A. E. Wiggins Hipp Clock

Richard Watkins

The right of the cover photo shows part of Rees "Cyclopaedia or universal dictionary of arts, sciences, and literature" first published in 1802-20 in parts once per month. There are 45 volumes including 6 volumes of plates in my binding. I think it is the very best English encyclopaedia.

I would like to thank Norman Heckenberg and Andrew Shepherdson who provided help and information, and Norman Heckenberg who provided the photo of the Avoca (Tasmania) clock, Figure 7-10, page 24.

Contents

1 Precautions Taken Before Moving

These precautions ***must*** be taken whenever the clock is moved, otherwise damage to the pendulum suspension spring will result. I hope things have been put back in their rightful places!

Figure 1-1 Pendulum lock base

Figure 1-2 Pendulum lock storage

Figure 1-1 shows the lock base and Figure 1-2 shows the pendulum lock beneath the shelf.

1. Loosen the two bolts for the pendulum spring, Figure 1-3. This enables the pendulum rod to swivel front and back. They should *very* loose to manipulate the pendulum and allow it to rise a little without damaging the suspension spring.

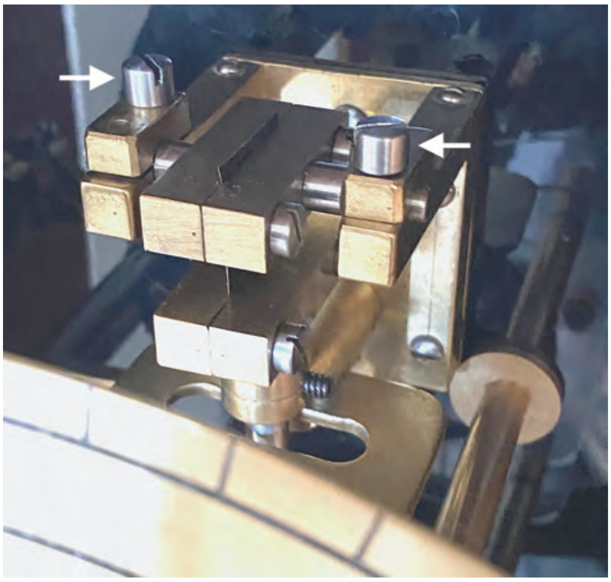

Figure 1-3 Bolts for the Pendulum spring

2. The lock is hinged. Remove the lock bolt (Figure 1-4) and carefully manipulate it and the pendulum rod into the lock's base ensuring the pendulum is vertical before tightening the lock bolt.

   The lock bolt needs to very tight to hold the pendulum.

   Tighten the screw holding the lock.

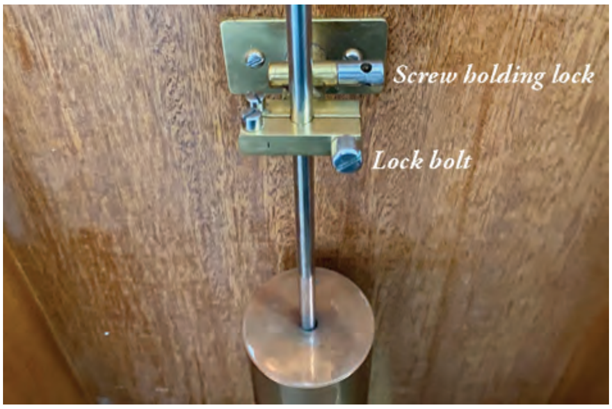

Figure 1-4 Lock in position

4. Remove the power supply (battery).

Figure 1-5 Screws holding the case to the wall

3. Look to see if the case is screwed to the wall. (Figure 1-5 shows the present screws.)

   Remove these screws.

Then the clock can be shifted safely.

2 As Found

I have lusted after a Hipp clock ever since I had been with a group of electric clock fanatics to Avoca in the north of Tasmania, to see the Avoca church clock, installed in 1939 (see page 24).

So when I found Hipp clock in the local auction I had to buy it. It is vastly lighter in construction than the Avoca clock or the commercial clocks I have seen.

It wasn't possible to inspect it in detail on the viewing day, but anyway my lust got in the way and a cursory glance is all that I did. But I was aware that the pendulum suspension spring had broken, presumably as the very heavy pendulum wandered about during transportation to the auction rooms.

It was described in the catalogue as the brass plate on it said:

HOPE JONES HIPP CLOCK BUILT 1977 E A WIGGINS

The day of the auction, 3rd November 2023, I was the high bidder on the clock. So I drove in, paid for it, and picked it up. I struggled to lift it, because it was very heavy and I am very old, but I managed to get it, and the tangle of white wires, into my car which fortunately was parked nearby; no one offered to help me. On the drive home I could hear the pendulum bounce around with every bump in the road.

The clock lived in the back of my car for a couple of days, and then it was leant up in the hall; Figure 2-1.

Figure 2-1 As it was in my home

Then I investigated the shelf at the bottom of the case, covering most of the electromagnet. It was removable and I found five bits in there. Most important was a lock for the pendulum, Figure 2-2, which I installed instantly even though the pendulum spring had broken. It is a pity that the pendulum lock hadn't been installed when the clock was taken to the auction and, of course, it would have prevented the damage.

There was also another four bits, Figure 2-3, and I preserved them to contemplate them afterwards. It was at that time that I realised that they didn't belong to the clock and they were random bits of detritus. Top is a striking lever for a cheap clock (probably American) and the steel washer (lower left) is bit of miscellany. I have no idea what is the use for the brass clamp, bottom right or the wire second from the top.

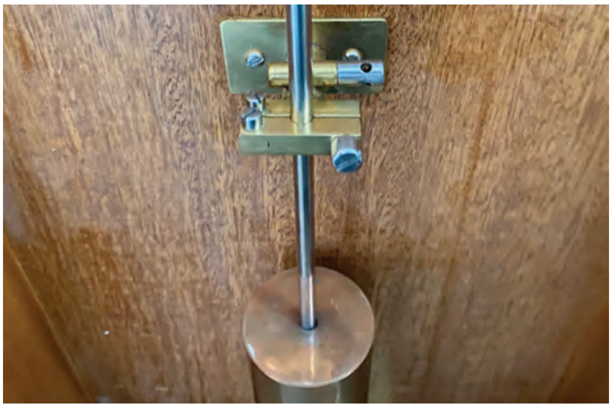

Figure 2-2 Pendulum locked

Figure 2-3 Miscellaneous bits

The clock was neglected until the following March.

First, in November my beloved dog Gryphon died and I was grieving for a long time. She was a person and not a dog if you get my meaning. (http://www.watkinsr.id.au/Gryphon.html)

Then, early in February, we got another dog Millie who was about 10 years old. I thought she was foisted upon us and it took a long time for me to bond with her. She was a dog and it is a work in progress converting her into a person.

I looked at the clock on and off during months and tried to understand how it worked. The Hipp aspect was no problem. The power to the magnet is switched by a Hipp-toggle device invented in the 1843 by Matthäus Hipp, Figure 2-4 (Wikipedia). The activator ***p*** is loose and when the pendulum swings too much it passes over three teeth ***a*** and doesn't do anything. After the pendulum swings have died down enough, ***p*** lodges at the bottom of the tooth and drives the lever up closing the circuit with the battery ***E*** and the electromagnet ***M*** impulses the pendulum.

There are many designs of the mechanism but all have a switch that the pendulum closes.

In Figure 2-1, about a third of the way down, at the bottom of the black plate, there is a *toggle* (as many people call it) which acts as a switch to power the electromagnet.

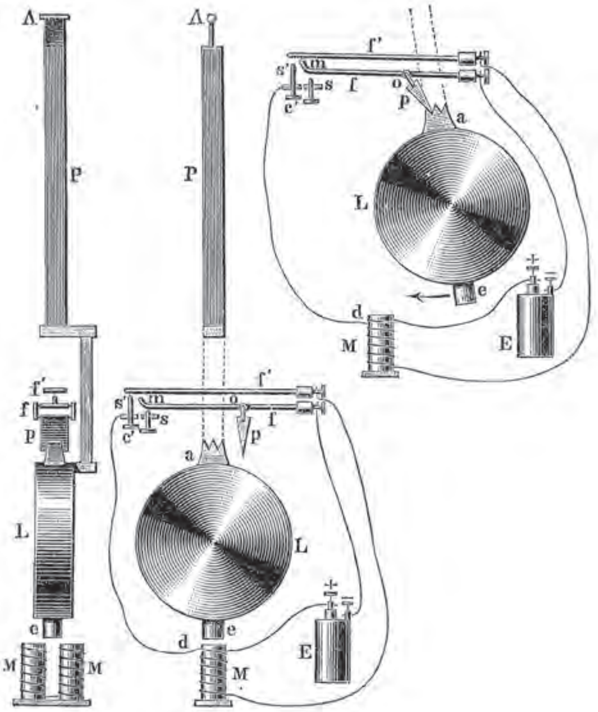

Figure 2-4 Action of the Hipp toggle

The purpose of the brass lever on the left hand side, Figure 2-1, was a mystery. It operated a steel wire that sometimes landed on top of the first wheel, a ratchet wheel connecting the pendulum to the motion works and did nothing, just following the turns of the first wheel. (The Hipp clock has only motion works because the pendulum drives the clock and not the clock drives the pendulum as in normal clocks.) And sometimes the wire would get caught up in one of the holes in the first wheel and stop it moving, which is obviously a disaster. I was puzzled about this and could make no sense of the purpose of the lever.

It was suggested to me, belatedly, that I took before and after photos. I had not, but it didn't really matter because only a few things needed them.

The following describes roughly in the order that I repaired it. Most of my repairs are obvious; for example using Phillips-head screws and different timbers.

