so are self-aligning. Do not add extra grease to the bearings if lubricators are fitted they should be removed and replaced with plugs. Overgreasing is as bad as undergreasing as the bearing acts as a sort of churn and the grease loses its lighter oil content, becoming cheese-like. Also once oil/grease has been forced past the felt seals it will continue to exude until the seals are replaced (a professional job.

When disturbed, bells should continue to rock to and fro through a small arc for half a minute or so if the bearings are sound. If the bell stops quickly, look for a sheared gudgeon pin. The pins should be central in the bearing housing holes. If a pin is found to be resting on the bottom (at six o'clock) then it has sheared inside the bearing housing. No further attempt should be made to move the bell and bell founder/hangers advice should be sought immediately.
If the gudgeon pin is central then it is likely that the bearings are worn or damaged internally; if the clapper is tied and the bell rung it is likely that vibration and noise will be evident. Replacement of the bearings will normally be a professional job.
Check that securing bolts are tight and that as the bell swings in a full circle there is no movement of the bearings relative to the frame. Any movement will be evidenced by a "thump" as the bell is rung; if the bell is "lashed" it may be easier to hear any noises..

Plain
Plain bearings are in almost all cases not self-aligning and any movement of the frame or bearings can cause pinching of the gudgeon pins. Bearings should be cleaned out with paraffin and all solidified grease should be removed. Wash any felt pads in paraffin and refill with a mixture of Castor oil, Russian tallow and Molybdenum Disulphide from a plastic bottle fitted with a nozzle which will exude the grease when squeezed. The actual bronze bearing block is often in a cast iron box bolted to the frame.
Check that the bronze block remains firm in the box and that the latter is firm on the frame when the bell is swung. A loud knock when the bell is swung full circle indicates that the bearings and gudgeon pins are seriously worn. If this is the case, check the beams under the floor in the affected pit to see whether there is any possibility of the bell falling through if a gudgeon pin sheared. If this could happen, consider placing stout beams on top of the floor in the pit. Be especially wary if the bell is over a hatchway, a very weak zone.

1.5 STAPLES AND CLAPPERS

The Staple is the fitting on which the clapper swings.

Independent Staples
Independent staples (secured by a threaded rod which passes through both the crown of the bell and the headstock) are by far the best. They should be fixed with a castellated nut and split pin or two nuts on the top of the headstock. In the former case the split pin should always be renewed if withdrawn. The staple must be set square in the bell to ensure that the clapper swings in a plane at right angles to the axis of the bearings (to reduce the wear on the clapper pivot) and must be central in the bell to avoid making the bell odd-struck. Methods of reducing odd-struckness will be discussed later. Grease the joints as instructed by the founders. Some have screw down lubricators, some a nipple for use with a grease gun. Most modern joints do not require lubricating.

Cast-in and False Staples

Until the industrial revolution it was very difficult to drill through the crown of a bell, so the staple was a loop cast into the bell. These cast-in staples are prone to crack the crowns of bells as they rust and expand. They are unsatisfactory mechanically especially when the bell has been turned; false staples are only a little better. The lining in a false staple is usually leather or wood which must be renewed when worn to ensure that "clapper roll", or sideways movement is kept below 50 mm and to avoid a "clonking" noise as the bell swings in a full circle. The leather should have been soaked in Castor oil before fitting. Keep ironwork tight on the staple when reversing dogs have been fitted for a bell which has been turned. If the leather has been worn away for some time the pin is likely to have become sufficiently worn to make merely replacing it an unsatisfactory option. In this case professional advice will be required.

Clappers

When the clapper ball is badly worn at the point where it strikes the bell a blacksmith could heat and twist the stem to bring spherical parts of the ball into use. When a ball is badly worn the metal at the point of wear may creep, harden, and eventually break off (a process known as spalling) leaving sharp edges which can damage the bell. Where this is starting to occur, the clapper can be removed and lightly ground with an angle grinder to restore the profile and remove any sharp edges. Because of the sparks (and the consequent risk of fire), grinding should not take place in the bell chamber.

Check that the flight clears the slider under all conditions.

Odd-struckness

If a bell strikes earlier than expected on one stroke and later than expected on the next, it is known as odd-struck and this is usually due to the fact that the clapper is not quite in the centre of the bell. Modern bells usually have adjusters so that the clapper can be easily centred, but with older bells other methods may have to be used. This subject is dealt with more fully in a Technical Note (TBC03) obtainable from the Towers & Belfries Committee, or downloadable from the Guild web-site.

