Woodhouse Walk-through

The Woodhouse Change Ringing Machine is an interesting piece of Ringing History. Since the death of Bobby Woodhouse, in 1957, the machine has been owned and cared for by the Lancashire Association of Change Ringers. It has had a major rebuild by Gordon Thwaites in the 1960s and lesser attention by him subsequently. This document is intended to act as an introduction for people who have care of the machine, and explains how it works, what the various parts do when it is operating, and generally familiarise you with the machine.

We start by looking at the machine as a whole:

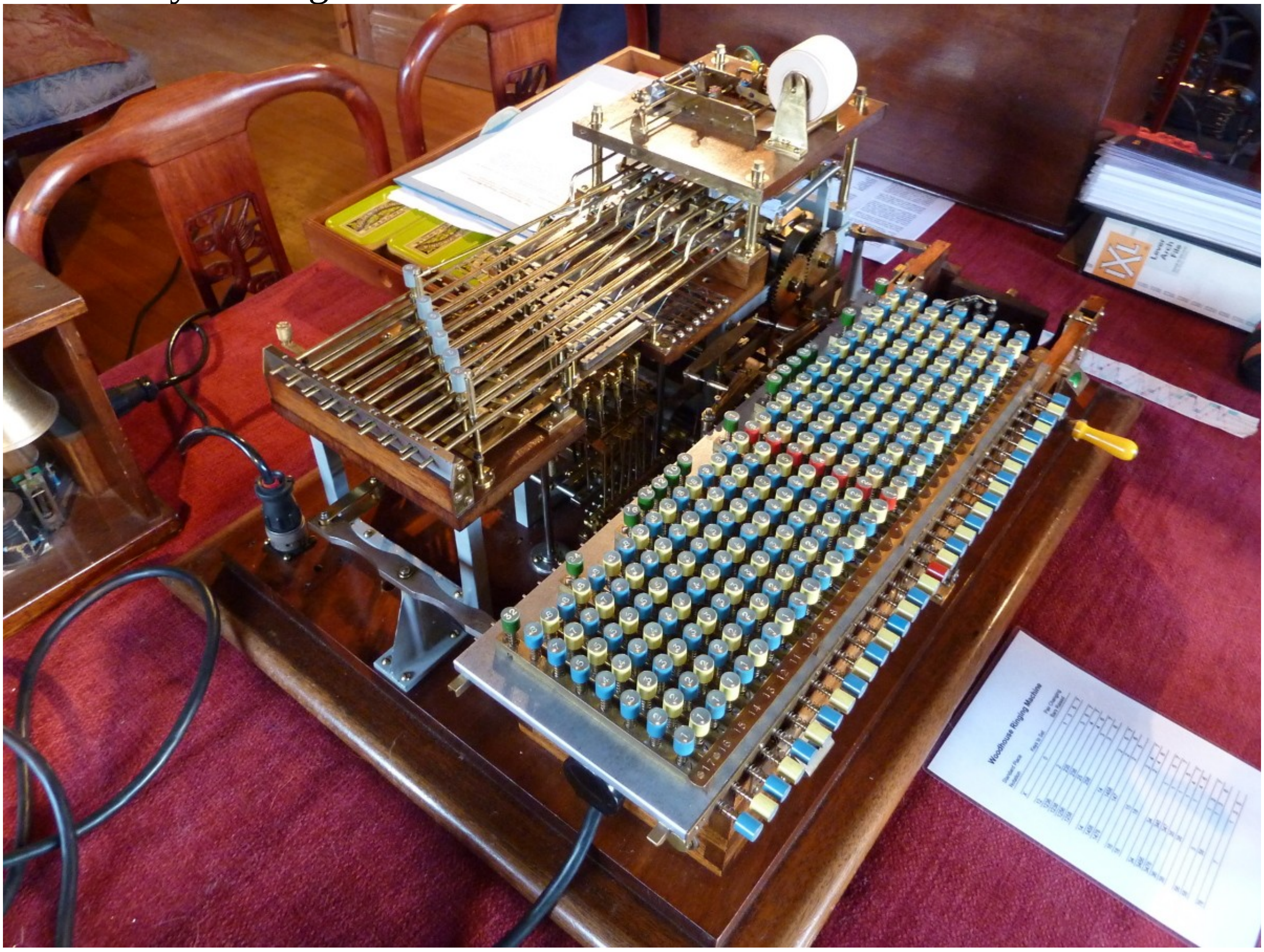


Fig 1. Overview

As well as the actual machine, there are two items, the bells, and the drive motor, seen in figures 2 and 3. There are eight bells in the cabinet, each with a solenoid and hammer to strike it. The bells are connected to the main machine by a cable.