A fundamental rule of repairing complex things is:

Do not do anything that cannot be reversed.

This obviously doesn't apply to broken parts, but ***preserve the original parts with the timepiece***.

A second rule is:

If you have to modify a part then think, think, and think about it!

3 The Shelf

The shelf front is shown in Figure 3-1. Note the errors. First, the front is made of varnished ply wood and there are four big chips in the base plus many minor ones. Second, the height of the left-hand end is 105 mm ($4\frac{1}{8}$ inches) and the right-hand end is 109 mm ($4\frac{3}{8}$ inches).

Figure 3-1 The shelf front

Figure 3-2 The brass name plate, about 3 x 2 inches (78 x 54 mm)

The inside of the shelf, Figure 3-3, shows that the top is made from varnished masonite. More to the point is that the left end, Figure 3-4, is angled down and not straight; the front of it is 108 mm ($4\frac{5}{16}$ inches) and the back is 98 mm ($3\frac{7}{8}$ inches)

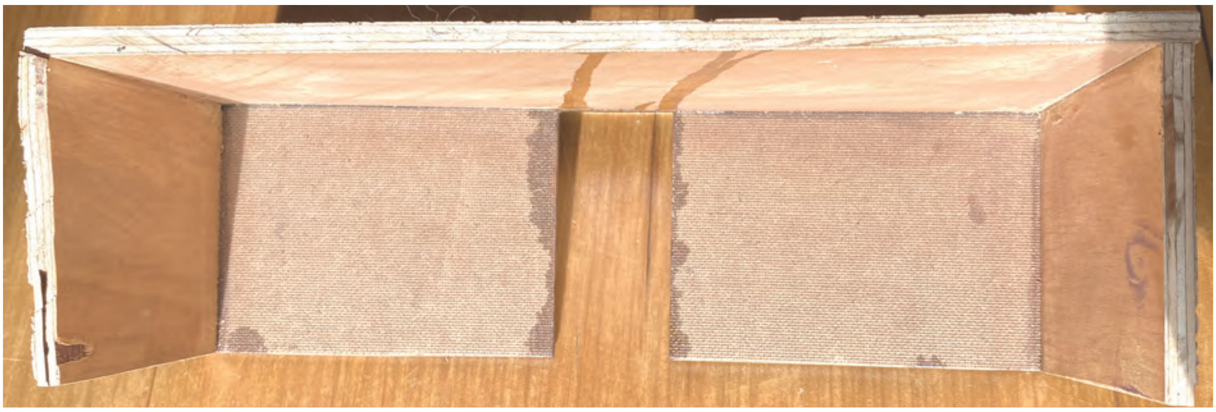

Figure 3-3 The shelf inside

Figure 3-4 Shelf out of square

The shelf brass plate, Figure 3-5, covering the slot in the top of the shelf is loose and obviously out of square.

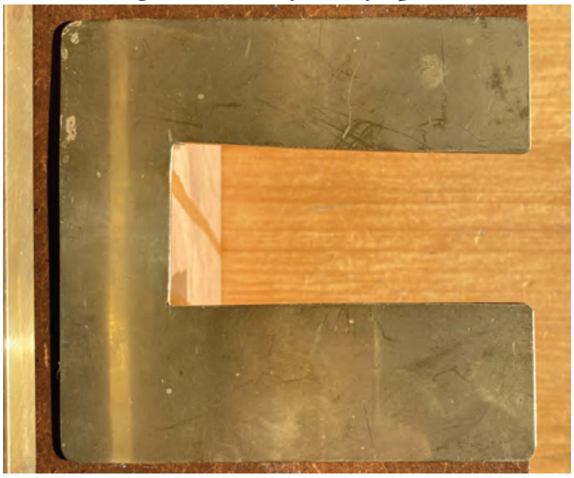

Figure 3-5 The brass cover plate out of square

The cut-out in shelf in position, Figure 3-6, is too wide at the left. Figure 3-1 shows that the shelf is approximately half way up the electromagnet coils and there is no need make the cut-out wide for the red wires and it should be closer to the electromagnet.

Also the shelf should be higher, covering the bottom half of the coils of the electromagnet. It only needs to be low enough to allow the nut on the end of the pendulum rod to pass through the gap between the electromagnets

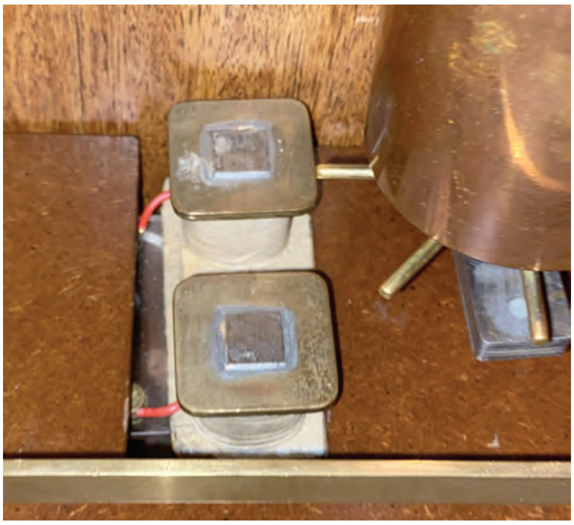

Figure 3-6 The shelf in position

The brass fittings on the shelf are very well made in contrast to the loose brass plate and the wooden pieces.

As the shelf was decorative (mainly to hide the electromagnet) I didn't change it.

4 The Electromagnet and power supply

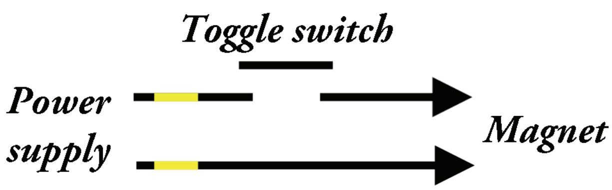

Figure 4-1 Circuit for battery and toggle

I had removed the shelf in the bottom of the case and I was confronted by a tangle of white, copper wires that someone incompetent had done. The white wires leading from the electromagnet out of the back of the case to the toggle were neat and rebated into the back of the case. But the identical pair white wires that once led to the power source were bare and were twisted around the bare wires to the power supply and toggle switch, Figure 4-1 green lines and Figure 4-3. The wires are stiff so there was no immediate problem, but if they had touched! The pair of white wires led through a hole in the bottom of the case and were about 2.4 metres long (8 feet) ending in nothing, but a power supply should have been connected; Figure 4-2.

Figure 4-2 The tangle of white wires

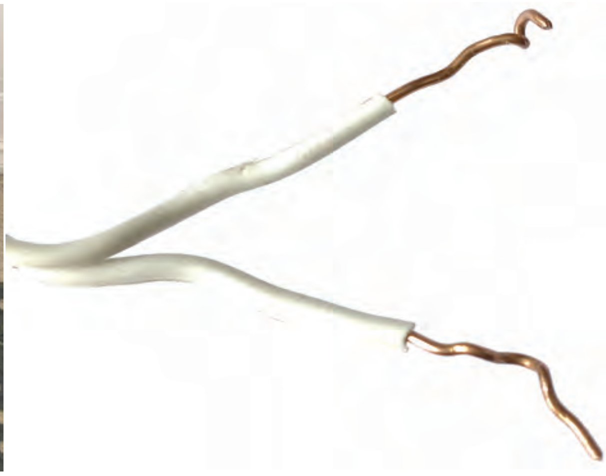

Figure 4-3 Bare ends of wire to power source

Norman Heckenberg, on the 5th November 2023, wrote to me as follows:

“Most likely the clock ran on 3 or 6V DC but if you measure the resistance of the coil and aim to get say 300 mA it will probably go.”

I measured the resistance and got 21 Ohms. So the clock most probably ran on 6V DC, using Ohm’s Law $V = I \times R$. It has run on 6V DC ever since.

As there was plenty of space below the shelf for a rechargeable battery or two, I tidied up the wiring and connected a pair of black wires through a junction box to have a battery added, Figure 4-4.

The electromagnet is off centre, Figure 4-4 and 8-1, page 26. It is probably intentional because the pendulum, when it switched the power on, receives an impulse from the magnet.


Figure 4-4 Electromagnet after wiring tidied up

I got two 6 volt lead-acid batteries and a charger. The batteries are about 60 mm high, allowing for the connectors, 98 mm wide and 25 mm deep; Figure 4-5.

How long the battery lasts depends on the frequency of the impulses (page 22). At present one small battery lasts for over a month.

Figure 4-5 The battery

The electromagnet, Figure 4-4, is on an adjustable post with the screw heads and nuts outside the case bottom; the old, bad bolts are shown in Figure 4-6. This is the second reason there must have been a plinth on the bottom of the case. I replaced the bolts by two countersunk bolts to avoid using a plinth, Figure 4-7. (There may have been a plinth at the auction, but I don't think so.)


Figure 4-6 Old bolts holding the electromagnet

Figure 4-7 Spacers on the case

Even so, I put a "plinth" on the case, Figure 4-7, consisting of two treated pine spacers screwed into the bottom of the case. They are unnecessary except for the smooth opening and closing of the door.

Figure 4-8 Battery location beside the clock

Later I realised that Wiggins was right, putting the power supply outside the case. The door needs to be closed for at least 6 months and with the battery below the shelf, Figure 4-4, I would have to open the door to replace the battery.

So I drilled a small hole in the back of the case below the shelf and used a battery outside the case, Figure 4-8. (Most houses have skirting boards so the clock case will have space at the back. Lacking skirting boards they can be added. Note, there has to be a piece of timber about halfway up the clock to fix it to the wall; although unlikely, the clock case can topple. So I have two screws to fix the case onto the wall and prevent it toppling.