1.6 STAYS AND SLIDERS

Traditional

Stays are safety devices to prevent damage to the bell. They should be made of Ash and not be too stout. Straight stays mounted on the side of a headstock should be tapered on one side from the top of the headstock to the tip – the un-tapered side should be against the headstock. Socket stays should be slightly thinner than the depth of the headstock to avoid the risk of breaking out the socket if the stay is hit too hard.If there is any concern about stay dimensions the bell founders/hangers, or members of the Towers & Belfries committee, will be able to advise. The wood used for stays should be as straight grained as possible and should be free from knots or other defects – especially in the area just above the top of the headstock, which is subject to the greatest stress. Slider paths should be free from grease and

should be lubricated with furniture wax or with grate polish. Stays and sliders must not be too long or they may foul other fittings so when a new stay is being fitted first, if possible, check the length against the original. When a new stay has been fitted the bell should be rung up slowly, with an observer in a safe position, to ensure that the stay neither hits the frame or other fittings nor is too short to contact the slider. The "set" of a bell can often be adjusted at the slider. Where a “side-fitting” stay is being replaced, check that it is being replaced on its original side (normally the same side as the rope) otherwise the setting of the bell may be dramatically altered, since the track is offset to allow for the normal displacement of the stay. The replacement of curved stays is normally best left to the professionals as the grain direction is very important.
Stays (particularly side-mounting ones) should be regularly checked to ensure that they remain tight. A hard tap sideways with a clenched fist will produce either visible movement, or a click if the stay is only very slightly loose. Tightness is very important with a side-mounting stay, as the tip of a loose stay may work sideways along the slider and eventually come into contact with the runner board (slider track). If this happens the “go” of the bell can be severely affected. Signs that a stay is contacting the runner board will be a “rub-mark” on the tip of the stay and a circular mark on the runner board.

Hastings Type

Taylor's instructions must always be followed when fitting Hastings stays. They must be the correct length and must taper on all four sides. The dingle (the finger at the top) must be free to move easily from side to side. When a new stay has been fitted, the bell should be rung up to see that the stay is not too long and does not bind on the fixed plate.

SLIDERS

These need to move very freely – especially on lighter bells, where any resistance can noticeably affect the “go” of the bell. As previously stated they can be lubricated using furniture wax or grate polish; check also that the slider is not binding at the pivot end. If a new slider is being fitted, check the length to ensure that it does not foul anything else (e.g. frame or walls). On little bells the slider track can become very worn in the centre with a pronounced “dip” which can affect the “go” of the bell. If there is sufficient clearance (check carefully!) between the stay and the track (runner board) a strip of hardwood can be fixed to the inside to overcome the dip. Otherwise the runner board should be replaced.

1.7 PULLEYS

Sealed Ball Bearings

This type does not normally require any attention but check that the pulley (if wood) has not warped and that it does rotate freely. Most modern pulleys are made of plastic (nylon or composition) so are not liable to warp; however some

older ones are subject to grooving (especially when used with pre-stretched terylene ropes) although this is not usually a problem.

Older types

Oil and check for freedom of rotation. Clear out dirt below them and above the floor. Examine for worm attack and treat if necessary.

Replacement

If in a poor state, pulleys should be replaced as they have a major effect on the "go" of a bell. Replacement pulleys can be obtained from founders or bellhangers. When ordering, state whether the sally passes through and whether a double pulley is needed. Pulleys should not be too large or heavy because of the energy stored in them.

1.8 WHEELS

Examine the wheel while the bell is being rung for evidence of warping which may cause the rope to slip off the wheel. Adjust struts if necessary. Ensure that the wheel is tight on the headstock. Check the wear at the garter hole and fit half cylinders (e.g. sliced cotton reels) if necessary, to increase the minimum radius. The rim must be kept firmly secured to the sole by screws – check that these do not protrude into the rope path. If necessary, treat for worm attack. Check that the wheel is vertical, at right angles to the headstock (parallel to the frame), and is aligned with the pulley.

1.9 ROPES

Adjust ropes regularly to minimise wear at the point where they pass through the garter holes. Fitting leather sleeves at this point can be beneficial. Use only long splices near the wheel or pulley (see Educational Leaflet No.1 "Rope Splicing"). Check that the rope is not rubbing on the frame cill or the pulley box. If necessary, put up a board by the cill and cut away the pulley box. Examine ropes for wear at intermediate floors, guides, chutes etc. Fit pulleys at changes of direction at floors. Worn ceiling roses can be turned through 90 or 180 degrees. Check that rope chutes are anchored at both ends and cannot foul the rope by moving out of alignment.