Fig 2. The Bells

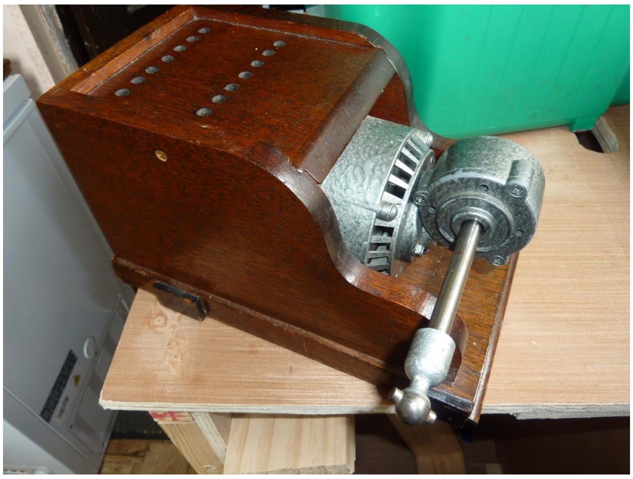
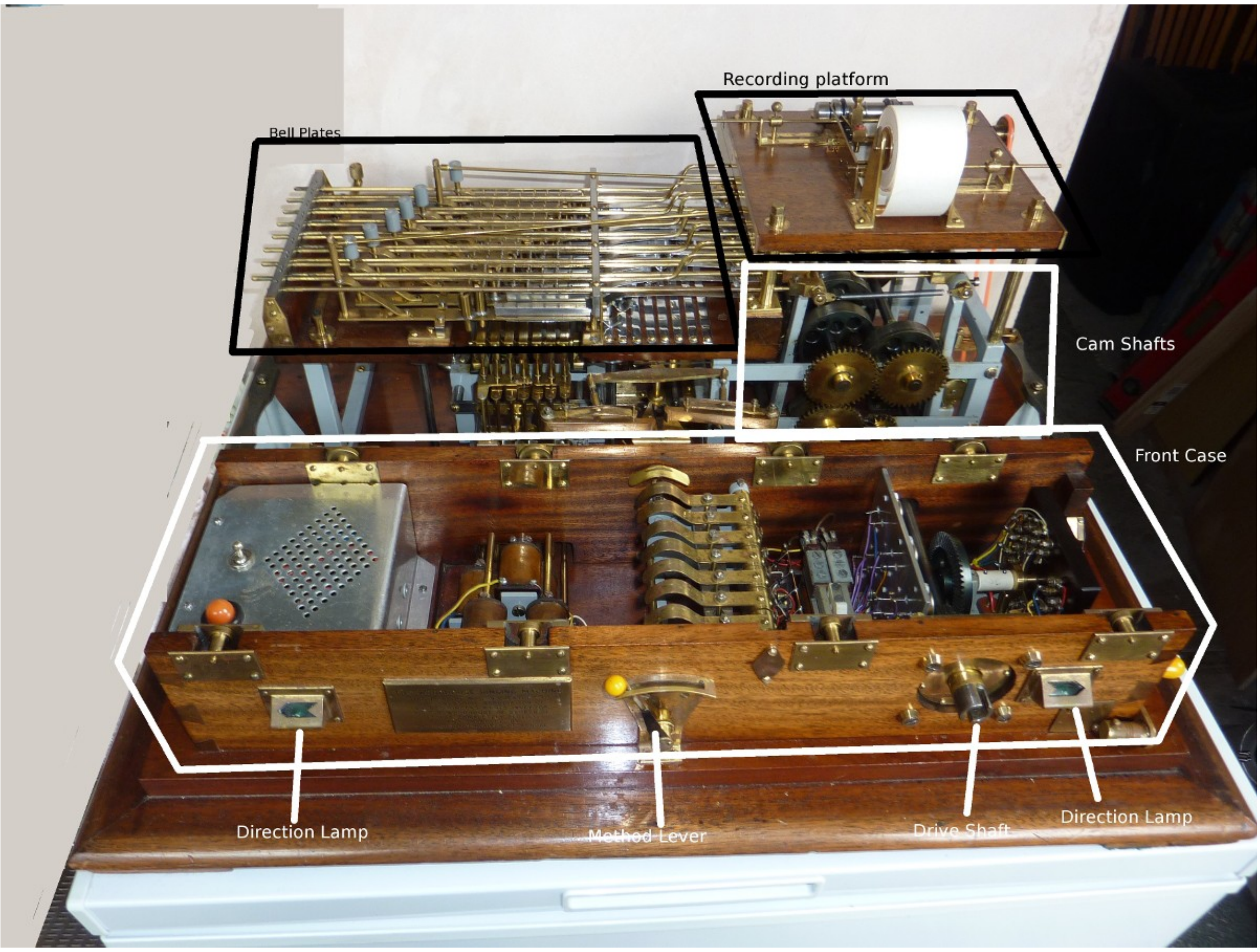


Fig 3. Drive Motor

The drive motor has a connector on the shaft that plugs into the main unit. Alternatively the yellow handle seen in Fig 1 can be used for minor adjustments and tests.



This annotated photo labels the main sections of the machine.