5 The Pendulum

The pendulum suspension spring was a priority because without fixing it the clock would not run.

Figure 5-1 shows the broken suspension spring in situ when I got the clock.

The spring is clamped between four brass blocks, and the top brass blocks run in pivots so that any slight out-of-vertical of the case is compensated for and the pendulum hangs vertically. Tightening the screws that held the pivots kept the pendulum steady so its motion would be only side to side not back to front.

Loose screws are a problem. As the pendulum swings from side to side the pivots can also move if not held firmly, so the motion of the pendulum will be disturbed. But they have to be loosened to insert the pendulum lock.

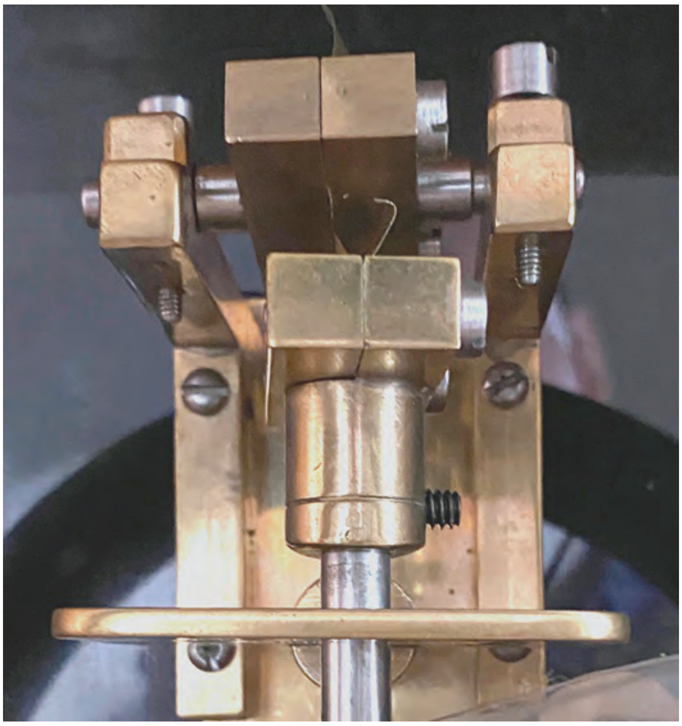

Figure 5-1 Pendulum suspension spring

I removed the pendulum, held by a grub screw, and then the two parts of the spring with the brass blocks. The spring was held by friction and the screws were very tight.

The suspension spring was split in two, close to the upper brass blocks, Figure 5-2. It is a brass spring, 0.09 mm thick and the brass blocks were separated by about 11 mm.

Norman Heckenberg had suspension spring material gave some to me. The arrived on 26th of March 2024. It was a phosphor bronze strip 0.17 mm thick and it was long enough for two suspension springs.

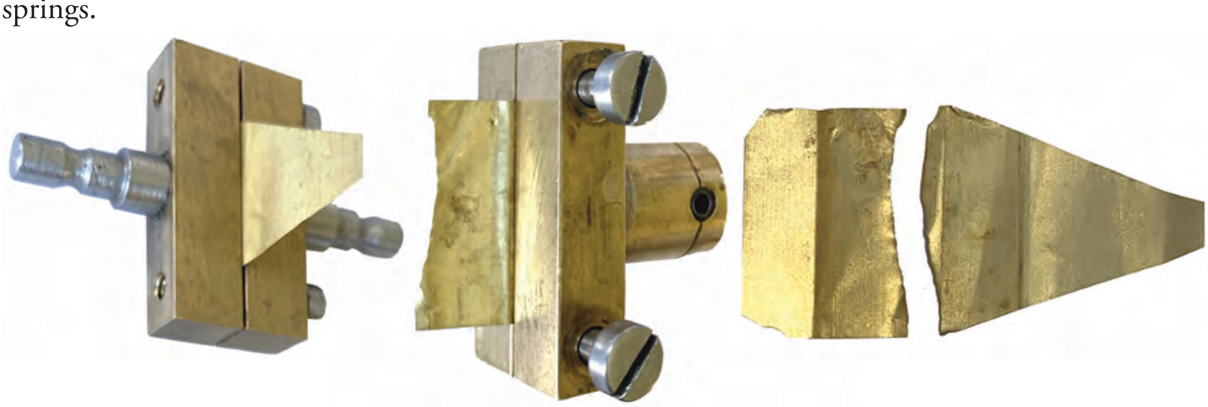

Figure 5-2 Original pendulum suspension spring

The following day I bought tin snips and cut the new spring to shape, using the old spring as a guide. A few finishing touches were necessary because the springs, both old and new, were wider than the space between the bolts. And a bench-vise was needed to tighten the screws enough before the new suspension spring was installed.

The pendulum is about 5.2 kg (about 11½ lbs) and I didn't think that the difference in thickness of the spring would matter. On the first test, without the motion works or battery, the pendulum swung for about 5 minutes.

The first phosphor bronze spring buckled throwing the pendulum out, Figure 5-3. I made a second phosphor bronze spring which also buckled, Figure 5-4. This was probably caused by the pivots being clamped, allowing no front to back motion, and I inadvertently (also known as stupidly!) moved the pendulum and creased the springs.

I then made a new spring out of 0.075 mm steel shim, about 24 mm wide and 30 mm long, holding the blocks 10 mm apart. It also buckled and tore (Figure 5-5) before I realised that the pivots had to be free while I played the pendulum or locked it! I made I fourth spring out of 0.075 mm steel shim and it has worked ever since.

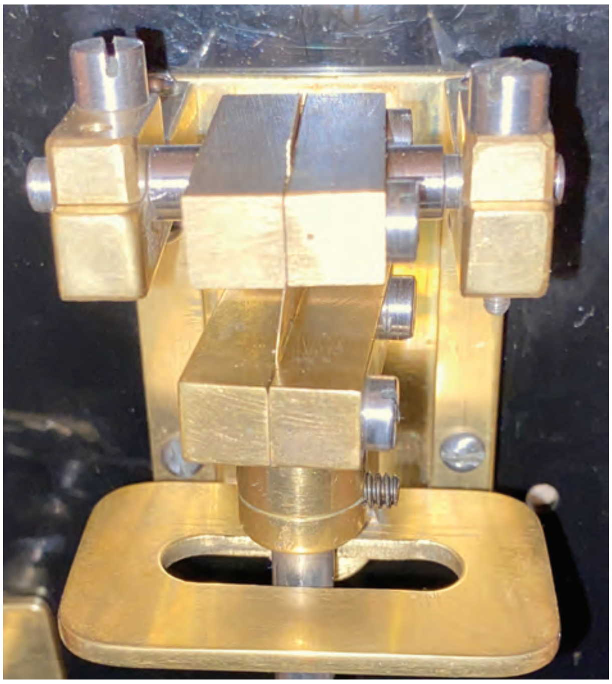

Figure 5-3 Phosphor bronze spring buckled

Figure 5-4 Second phosphor bronze spring

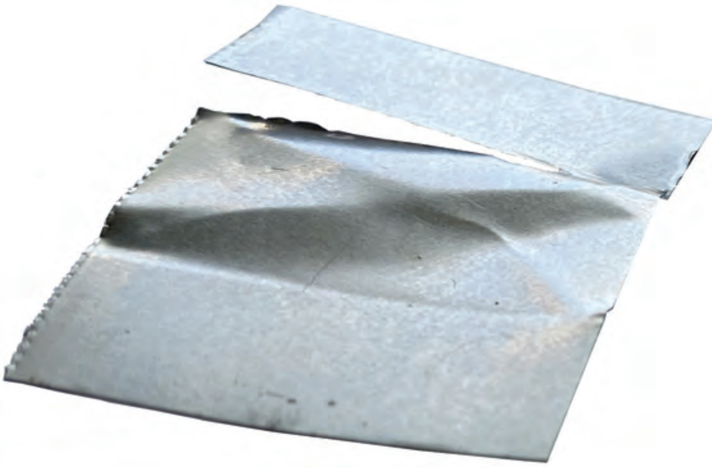

Figure 5-5 First steel spring

Three notes:

First, hand tightening, with a screwdriver, the bolts in the two brass blocks applies sufficient force to stop the spring working loose.

Second, the pivots should be firmly clamped to swing by hand the pendulum. The nut that fixes the steel bar on the pendulum runs between the two electromagnets, Figure 5-6; the steel bar has to be very close to the magnets to impulse the pendulum. With the pivots loose, Figure 5-1, the pendulum has a back to front motion so that the nut bounces off the magnets and it is almost impossible to swing the pendulum by hand.

So the pivots have to be clamped firmly to run the clock and loose in order to adjust the pendulum! This is especially important for the pendulum lock, Figure 1-3 (page 3), has a back to front movement and it is impossible to set it so that it doesn't move the pendulum to the back or front. So the pivots have to be free to lock the pendulum in the right position. The pivot bolts need to be only finger tight to stop the back to front motion of the pendulum.

I eventually got adept starting the clock with one finger just below the dial with the pivots free; I increased the pendulum movement little by little until the pendulum passed over the toggle and then the battery took over.

Third, the tin snips create serrated edges, Figure 5-5. I belatedly found that household scissors would cut the steel and produce fine edges. The second steel spring was cut out using scissors.

Bringing the clock to time is in a separate section *"Regulation"*.

Using the photo in Figure 5-6, the weight is distributed and not a single mass; it consists of the main weight, the star wheel and, the secondary weight operating on the electro-magnet and its two nuts.