1.10 ELLACOMBE HAMMERS

These are potentially a major source of trouble. Check that the hammers strike the point of maximum thickness and on unworn zones. Check that the heads drop clear of the bell and clapper flight and that the tail also clears them. The stop on the Taylor type should be examined to ensure that the hammer cannot be held against the side of the bell. Lubricate the pivots. The hammers should not be fixed too firmly to the frame in case of accident. If the manual or chiming ropes are out of the ringing chamber, they should be locked up or disconnected when the bells are being rung.

1.11 CLOCK HAMMERS

Check that the heads are firm on the stems and are approximately 3 mm clear of the bell when at rest. If a hammer rests on the bell, reset the spring below the arm. Arms should not have been bent by having been caught in the wheel spokes. Check that when pulled off they are clear of the bells, wheels and stays. Hammers should not strike a bell at the point opposite any internal wear marks (such as in the case of a quarter turned bell).

2. THE BELLS

2.1 WEAR

Using callipers, measure the depth of the wear at the point where the clapper strikes each side of the bell; it should not exceed 6 mm. Bells are normally turned when this wear reaches 5 mm.

2.2 CLAPPER

Check that the clapper is of the right length and strikes the bell at the chord of maximum thickness, i.e. the soundbow.

2.3 CRACKS

If the sounds from the bell die away quickly there is probably a crack somewhere. A common place for cracks to start is in the crown where the cast-in crown staple may have expanded. If this is made of rectangular section iron bar the crack will start at one of the corners of the bar and will radiate out on a diagonal. Cracks are more easily seen inside the bell than outside as a general rule. Cracks spread as the bell is used and can ultimately lead to part of the bell falling.

2.4 CANONS

Examine canons and argents (the loops on the crown), if they still exist and are used, to see that none is cracked.

3. THE BELL FRAME

3.1 METAL

All bolts must be kept tight. Painting is necessary every 7 to 10 years and is a major job, so the Incumbent should be advised when this is necessary. The Quinquennial architectural survey of the church should also cover this item.

3.2 WOOD

Keep all bolts tight and all threads treated with graphite. Watch for beetle and woodworm attacks and treat affected areas. Note any undue movement of the frame when the bells are being rung; such movement should not exceed approximately 2 mm horizontally and vertically relative to the walls. Seek technical advice if in doubt.

3.3 SPANNERS

Spanners should be available to tighten every nut in the gear and frame. An adjustable spanner with approx fifty mm jaw clearance is most useful for odd-sized nuts. Two spanners may be needed to prevent bolts turning or to tighten lock nuts.

4. TOWER

4.1 MOVEMENT

All towers move a little when bells are ringing. This movement should not exceed 2 mm horizontally at roof level if the "go" of the bells is not to be affected. Observe cracks in walls and place finger tips across them when bells are being rung to check whether they widen. If they do, seek technical advice. Report any unsafe ladders, floors, defective roofs, parapets, pinnacles, flag-poles, louvres and masonry, to the Incumbent.

4.2 LEAKING ROOFS

Any leaks should be pinpointed by inspecting the tower on a wet day. Repairing lead roofs is a skilled job but as a temporary measure there are composition bandages on the market which can be applied to the affected area. Advise the Incumbent of any roof leakage.

4.3 BIRDS

Birds must be kept out of the tower to avoid the build up of debris which can harbour woodworms, diseases and parasites. Louvred towers can be made bird proof by placing NETLON plastic netting, stapled to a suitable timber frame, inside the openings. Once the tower has been made bird proof, clean out all the debris and treat timberwork.

4.4 WOODWORM ATTACK

Any timber in a tower is vulnerable to attack, including wooden frames and fittings. The two main forms of attack are from furniture beetle (normally regarded as woodworm) and from death watch beetle. The furniture beetle is normally evidenced by very small holes (around 0.5mm) and a white dust residue. This beetle tends to attack softwood, so that on bellframes and floor beams there is usually only damage to the surface and the strength is not seriously compromised. Floor boards and wheels (if left untreated) can be seriously weakened to the point of failure.

Death watch beetle has larger holes (1mm) and the residue is a dark reddish dust. The beetle tends to prefer the harder wood, such as the centres of beams and areas of compression (such as the ends – especially if they are damp). If left untreated, beams can remain largely unaffected visually whilst being almost entirely eaten away inside. If death watch beetle is suspected, professional advice needs to be sought in order to assess the extent of the damage and the strength of the timbers.