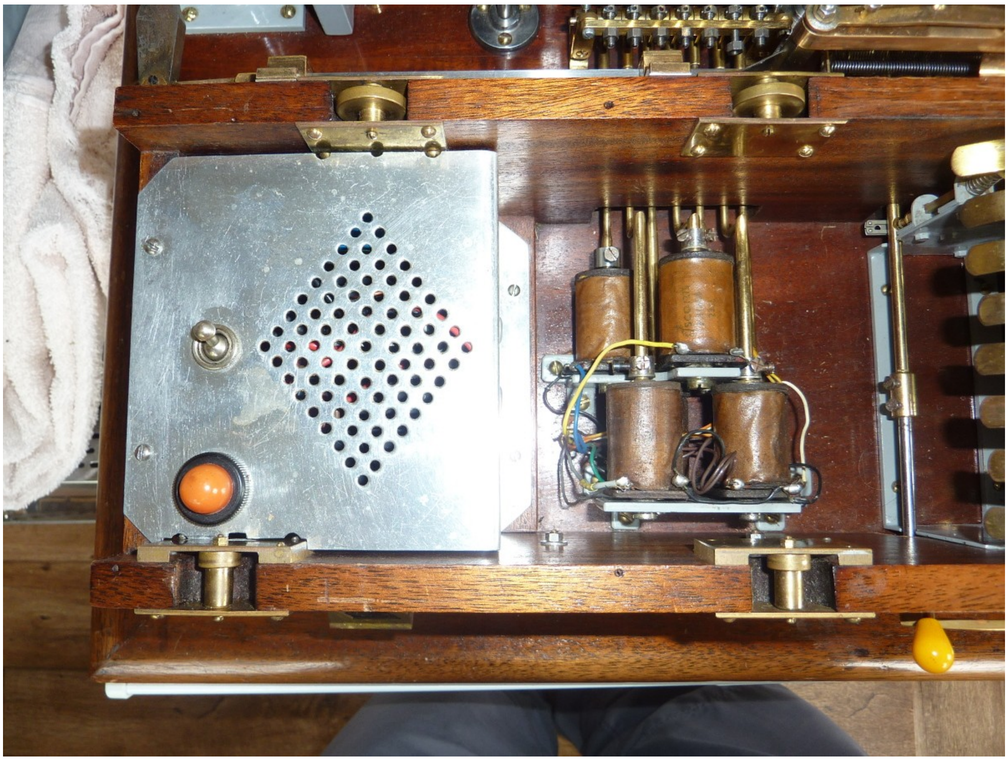
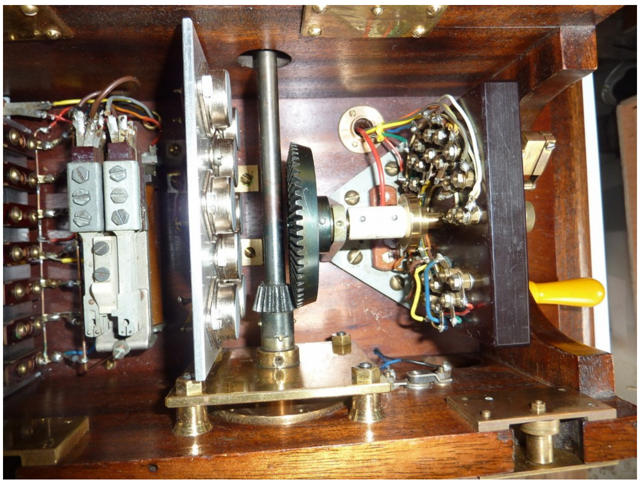


Fig 4. Power Supply and Solenoids.

At the left end of the front case we find the Power Supply unit. On the end of the unit is a socket into which the power cable should be plugged. This brings power from the Power Box. The switch seen in fig 4 controls the power to the bells and solenoids. I will leave the solenoids until later. Also visible in this photo are 4 brass rollers, two near top and two near bottom, that the programming bed will rest on. Others are further to the right.



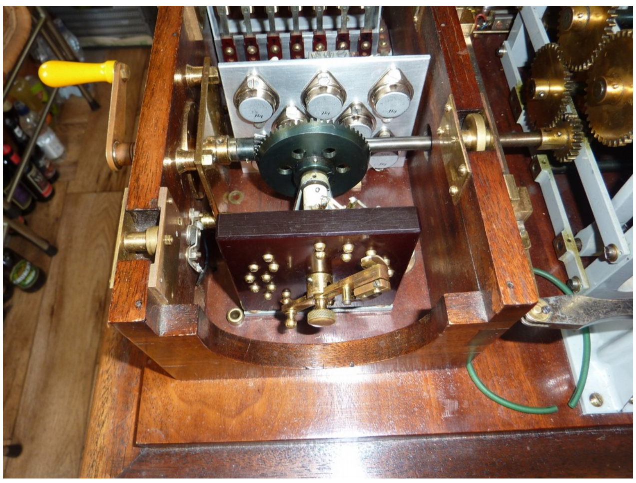


Fig 5. Main shaft and Rotor

Fig 6. Rotor end view

At the right end of the case there is the main drive shaft, and linked via bevel gears, the rotor shaft and rotor. As the main shaft is rotated, the rotor shaft is forced to rotate, but at a slower rate thanks to the gear ratio. The rotor on the end of the rotor shaft is a brass arm that carries a wiper that connects power to two circle of studs. The outer circle has sixteen studs and is used when ringing 8 bells. The inner circle has 12 and is used for 6 bell ringing. There is a gap to the left of the top centre, providing the traditional backtroke-to-handstroke gap. There is a ceramic coupler on the rotor shaft as the rotor is supplied with power to activate the bells when the wiper contacts each of the studs and the coupler isolates this from the rest of the machine. Also seen in the above photos is a group of power transistors mounted on an aluminium plate. These are connected to the rotor studs and boost the current to a level suitable to activate the bell solenoids.