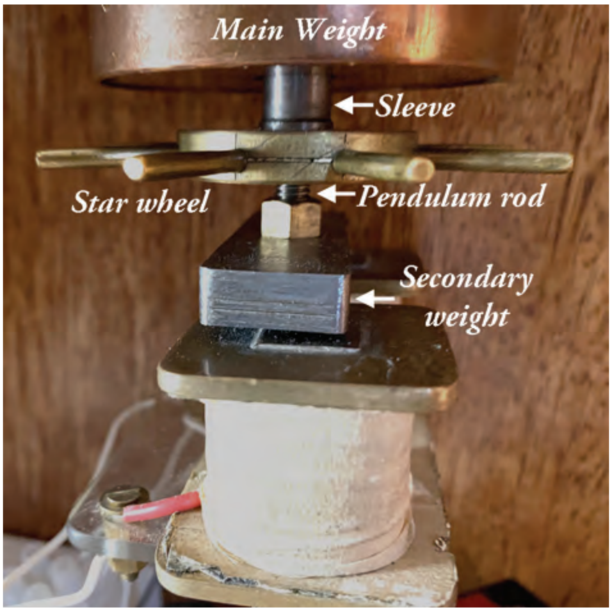

Figure 5-6 Action of the Star Wheel

The pendulum rod, running from the suspension spring is about 8 mm in diameter and is threaded on the bottom to take the star wheel and the nuts of the secondary weight.

The main weight is loose in a steel sleeve about 11 mm in outside diameter and 8 mm inside diameter so it can move freely up or down depending on the position of the star wheel. (In the photo the main weight has been moved up to show the sleeve.)

The star wheel is threaded and it runs on the pendulum rod. It has a short, steel sleeve that the main weight rests on. Thus the star wheel lengthens and shortens the pendulum without effecting the position of the secondary weight.

6 The Motion Works and Isolator Mechanism

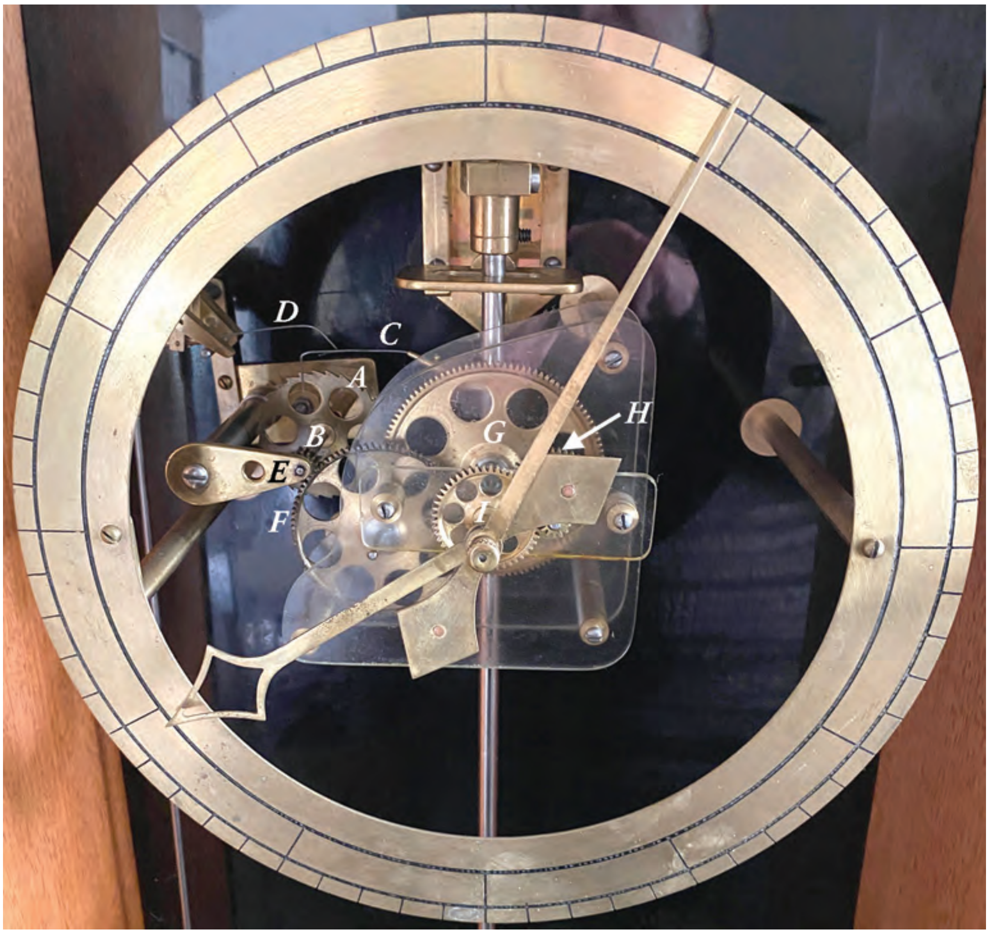

Figure 6-1 The motion works (November 2023)

The first wheel, ***A*** figures 6-1 and 6-2, is a ratchet with 30 teeth. It is impulsed by the pendulum through the wire lever ***C*** every alternate swing so the first wheel turns once per minute.

Figure 6-1 shows the motion work is between perspex plates so the wheelwork can be seen. This photo was taken 2 days after I had got the clock and shows the original positions of levers ***C*** and ***D***.

The first wheel pinion ***B*** turns the second wheel ***F*** and its pinion drives the wheel ***G***, providing the 60:1 reduction for the minute hand which is squared onto it. ***G*** also has a pinion that drives the wheel ***H*** and it drives the wheel ***I***, loose on a canon surrounding the pivot of ***G***; these wheels have the 12:1 reduction for the hour hand that is mounted friction tight on the canon.

The tooth counts of the train are large, and some of the pinions are brass instead of steel.

The perspex plates and brass pinions don't matter because the train is not load bearing, all except for the first wheel ***A*** and pinion ***B*** which may get some load from the pendulum and its steel pivots run in the standard brass. The hands are poised.

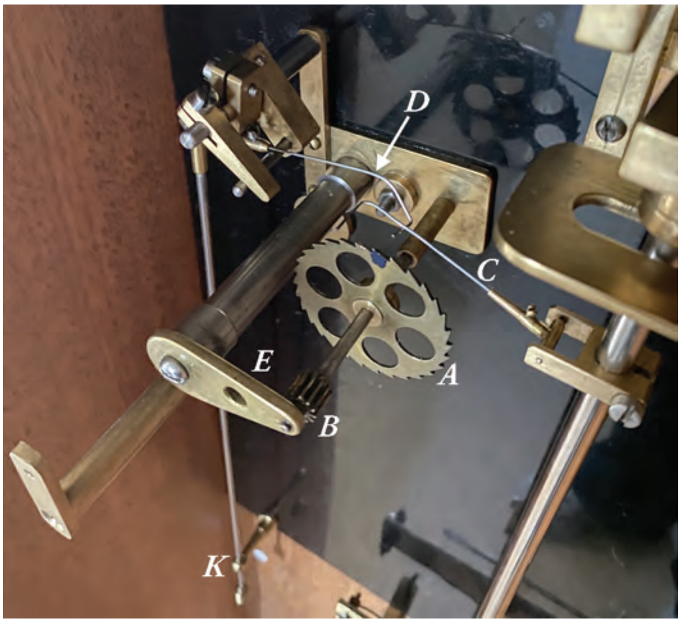

Figure 6-2 First wheel and pinion of the motion work

Figure 6-2 shows the first wheel separately with the isolator mechanism active. ***E*** is loose and the weight of it and ***A*** ensures that ***B*** and ***F*** are in mesh.

The hand lever for the isolator mechanism on the left hand side, ***K*** in Figure 6-2, operates the steel wire ***D***, raising it when ***K*** is pulled down. This raises the wire ***C*** disengaging it from the first wheel ***A*** and the pendulum, still swinging and impulsed by the toggle switch, does not turn the motion works and the hands. If the clock had a seconds hand connected to the ratchet, it would stop too.

Here is another view of the motion work without the dial:

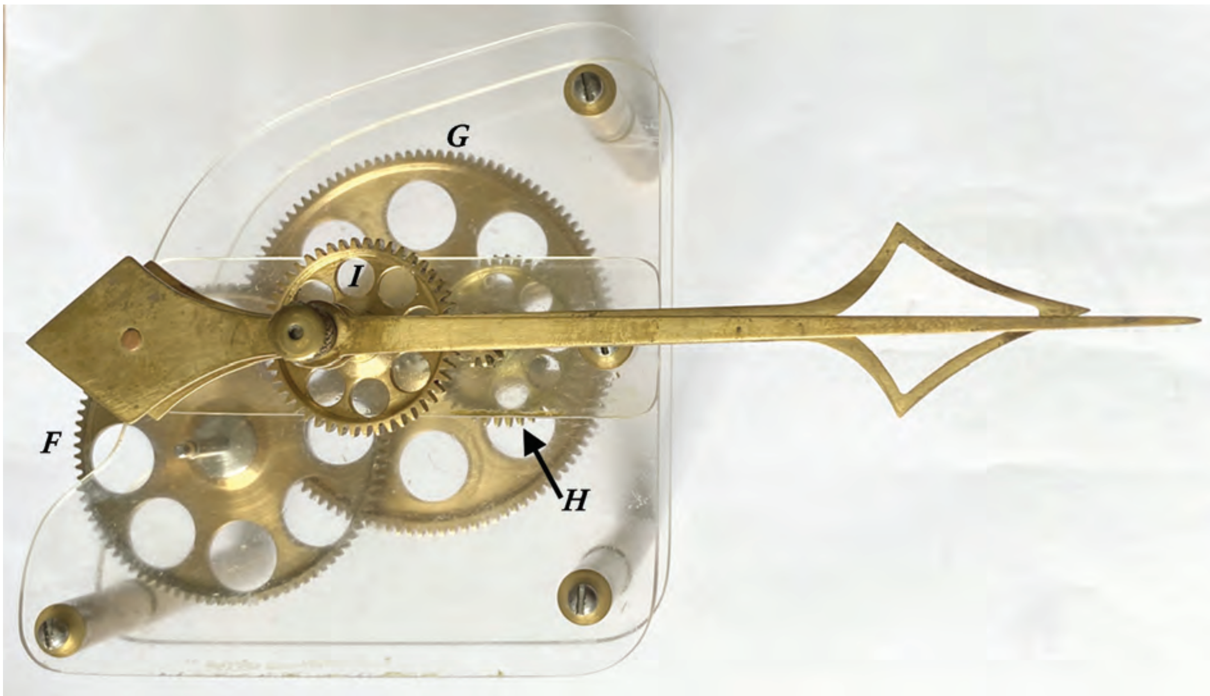

Figure 6-3 The motion works without the dial

The isolator mechanism is so that the hands can be adjusted without affecting the motion of the pendulum. A good example is *daylight saving* when the hands of every clock have turned forward an hour every Spring and turned back every Autumn. Without an isolator it would be impossible to turn the ratchet wheel back because the wire ***C*** would interfere, stopping the motion and the minute hand.