For Furniture beetle treatment with WYKAMOL PLUS or equivalent is

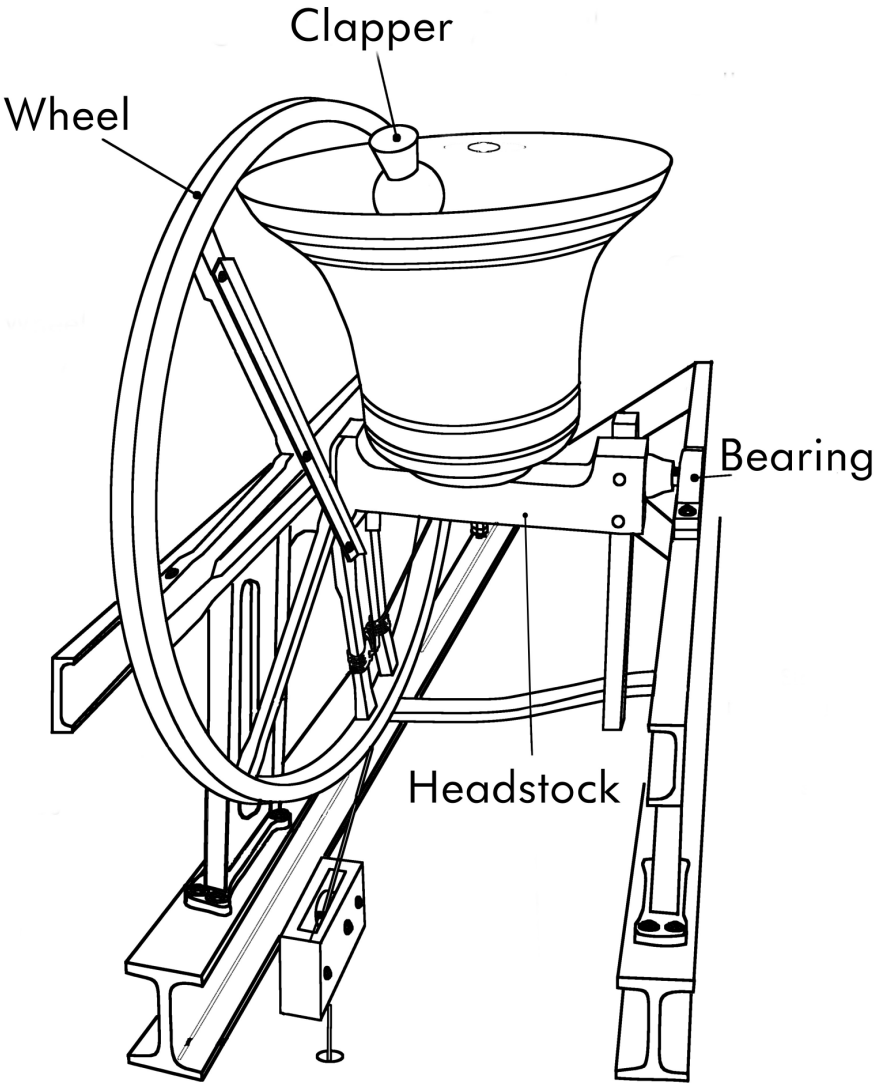
recommended, in the case of Death Watch beetle, effective treatment may require pressure injection of fluids, so is probably best left to professionals.
Most treatments work by killing beetles by direct contact, hence the need for pressure treatment. However, there is now (2010) a treatment, Low Odour FLX F/1 which works by preventing larvae creating a new skin as they grow – thus killing them. If any do survive to adulthood any eggs will be infertile. This could be considered as a preventative treatment prior to attack. Advice on its use can be obtained from the manufacturers (Sovereign Chemicals Ltd, Cumbria)

4.5 ROT

Any timber subject to continued exposure to dampness is liable to rot. In general, wet rot occurs where the timber is, and remains, very wet. The affected timber breaks down and becomes friable, but if allowed to dry out the fungus tends to die. The area can then be treated with a proprietary rot treatment. Dry rot is more serious because although it starts as the result of dampness or wetness, even though the source of the damp is removed, the fungus can absorb moisture from the air to maintain its ideal conditions. Dry rot can be identified by the fact that the affected wood cracks across the grain into cubes, there may be a smell of mushrooms, and white growths may appear. It can also travel through walls and even though the area is dried out, the spores can remain dormant until conditions are again suitable for growth. Outbreaks of dry rot are difficult to treat and should be reported to the Incumbent or PCC so that professional treatment can be arranged. The main risk areas are the ends of beams and floorboards where these enter or abut walls.