Fig 7. Place bars

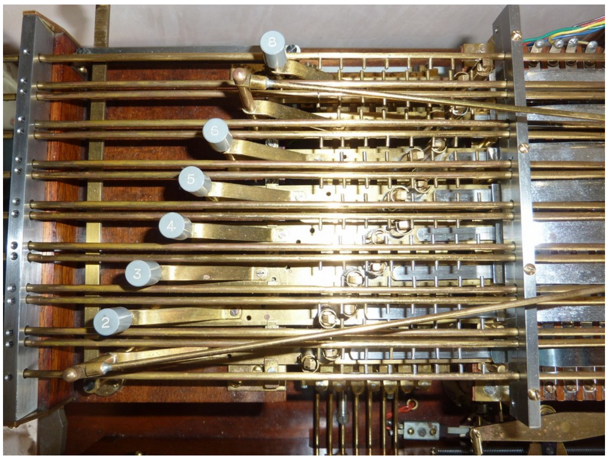


Fig 8. Bell plates

Moving towards the rear of the machine, we find the bell plates and place bars. The bell plates can slide left and right. In Fig 8 they are seen in position to ring rounds. Each has a grey plastic cap, apart from 1 and 7 which have brass rods linking them to the printing device. The caps have the bell numbers engraved on them. I will deal with the mechanism that moves the plates later, for the moment it is enough to see that each of them have a springy contact on top and underneath. The upper ones are fixed to the beam at the right of Fig 7 and are connected to wires that feed, via a socket on the baseboard, and a cable, to the bell cabinet. Thus each bell plate is connected to a specific bell.

The contact on the underside if the bell plate moves with the plate and contact the place bars which run across the platform and are clearly seen in Fig 7. Each place bar is wired to one of the power transistors, the sequence being left to right. Thus when the plates are in position as shown, the pulses generated by the rotor via the transistors is applied to each bell in turn, thereby ringing rounds. If the plates are moved to different positions then the bells will ring in a sequence determined by these positions.

This far, we have seen the power unit supplying power to the rotor which generates a sequence of pulses as the main shaft is turned. These pulses are fed to the bells via the place bars and bell plates.

We now move to consider how the plates are moved and how this can implement the changing sequences of a method.