When I got the clock, the lever ***D*** interfered with the ratchet, sometimes stopping it from turning. So I cut off about 8 mm of it so that it does not interfere with the ratchet. But that was wrong!

The wire lever ***C***, Figure 6-1 and 6-2, driven by the pendulum to the left could rotate the ratchet anti-clockwise to the left by friction, and the pendulum would not gather a tooth causing the clock to run slow intermittently. (Of course the lever cannot gather two teeth or the clock would run fast intermittently!) Lever ***D*** needs to land at the edge of a tooth of ratchet to stop the ratchet turning anti-clockwise in the unlikely event of this happening (it has never happened). In principle, when the pendulum swings to the left and reached the vertical position, lever ***D*** must fall on a full tooth and lever ***C*** must encompass half a tooth. I have never achieved that situation.

Obviously I had to replace the wire lever ***D***. The replacement was 0.75 mm, thinner than original, but when I tried to push it through the mounting it stuck half way, probably hindered by the brass wires that formed the pivots. So I drilled the hole out using a 0.75 mm drill bit, Figure 6-4, resulted in remains of the axle ***2*** promptly dropping out! I inserted a replacement 0.70 mm wire from a pin. The hole in the body for the axle ***2*** is wider so the body still swings. The screw at ***1*** holds the wire securely and the screw ***3*** is not used.

*Figure 6-4 - Drilling for a new wire lever **D***

The isolator mechanism looks overly complex, Figure 6-5.

All three pieces, ***2***, ***3*** and ***4***, are on the rod ***5***; ***2*** and ***4*** are fixed and ***3*** can rotate; ***3*** is connected to lever ***K*** and has a thick steel rod ***3a*** inserted into it.

The left photo in Figure 6-5 shows the position when the pendulum is driving the motion work. The lever ***3/K*** is raised moving its rod ***3a*** out of the way of the wire ***D***, pivoted at ***1*** at the end of ***2***, and ***D*** drops down to the ratchet and allows the wire ***C*** to drop (Figure 6-2).

The right photo is the position when the pendulum is isolated from the motion work (as in Figure 6-2). The lever ***3/K*** is pulled down and ***3*** rotates anti-clockwise. The rod ***3a*** is raised and it lifts the wire ***D*** which lifts up ***C*** and the pendulum is no longer linked to the motion work. The fixed piece ***4*** is a stop which limits the rotation of ***3a***. Everything, of course, can be adjusted.

The isolator has a fault; it is too sensitive. In the isolation position, just a touch will move it to up and the running position. The shaft ***E*** is threaded into ***3***. Two or three turns anti-clockwise overcomes the fault, but extra weight would be ideal.

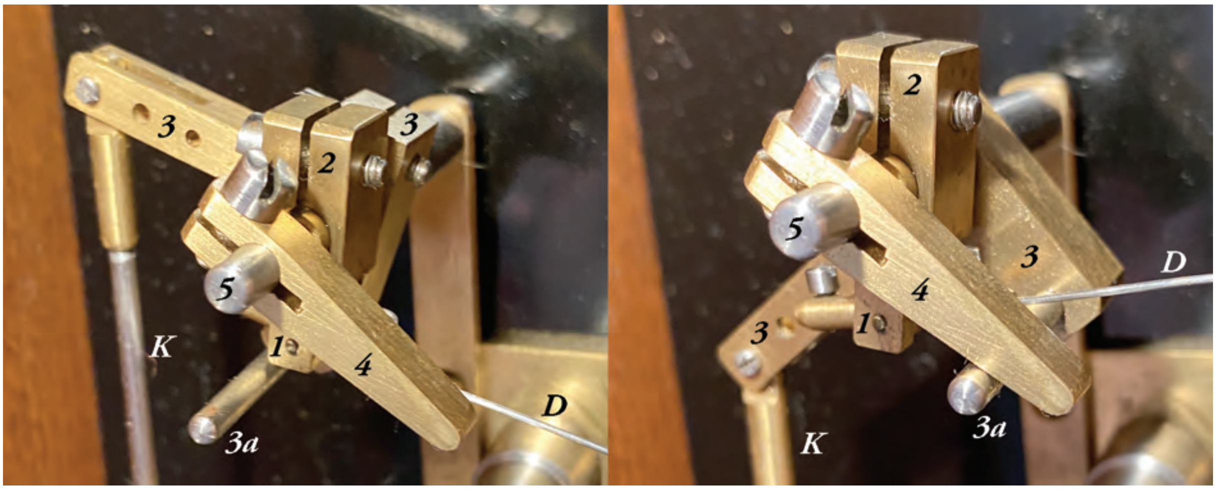

Figure 6-5 The isolation mechanism

7 The Toggle

This is the centrepiece of Hipp's design. Some books call this part, shown in Figure 7-1, the *contact device* and others the *toggle*. One dictionary defines *to toggle* as *to switch between usually two different options, states, or activities,* which is why I call it the toggle.

This piece differs wildly from clock to clock, but all the ones that I have seen (much more robust turret clock movements and Figure 2-1, page 24) operate on the same principle.

Everything is adjustable, even its horizontal position and the mount, Figure 7-1, allows swinging adjustment.

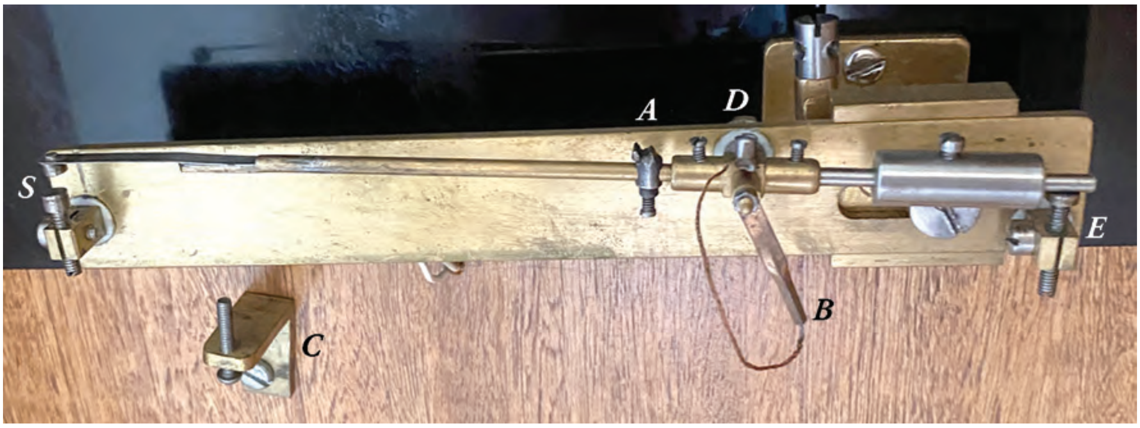

*Figure 7-1 The toggle showing the original positions of **A** and the toggle stop **C***

The switch activator ***A***, is in the wrong position on the rod and originally it was not vertical (see Figure 9-3, page 31), and the *toggle stop* ***C*** is discussed later.

The toggle itself is insulated from the brass base at ***S***, ***D*** and ***E*** (obvious at ***S*** and ***D***), and the wires from the battery and electro-magnet are connected at ***S*** and ***D***, the pivot point of the toggle, meaning that the toggle arm is *live* and the base is not. So that there is not a problem with resistance, because of oil and dirt on the pivot (very unlikely), the copper plate and wire at ***B***, a safety measure, ensures that current will flow unhindered to ***S*** and hence to the electromagnet.

The mount for the toggle, Figure 7-2, is poorly made. The tapped hole in ***1*** is out of alignment with untapped hole and the bolt ***3*** binds and is difficult to put in. And ***1*** is screwed into the base ***2*** and unscrews anti-clockwise by a moderate pressure; which why stop ***C*** (Figure 7-1) is necessary.

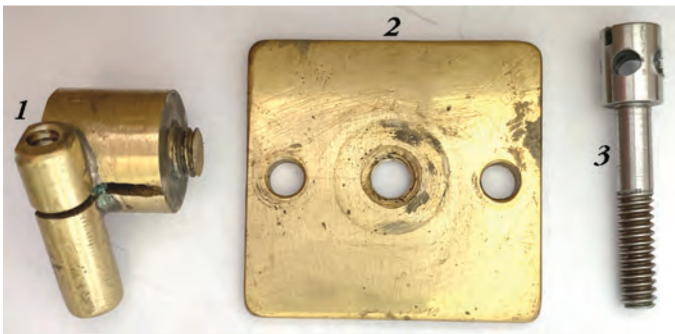

Figure 7-2 The toggle mount

The Toggle Switch

Figure 7-3 shows the original switch ***S***; note that the two contacts are not aligned correctly. A slight pressure of my fingers was enough to detach the switch, centre of Figure 7-3, because it had been dry soldered. The middle and right photographs show what was left.