The best defence against many of the problems outlined above is a regular inspection of the installation and the tower by the steeplekeeper or members of the local band coupled with a good standard of cleanliness throughout the tower, since dirt and rubbish can retain damp, harbour insects and obscure evidence of attack. Maintenance check sheets are available in Central Council publications and also from the Oxford Guild Towers and Belfries committee as part of their maintenance award scheme.

Appendix I – The Parts of a bell



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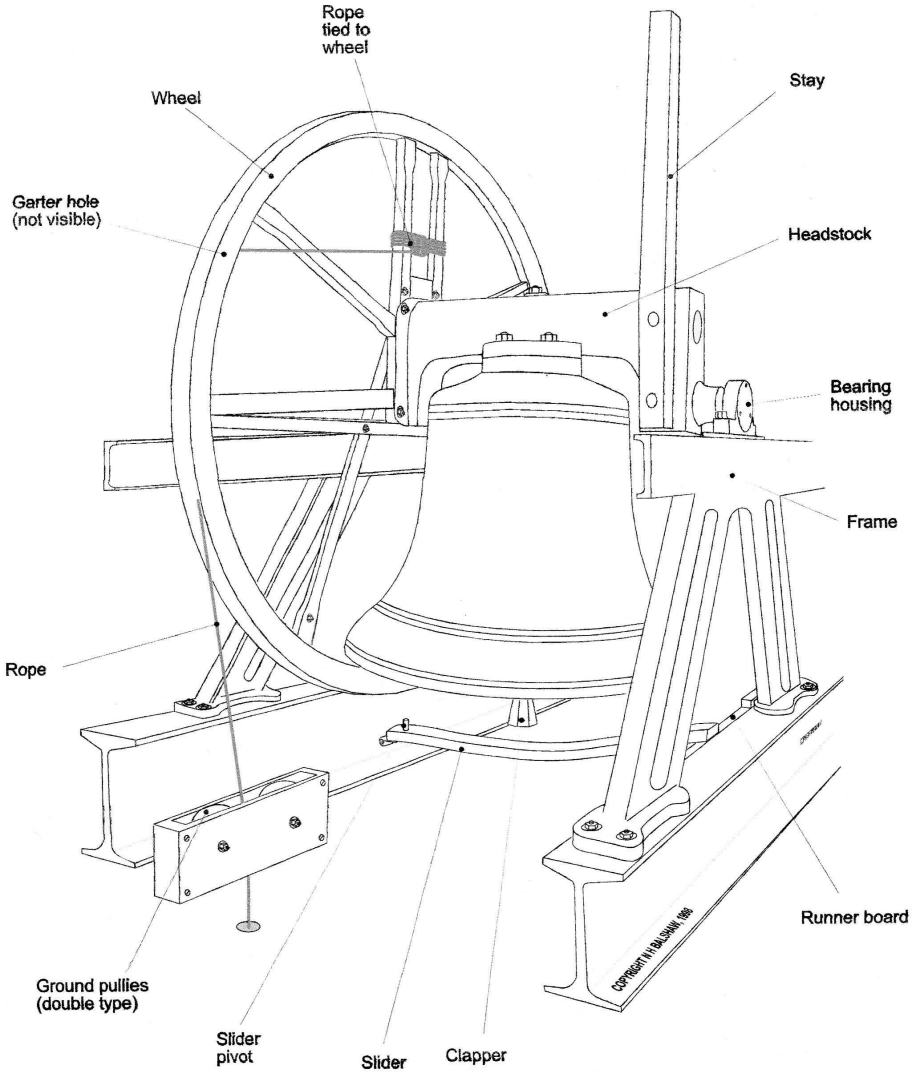

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Appendix II – A suggested maintenance schedule

Weekly

Year:……..

Lubricate plain bearings
Check lighting throughout the tower

Monthly

Weekly +

Oil plain bearing pulleys
Check ropes
Check stays for looseness and cracks
Check for loose clappers/staples

Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec

Quarterly

Grease ball bearing pulleys
Clean and check runner boards/sliders
Grease clappers (if applicable)
Check tower roof drainage
Check tower for water ingress
Check pulleys for wear
Check "Spider" cord
Clean ringing chamber

Date Done

Every Six Months

Check frame bolts
Check bearing bolts
bearings
Check clock hammers and springs
Check barring apparatus
Check access stairs/ladders/traps
system

Check headstock bolts
Check for worn clapper
Check for loose wheel bolts
Check chiming hammers
Check for birds, etc.
Check safety of sound control

Date Done

Yearly

Check rope chutes/bosses/guides	
Check clock hammer wires	
Check clock weights, wires & pulleys	
Check tower or spire structure	
Clean out dirt and rubbish	
Treat rust outbreaks	

Date Completed