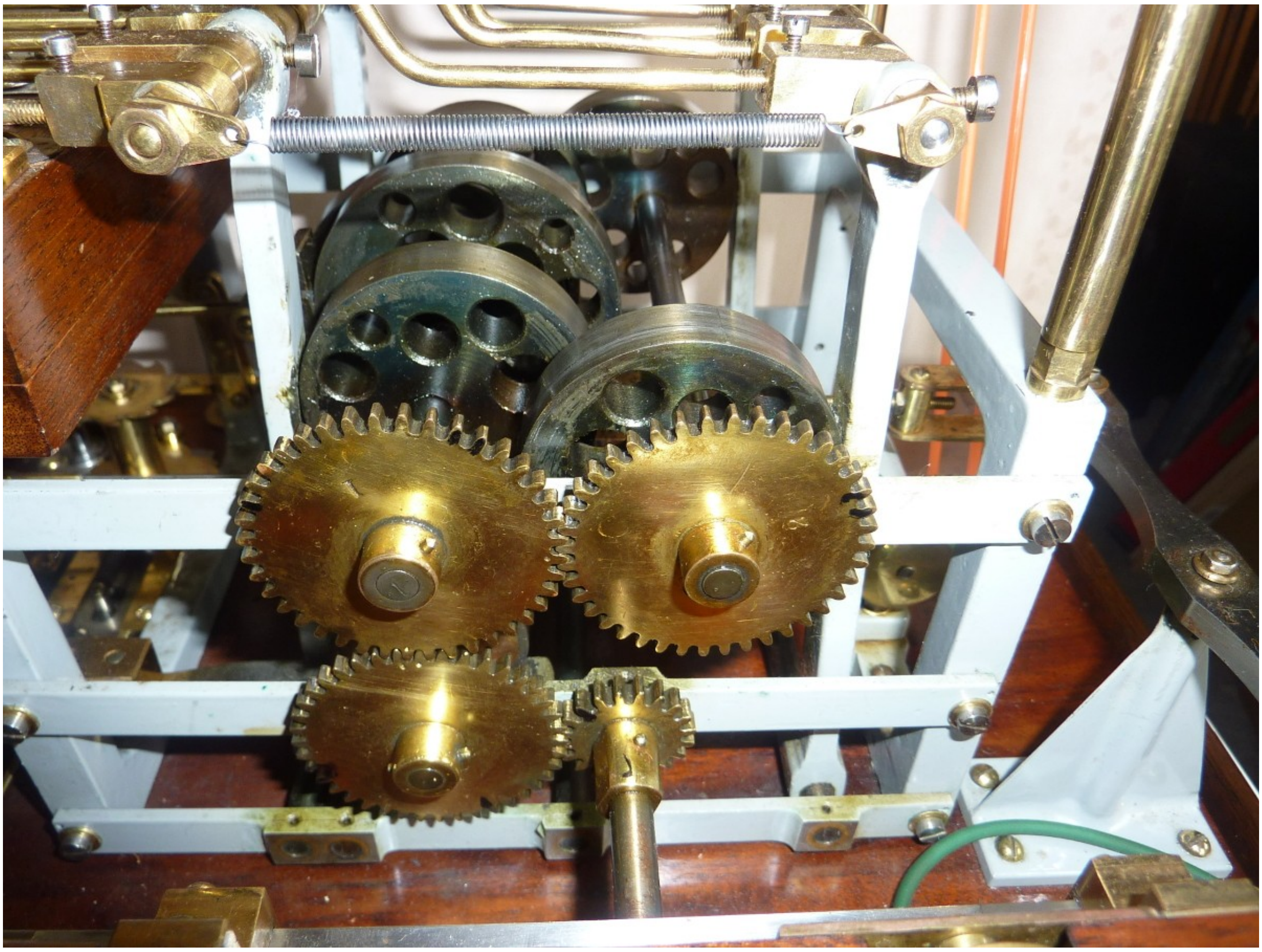


Fig 9. Gears and Cams

Behind the main shaft is the talles part of the machine, which I refer to as the tower, for fairly obvious reasons. This supports three shafts, which are driven by the gears in this photo. For each revolution of the main shaft these shafts each rotate by half a turn, thus two turns are needed to complete a cycle. This is equivalent to a stroke, either handstroke or backstroke. Clearly the gear ration to the rotor needs to be 4:1 so that the rotor will generate the handstroke and backstroke pulse over four rotations of the main shaft.

As the upper two shaft rotate they each have two cams which press against the vertical bars seen here. These move in opposite directions to each other and each is connected to a series of rods, know as the push/pull rods. These can be just seen at the top of this photo, and are more clearly seen in Fig 8 passing across the machine and over the bell plates. As they move to and fro, they can catch on hooks that slide in tubes mounted on the bell plates. If they catch then the motion of the push/pull rods is just enough to move the plate one place left or right. This provides the means of moving the plates from one place to an adjacent one.

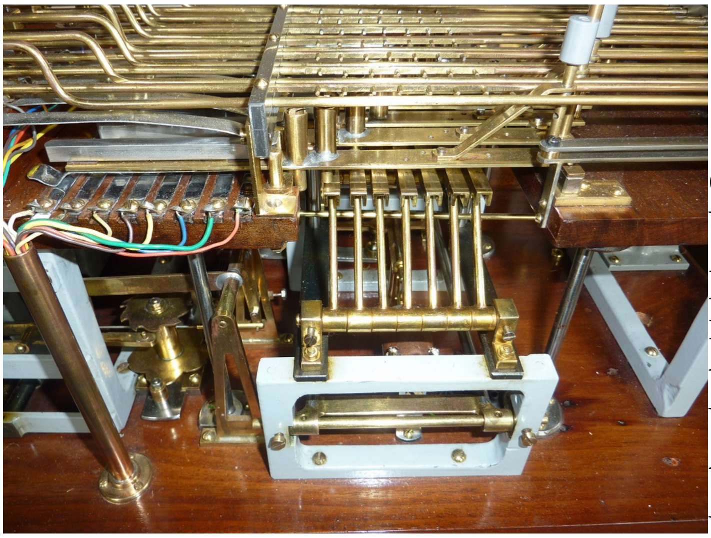


Fig 10. Parallel Bars

This photo is taken from the rear of the machine, and shows seven brass bars that run under the bell plates. These are supported on rods which pivot in such a way that the bras remain parallel to the base. If a bar is lifted then any of the hooks which is over that bar will be lifted up enough to catch on the spines of the push/pull rods and so will move the plate accordingly. In this photo you can see the tubes that contain the hooks. Each plate has two such tubes spaced as you can see on the nearest plate (Bell 8). They are spacedalong and across the plate, so that one further from us in this photo is nearer the lead end by one place. If the left parallel bar in this shot was raised, it would raise the further hook on Bell 8 and the nearer hook on Bell 7. The push pull rods are so arranged that they would pull Bell 7 into 8th place and push Bell 8 into 7th place.

One of the basic rules in ringing is that a bell can only move in one direction at a time, and so it is very important that two adjacent parallel bars are not raised at the same time. If this happens, then the rods will be trying to move the relevant plates in both directions and the machine will jam. If this happens it is usually caused by an error in setting the method, which we have yet to describe. In order to resolve a jam, switch to using the handle and rotate gently backwards until the hooks are released and drop.

The next question is what raises the parallel bars?