Figure 7-3 The switch on the toggle

I re-soldered the switch onto the body of the toggle, making the contacts align, Figure 7-4 left.

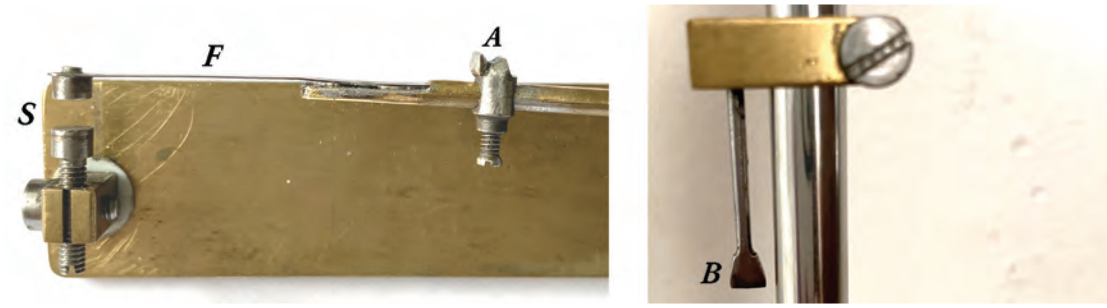

*Figure 7-4 The switch activator **A** and trigger **B** on the pendulum*

The switch activator, ***A*** Figure 7-4, has a corresponding piece ***B*** on the pendulum, the trigger. When the pendulum swings too far to the right, ***B*** slides into notch on ***A*** and out of it, and the switch is not activated. And on the return swing to the left ***B*** passes over the notch in ***A***.

The swings of the pendulum are a fraction of a millimetre shorter, one swing to the next swing. When the motion of the pendulum drops enough, at the end of the right swing ***B*** slides into the notch on ***A*** and stays there. The left face of ***A*** is nearly vertical, so the pendulum, swinging to the left must push ***A*** out of the way and the contact ***S*** is driven down to switch on the current to the electromagnet, which then magnifies the motion of the pendulum. And so it continues. The thin steel flat ***F***, Figure 7-4 left, allows ***F*** to flex as the switch is activated. Note that the pendulum is live (6 volts) at this time.

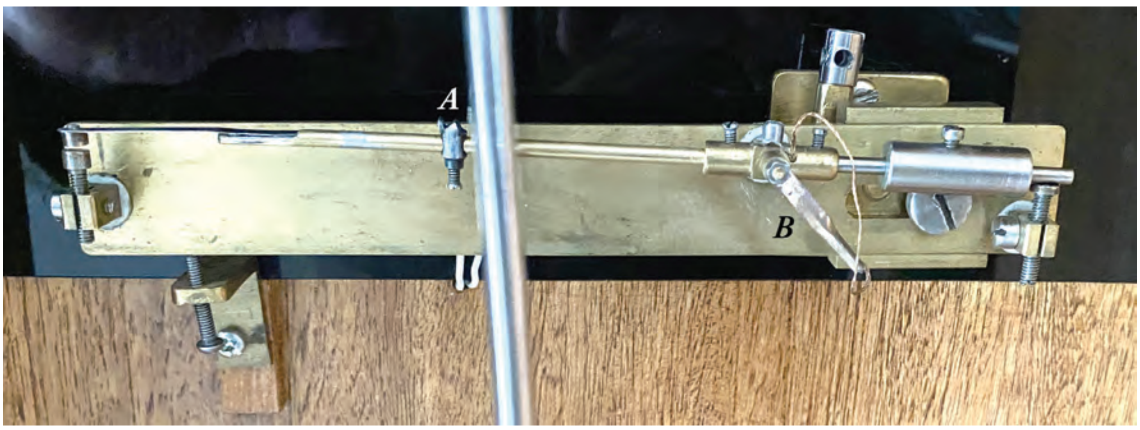

*Figure 7-5 The toggle showing after it had been fixed with **A** in its rightful position (The pendulum was swinging to the right when this photo was taken)*

Frequency of Impulses

The position of the switch activator ***A*** affects time between impulses. But it was loose on the brass rod, because, although the hole for the screw goes right through, the thread does not and the screw cannot bind on the rod; see Figure 4-1. Andrew Shepherdson has an BA #8 tap and die and he, in April 2024, finished the job that the maker left unfinished.

The horizontal distance of the iron block on the pendulum from the electromagnet limits the longest time between impulses. However, as the pendulum is very heavy, and it is swinging the direction of the electro-magnet, it doesn't need much magnetism to keep it swinging.

On an NAWCC Message Board the following question occurred:

"I'm curious about such clocks. How many swings of the pendulum before the finger caches and makes contact?"

And the answer:

"Nearly 20 to 23 swings (*seconds*) up to the next impulse. That means 2 up to 3 impulses per minute. The impulse is very strong, and the pendulum bob is very heavy."

My conclusions are vastly better than the NAWCC Message Board and that the time between impulses varies depending on the position switch activator, Figure 7-6. Possibly the NAWCC Message Board response is in a system where the switch activator is fixed.

The position of the toggle stop ***A*** effects the time between one impulse to the next; it doesn't effect the time, which pendulum length does. 59.4 mm is too long, the position of ***A*** should be about 59.1 mm. I kept on fiddling with the position of ***A*** to see if I could get the time between impulses as great a number seconds as was possible.

Figure 7-6 shows the toggle stop ***A*** and the brass rod on which it is mounted and the measurement is 59.4 mm. I decreased or increased the distance of ***A*** from the end of the rod, put the rod into the toggle and measured the time between impulses using the clock in my iPhone (which is accurate to 50 milliseconds or so); the readings were taken in August to October 2025.

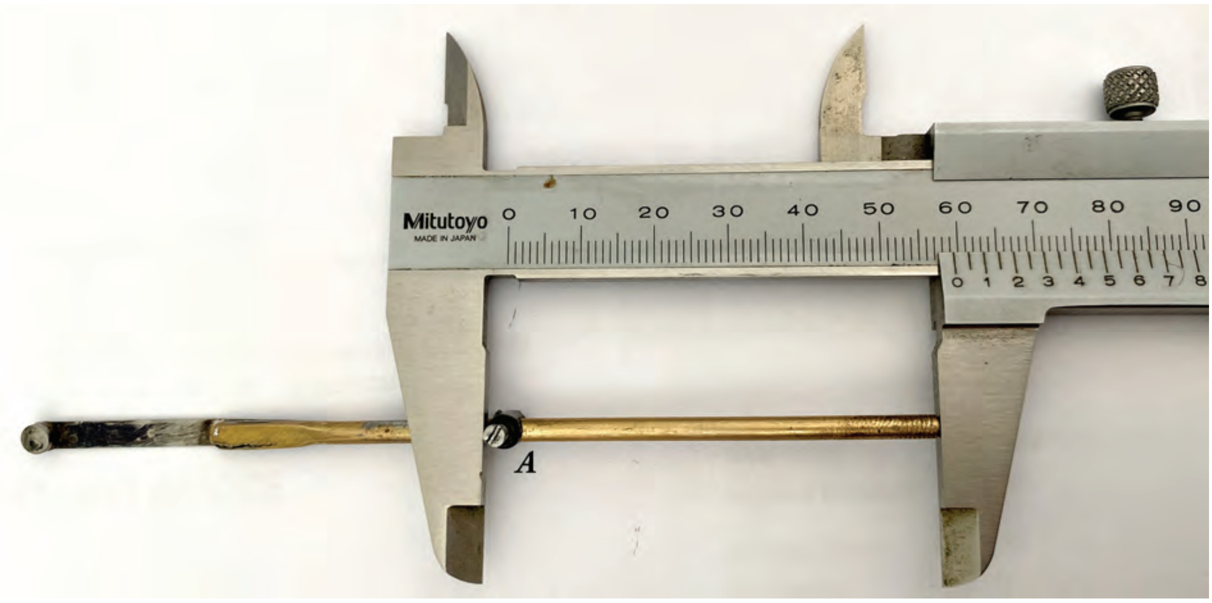

Figure 7-6 Measuring the position of the switch activator ***A***

(As an aside, September, October, November and December are seventh, eighth, ninth and tenth months according to their names. So the year actually runs from March to the following February. This makes more sense of the leap year's February 29th and the new year's day should be March 1st.)

In the last but one position of the switch activator there is exactly 48 seconds between impulses, the average of 21 tests. In the second test there is 48.83 seconds between impulses, the average of 12 tests. The number of seconds between impulses cannot be an odd number, so to round the figure it must be rounded down to 48 seconds. In the third and final test (October 2025) there is 48 (actually 47.592) seconds between impulses, the average of 27 tests.

(But with the isolator active the pendulum didn't suffer the drag from the motion works and the time between impulses is about double that with the motion works active.)

The Big Bang

The switch activator ***A*** had flats on it, Figure 7-7 ***F*** and ***G***. Every now and again the trigger lands on ***F*** or ***G*** instead of going into the slot on the left of it. This means that the switch ***S*** is driven down too far, which it can do because it can flex, and the toggle springs back too vigorously and makes a loud bang.

In addition, in the next oscillation of the pendulum the trigger ***B***, Figure 7-4 right, lands in the notch and a double impulse is given, which doesn't matter.

I filed the switch activator into a sharp peak, to minimise the big bangs occurrence, and almost eliminated them.

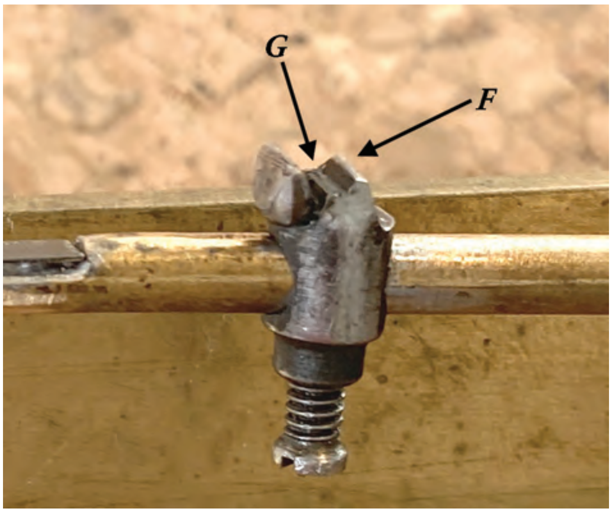

Figure 7-7 Flats on the switch activator

The trigger ***B*** was not square with the switch activator, ***A*** so I turned it. Judgement needed because there is no flat on the pendulum rod.

The Toggle Stop

The original position of the toggle stop ***C*** is shown in Figure 7-1 and Figure 7-8.

The screw holding the stop isn't centred and the bolt isn't vertical.

But there is a bigger problem: It is useless! First, the position of the stop means that it cannot reach the body of the toggle. And second, if it could reach toggle, the bolt on the stop slides underneath the toggle frame and doesn't stop it rotating!

The toggle stop prevents the toggle moving anti-clockwise if the mount is loose and the force of activating the switch makes it rotate. More importantly, the bolt allows fine adjustment of the toggle.

I made a piece of timber to raise the stop to the height of the toggle and installed it using a new screw, Figure 7-9. The toggle stop is moved closer to the toggle so that its bolt is effective.

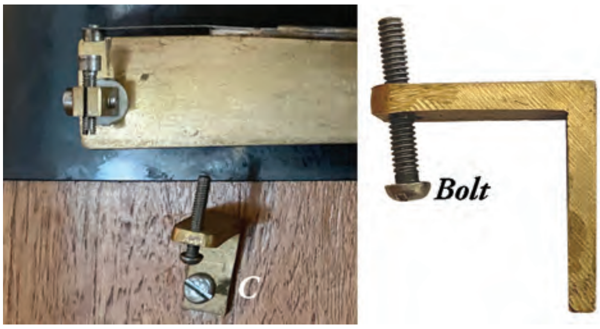

Figure 7-8 The toggle stop

Figure 7-9 The new toggle stop

The Avoca Hipp Clock

Figure 7-10 The Avoca church and Hipp clock

Figure 7-10 is of the Avoca (Tasmania) church and clock, installed in 1939.

It is on a massive iron frame. The motion works is in the upper left corner at ***A***; it consists of two, large bevel gears and a ratchet wheel (of 15 teeth, which the pendulum pushes) and other wheels, which drive the external hands. The toggle ***B*** is in the centre left; the part on the pendulum that has the trigger ***C*** freely attached to it which interacts with the switch activator. The electromagnet operates a lever whose pivot point is very close to the magnet and ends in a roller ***F***. The spring holds the lever up unless the magnet is activated, when the roller ***F*** impulses the pendulum.

8 Regulation

Regulation is by adjusting the pendulum length. The pendulum length can only be adjusted by the star wheel which is threaded onto the pendulum rod, Figure 8-1; a reproduction of Figure 5-6 (page 15). It has 8 spokes so $\frac{1}{8}$th and $\frac{1}{16}$th a turn is easy. It is a right-hand thread, so to slow down the clock the star wheel needs to be rotated clockwise (looking from above the star wheel), and to speed it up the star wheel needs to be rotated anti-clockwise. I didn't measure the pitch of thread, an oversight.

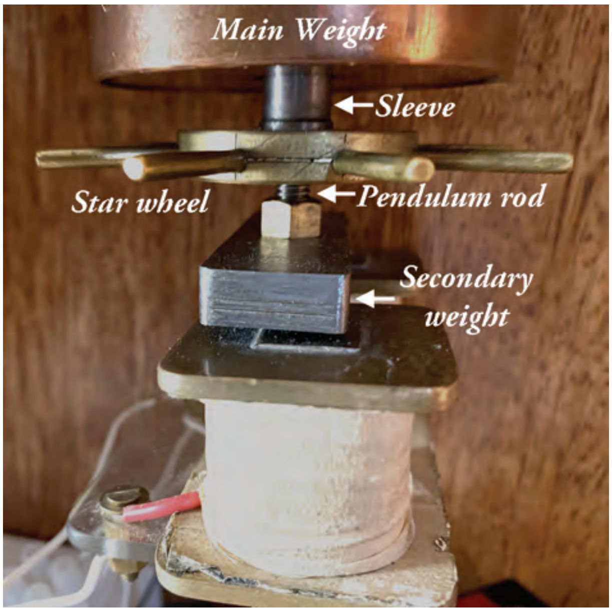

Figure 8-1 Action of the Star Wheel

The weight is loose on the sleeve and fine adjustment is by the 8 star wheel.

To slow down, the pendulum needs to be locked, adjusted, and the weight forced gently down (holding the bottom nut on the pendulum) or otherwise sometimes it won't change.

To adjust the time, the isolator must be active, disconnecting the first (ratchet) wheel ***A*** and its pinion ***B***, Figure 6-2, page 17. Sometimes the motion work sticks and the minute hand doesn't move the wheels and instead its arbor turns; a disaster because hour hand will be wrong. I lead-soldered the minute hand to the square of arbor. As a result the hour hand needs no adjustment.

(Lead solder is a "no-no." But it is easily removed, unlike silver solder. This is the only time that I use solder for correcting errors.)

However, I got into the habit of rotating the wheel ***F*** by hand (Figure 6-1, page 16)

The following table is based on the equation for a ideal pendulum:

$T = 2\pi\sqrt{\frac{l}{g}}$ with gravity approximately 9.8067.

The length l = 993.6214 mm of a pendulum equals 0.000313773 seconds in error from the *seconds pendulum*, oscillating exactly 2 seconds.

The pendulum rod is 8 mm and probably steel or stainless steel as it expands and contracts too much to be Invar. (In the time that Hipp lived, Invar had not been invented so steel is appropriate. Hipp must have had his clock in an environment where there was stable temperature. Or he used a wood pendulum rod.)

The coefficient of expansion for steel is about 0.000012 (12.0×10^{-6}), and rods of 992, 993 and 994 mm will expand and contract about 0.12 mm for every 10°C change, an error of about 2.6 seconds in 12 hours. The following table shows that for every 10°C temperature the pendulum will have a variation of about 5 seconds per 24 hours or day. For wood it is about 5.0 x 10^{-6}, about half of steel; which is why a lot the Hipp clocks have wooden pendulum rods.

L mm	T secs	T/day	T/hour	Error/hour	Error/24 hour
990.00	1.99635	86242.4081	3593.4337	-6.5663	-157.59
990.25	1.99660	86253.2966	3593.8874	-6.1126	-146.70
990.50	1.99686	86264.1838	3594.3410	-5.6590	-135.82
990.75	1.99711	86275.0695	3594.7946	-5.2054	-124.93
991.00	1.99736	86285.9539	3595.2481	-4.7519	-114.05
991.25	1.99761	86296.8369	3595.7015	-4.2985	-103.16
991.50	1.99786	86307.7185	3596.1549	-3.8451	-92.28
991.75	1.99812	86318.5988	3596.6083	-3.3917	-81.40
992.00	1.99837	86329.4777	3597.0616	-2.9384	-70.52
992.25	1.99862	86340.3552	3597.5148	-2.4852	-59.64
992.50	1.99887	86351.2314	3597.9680	-2.0320	-48.77
992.75	1.99912	86362.1062	3598.4211	-1.5789	-37.89
992.88	1.99925	86367.7605	3598.6567	-1.3433	-32.24
993.00	1.99937	86372.9796	3598.8741	-1.1259	-27.02
993.12	***1.99950***	***86378.1983***	***3599.0916***	***-0.9084***	***-21.80***
993.25	***1.99963***	***86383.8516***	***3599.3272***	***-0.6728***	***-16.15***
993.50	***1.99988***	***86394.7223***	***3599.7801***	***-0.2199***	***-5.28***
993.6214	2.0000	86400.0006	3600.0000	0.0000	0.0006275460
993.74	2.00012	86405.1743	3600.2156	0.2156	5.17
994.00	2.00038	86416.4596	3600.6858	0.6858	16.46
994.25	2.00063	86427.3262	3601.1386	1.1386	27.33
994.50	2.00088	86438.1914	3601.5913	1.5913	38.19
994.75	2.00114	86449.0552	3602.0440	2.0440	49.06
995.00	2.00139	86459.9177	3602.4966	2.4966	59.92
995.25	2.00164	86470.7788	3602.9491	2.9491	70.78
995.50	2.00189	86481.6386	3603.4016	3.4016	81.64
995.75	2.00214	86492.4969	3603.8540	3.8540	92.50
996.00	2.00239	86503.3540	3604.3064	4.3064	103.35

Table of the length of the pendulum and errors in seconds

Also, the first 6 volt battery lasted 34 days (14 June to 18 July). Therefore the battery should be replaced monthly. And there is plenty of time do it in, provided you wait until after an impulse. However, the frequency of impulses makes a big difference to how fast the battery drains; the first battery was half full after a month.