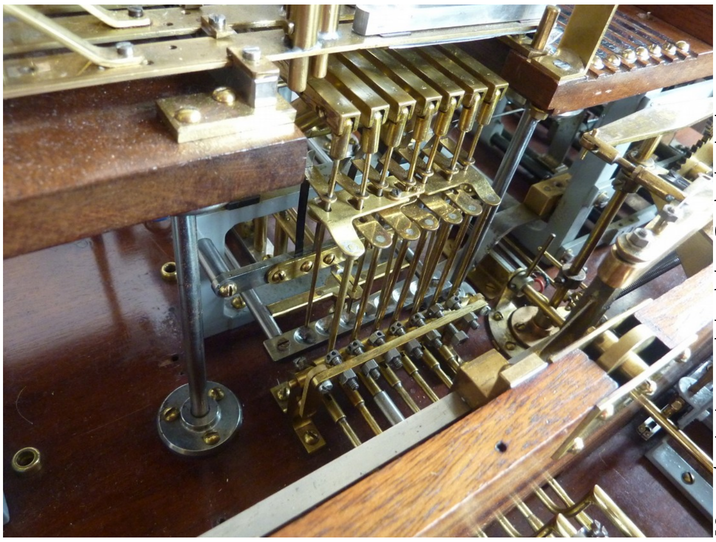


Fig 11. The Needles.

Here we see the front view of the parallel bars. From this side we can see that each has a vertical rod, which we refer to as the needles as they are very slender.

If they were allowed to hang vertically, each would rest over a steel bar which has a depression immediately below the needle. When the main shaft is rotated a further cam on one of the gear shafts operates a lever which alternately raises and lowers this bar. I refer to the bar as the lifting bar. Clearly is nothing was deflecting the needles and if the bar was to lift, all of the parallel bars would also lift, and we would encounter a jam as described above.

However, it can be seen that as well as the needles, there are a set of guide plates through which the needles pass. These can act in two ways: they can pull the needles to the front, thus avoiding the lifting bar, or they can push the needles beyond the bar and equally avoid being lifted. These plates are mounted on vertical rods which are pivoted near the base. Below the pivots, the rods are linked to horizontal rods which are operated by the solenoids which are visible in Fig 4. Note that most of the plates operate on more than one needle, pulling or pushing. For example, the leftmost plate acts to push needles 1 and 3 beyond the bar when operated. When it is released, it pulls 2 and 4 to the front, off the bar. By means of the various combinations it is possible to arrange matters so that most of the combinations of changes in general use are feasable.

The Solenoids therefore determine which places will change and so, provided these are operated in the correct sequences, a method can be performed.

In between the solenoids and the main shaft, at the centre of the front case, there are a set of contact levers:

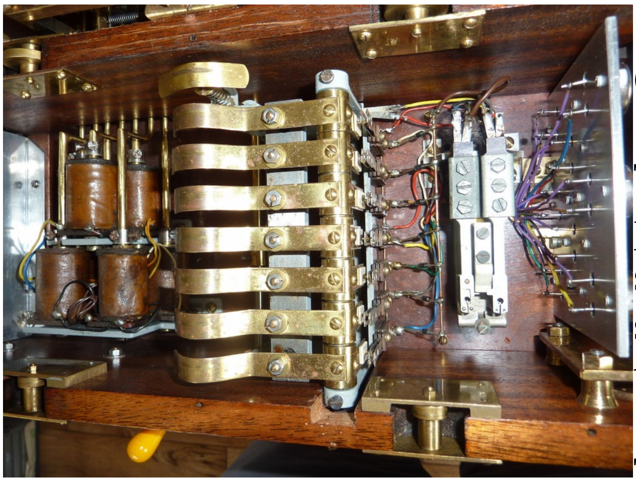


Fig 12. The Contact Levers and Contacts.

There are 8 of these brass levers, pivoted at the right end. The front seven of these operate a group of springy contacts. These in turn operate the corresponding solenoids.

The eighth lever is slightly different and this is intended to operate a reversing system.

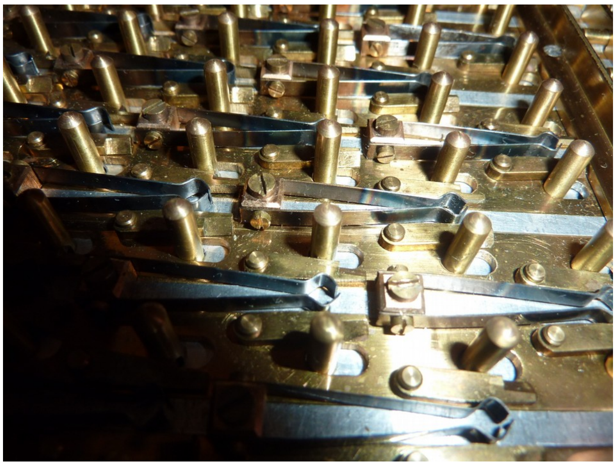


Fig 13. The program bed

Fig 14. Detail of the underside

In order to set up a method, there is a program bed, which is a panel with a large number of buttons, seen in Fig 13 above. These buttons have brass pins that project below the underside of the bed. When pressed the pin projects further and a latching mechanism holds it down until a release button, one per column, releases them. The release buttons can be seen at the front of the bed.

The bed itself rests on top of the front casing, on the rollers seen in Fig 4 and Fig 12 above. As it rolls along the pins which are immediately over the contact levers can depress the lever, closing the contact, and operating the corresponding solenoid. A system of ratchet pawls acts on small pins projecting from the back of the bed to move the bed left or right as needed.

Fig 15. Stepping Ratchets

The reversing mechanism controls which of the ratchet pawls, if any, are able to engage with the pins on the back of the bed, and hence to move the bed. In Fig 15 we see the pawls with hooks which catch the pins. The brass lever seen here above the pawls can be rotated and will move one or other of the pawls closer to the bed so that pawl will step the bed along when it moves. Both pawls move from side to side in opposing directions, driven by two cams on the lower gear shaft.

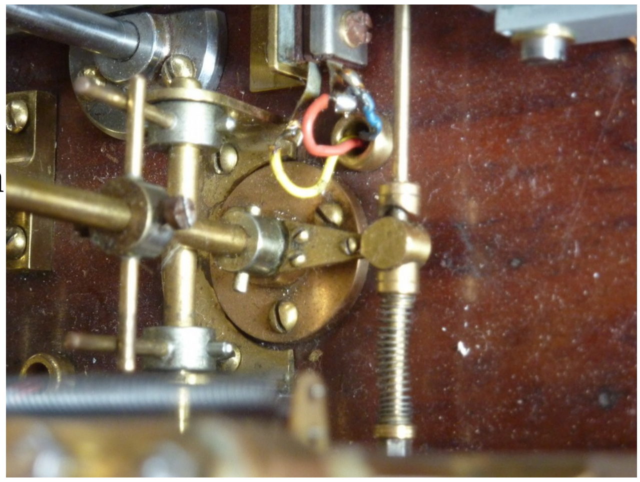


Fig 16. Pawl positioning.

Fig 16 is a slightly off-vertical closeup of what is below the rotating lever seen in Fig 15. The reversing rod which appears vertical in this photo, to the right of centre, moves from front to back to determine which pawl is active. However, it will be seen that the vertical rod, here seen rising slightly to the left, which bears the rotating lever, is being forced to a neutral position by two brass pins mounted on the method shaft, which also appears vertically to the left of centre. When the method lever is pushed to the left, the centreing pins move away, and the rotating shaft can adopt the position determined by the reversing rod.

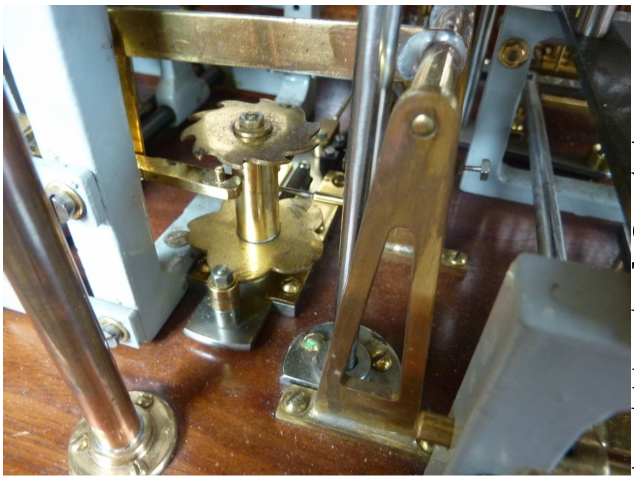


Fig 17. Reversing Cam and Ratchet.

At the rear of the machine is a short vertical shaft which bears a 5-lobed cam, and a 10-tooth ratchet wheel. The reversing rod seen in Fig 16 bears on the cam and as the shaft rotates the rod will move forward and back alternately. The ratchet wheel is turned by a pin on the end of a lever which can be seen emerging behind the pillar at the left. This level move to and fro during operation, but is normally just below the wheel and therefore does not operate it. When activated by the reversing contact under the bed, or by pressing the button on the left end of the machine, it is lifted by a solenoid seen here:

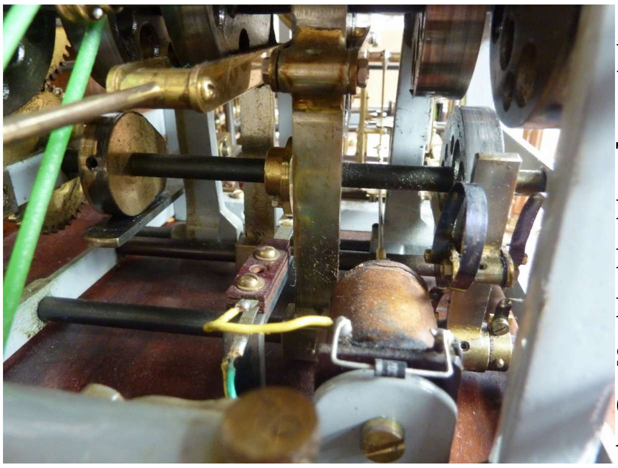


Fig 18. Reversing Solenoid.

The solenoid is the brown cylinder at rhe right. The Cam which drives the ratchet lever can be seen at the extreme right of the photo. To the left of the solenoid is a pair of contacts which are operated by a small cam above them so that the solenoid will only lift at the appropriate moment in the cycle and will engage smoothly with the ratchet wheel. This explains why the reversing button has no effect unless the machine is in motion.

We now come to the printing device.