A search on the internet for "lead acid battery how many cycles" yielded over 200 cycles of lead-acid battery is the minimum, so two batteries will last for about 33 years!

As an aside, we have a long-case clock, circa 1780, in the hall beside the front door, screwed to the wall.

No sunlight enters the hall and it is not heated, but the temperature is fairly constant. Probably because the house was built on a concrete slab; the house moves about 4 mm depending on how wet the ground is that the slab rests on.

For a clock with a simple pendulum with a light bob, it keeps excellent time. It only needs to be adjusted for daylight saving or once every few months when I fail to wind it up! It probably gains in the winter as much as it loses the summer.

Even a light pendulum swinging will move the case in sympathy and may stop the pendulum swinging.

Which is why the case is screwed to the wall.

Figure 8-2 Long case clock

The position for the Hipp clock is on another wall in the hall and likewise it is screwed to the wall, Figure 8-3, a necessity because the pendulum is much heavier and the case, which is on carpet, would move in sympathy.

Figure 8-3 Screws that hold the case to the wall

The motion of the switch activator ***A***, Figure 7-5 page 21, is counter-intuitive. If it is moved close to the vertical you would might expect the pendulum swings would be less until ***B*** on the pendulum would lodge in switch activator ***A***, and the time between impulses would be longer. Or so I thought.

But the switch activates the electromagnet and *there has to be* space between the pendulum and the electromagnet when the magnet is turned on so that it impulses correctly. With the switch activator too close to the vertical it switches on and off the electromagnet when the pendulum is still inside it and the pendulum will stop swinging.

The fact the pendulum rod expands and contracts with the temperature makes regulating very difficult. In principle, the clock should gain as many seconds in winter as it loses in summer as does the long case clock.

9 Faults, three people?

The Wiggins Hipp clock includes a number of faults, which made me decide there was more the one person involved. Probably:

One person made the movement and the motion works, using large tooth counts, and the toggle. These are excellent.

A different one made the case which is excellent.

And a different one finished it off and assembled it, probably done by A. E. Wiggins.

Case

The case and door have been very well made by a carpenter, except for:

First, there are two holes top and bottom in the door and only one top and bottom are used for bolts to keep the door closed. The two upper holes are shown in Figure 9-1 middle. The larger holes are used by the door bolts.

The door bolts (finely made) are out-of-square, obvious with the lower one. The threaded brass holes into which the bolts go were done incorrectly by a different person and added later.

Lower bolt Holes Bolts

Figure 9-1 The door

Second, there is no plinth necessitating adding wood blocks to the bottom to make room for the door to be opened and closed. There are no holes in the base of the case which are unused and probably for a plinth, suggesting there was no plinth. As the door needs to open, any plinth must have had room for opening the door which why I added two spacers, Figure 9-2.

The are six holes in the base of the case, Figure 9-2, including ***D***, (covered up by the left spacer) which was the original hole for the wires from the power source. At ***A*** and ***B*** there are two unused

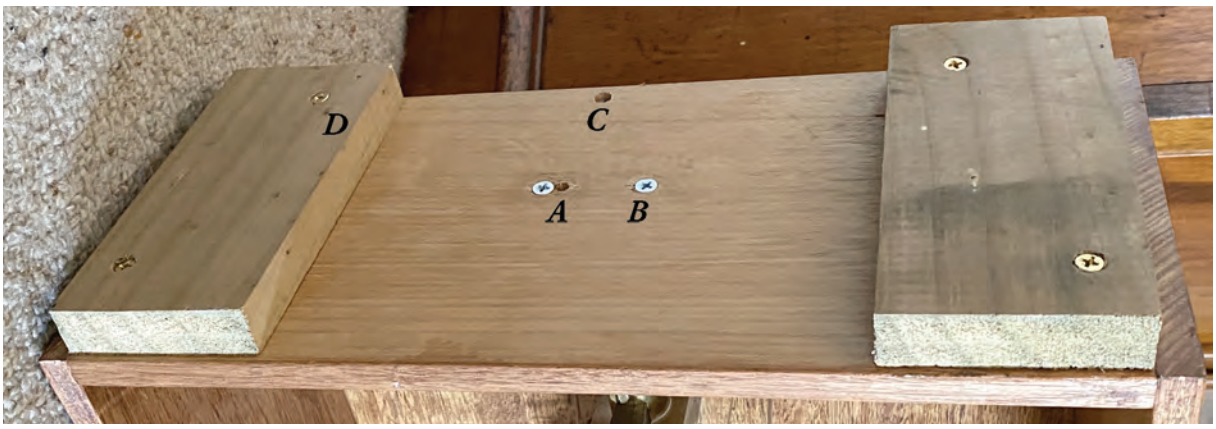

Figure 9-2 The holes in the base of the case

holes for the electromagnet as well as the used holes, certainly errors, and at ***C*** there is a hole in the base which runs into the back of the case, certainly a mistake (it could not have held a plinth).

Otherwise, the case and case door are excellently made, other than my additions which are designed to stand out using Phillips head screws, Figure 9-2 and Figure 7-9, page 24.

The shelf with name plate:

The shelf is badly made with sides out of square. There are chips in base and the cut out for the electromagnet not centred; see page 8.

The brass cover is out of square and loose so that it can wander around. Probably not finished?

So someone who was incompetent at woodwork made the shelf. It contrasts vividly with the carcass of the case. And someone else made the brass fittings on the shelf!

The plate on the shelf is the only thing that makes me say me say that Wiggins built the clock. An Internet search for "A. E. Wiggins" proved fruitless and the auction house, that I bought the clock from, also proved fruitless. A clock-maker with the necessary tools must have made the motion works and toggle and, as far I know, Wiggins was not a clock-maker. So two people, not Wiggins, must have made the case and brass and steel work, unless these two people were one.

F Hope-Jones wrote two books "Electrical Timekeeping" and "Electric Clocks & How To Make Them" (no date, but 1949). The former one has one chapter (Chapter VIII "Hipp and other pendulum-propelled clocks") appears to reprinted in full as a Google book. However it is general and doesn't into particular designs. The latter one has two chapters, one a long one, describing Hipp clocks. But none of them describe the Wiggins clock.

The toggle

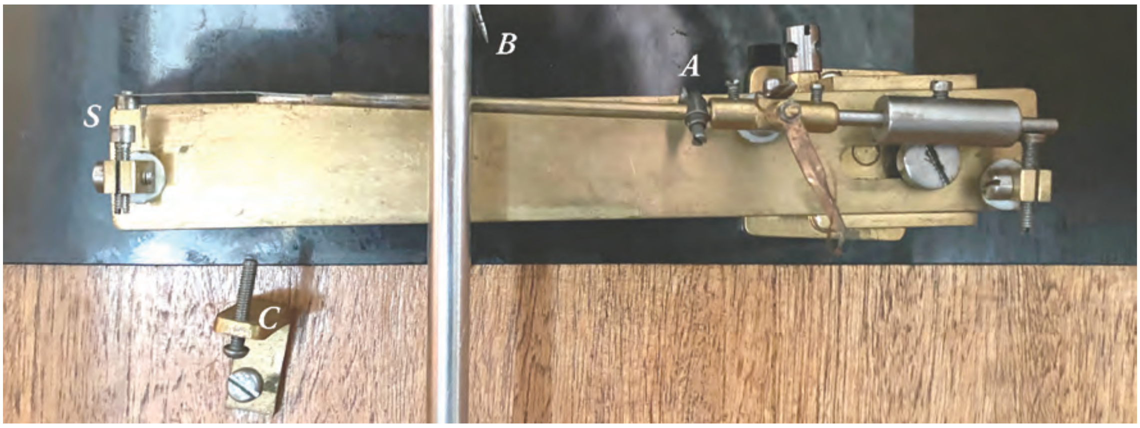

*Figure 9-3 The toggle showing the original position of the switch activator **A***

A.E. Wiggins cannot have got the clock going!

The main thing is the toggle, Figure 9-3. (This photograph was taken on 5th November 2023 just after I had got the clock.) The switch activator ***A*** is loose on the brass rod, twisted around and not in the right position. If it had been to the left of the pendulum rod it might have worked, but it is the wrong way round for it to be in this position.

Also, the trigger ***B*** on the pendulum cannot reach the switch activator and the electromagnet cannot be switched on by the pendulum. (Remember that this photo was taken after the pendulum spring had broken and after the pendulum had dropped. ***B*** should have closer to, even touching, the rod holding ***A***.) If the activator was on the left side of the pendulum rod ***B*** still wouldn't reach ***A*** except perhaps for a big bang (page 23).

Further, the two parts of the switch ***S*** are misaligned and the toggle stop ***C*** cannot reach the body of the toggle so the body is free to rotate exacerbating the problem of the trigger. Possibly ***C*** was an afterthought?

If there was a big bang it would be sufficient to pull off the part of the switch (Figure 7-3 middle, page 21) which had been dry soldered.

Because of the position of the switch activator ***A*** and the trigger ***B*** the clock ***could not*** run. If the loose switch activator and trigger were positioned correctly, the trigger would make it move along the rod, a disaster.

The person who put in the toggle (and it might be a different person to that who *made* the toggle) must have run the white wires from the electromagnet to the toggle and provided some extra white wires to the subsequent owner to connect to a power supply.

The wheelwork is excellent, using large tooth counts so probably the one person (a skilled clock maker) made the motion works, the toggle and the isolator.

So I think three people took part in making the clock; a skilled clock maker, a skilled cabinet maker and someone incompetent to assemble the parts.

Costs

The cost of my lust was $388.10 Australian dollars. The total cost, including extras (primarily batteries and battery chargers) was about $500. I did most of the work in early 2024 then finished it in late 2025.