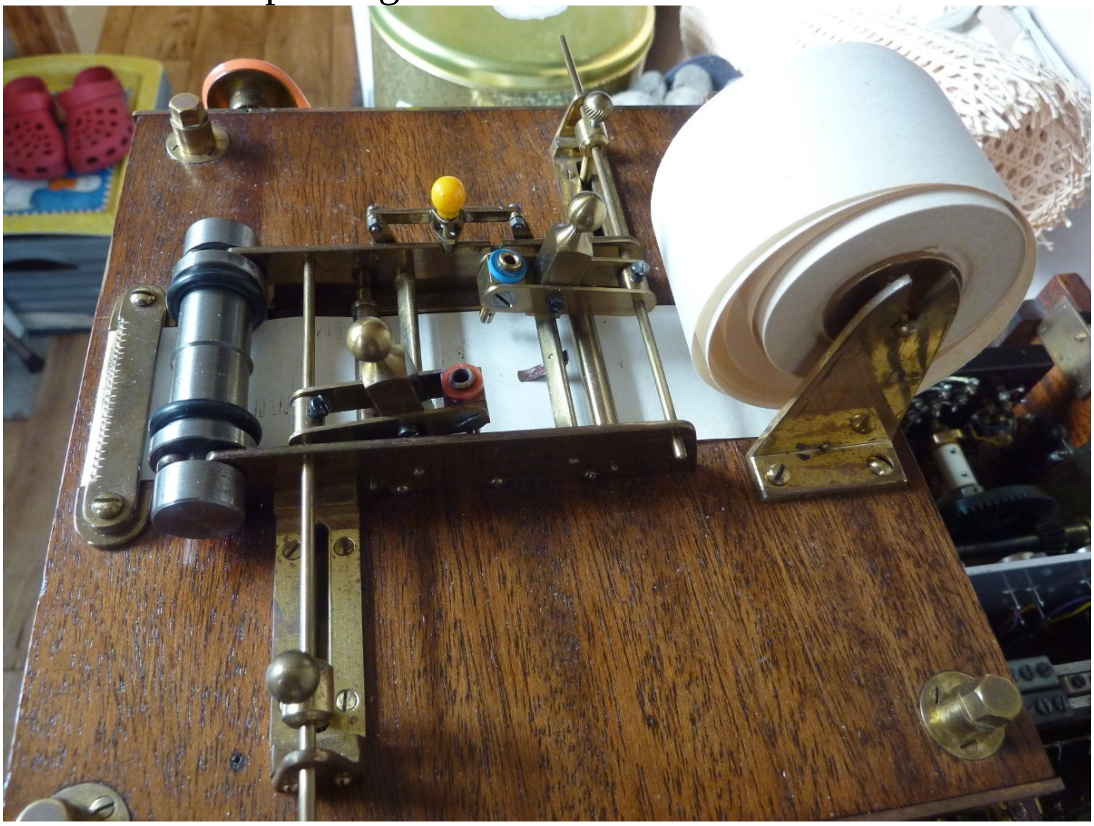


Fig 19. Printer

The printer is on the top of the gear tower, and is linked to two of the bells plates, the treble and the 7th. In the above photo, the penholders can be seen with the red one for the treble and the blue one for the 7th.The steel roller at the left presses the paper down on a roller positioned underneath which is rotated slowly as the machine operates. A system of linked levers underneath the platform ensures that the motion of the bell plates is scaled down so that it just fits nicely across the width of the paper roll.

In use, the penholders are fitted with Parker Gell Pen refills, which give a good clear trace, and fit nicely into the hole in each holder.

The yellow knob seen at the far side lifts or lowers the pens onto the paper, and also grips the paper to prevent it moving when the pens are lifted.

The printer is driven via two plastic belts and a reduction gearbox which slows down the paper motion to a suitable rate for recording the traces.

The design of the machine, as described above, is such that if the power is switched off and the handle turned, the machine will implement the ***all-change*** change, that is where the sequence 12345678 changes to 21436587. Continuing to turn, it will perform it again, and hence return to the 12345678 or rounds position. This is undesirable, so at some point the machine was modified by the addition of a relay, which can be seen in Fig 12, to the right of the contacts. When power is on, and the motion lever is to the right, i.e. method disabled, this relay is operated and causes some of the solenoids to be operated. The aim is to deflect all of the needles away from the lifting bar. It turns out that the guide plates are so designed that this is not quite possible. The best that can be achieved is to move all but needle 3 away. To overcome this deficiency, a further solenoid was added, underneat the bell plates and behind the needles. This solenoid's sole function is to pull needle 3 away. Thus the ideal state of ***no-change*** can be achieved. This solenoid, which I refer to as solenoid 8 (the seven in the front case being 1 to 7), is also operated by an additional contact on the relay. This means that the machine will happily ring rounds provided the power is switched on.

The relay is operated by a pair of contacts hidden behind the front case and operated by a small cam on the method shaft. There has been some problems with these contacts, and a temporary fix has been to insert a small wooden wedge, secured by a bit of white-tak which holds the lower contact spring at just the right height. I hope to acquire a relay contact spring adjusting tool, and guidance on how to operate it in the near future so that the contacts can be adjusted to give reliable operation and render the wedge unnecessary.