1 Synchronome Distribution Board

My unit was made in 1963 for Salisbury College of Technology. It is in excellent condition, though the variable resistors used to set the current have begun to break up.

The unit is able to drive the master movement continuously, whilst each loop, including the 'home' loop (loop 1) can be advanced or retarded (by missing pulses) independently. The home loop has the added complication of ensuring that the movement continues to run even when the home slave (the slave in the master) is being advanced or retarded.

The unit incorporates an elaborate and strange unit inside the rear door which is supposed to be a spark suppressor. In my installation, diodes are used, so it is largely superfluous.

The meter may be coupled into any circuit (except the master movement) with the jack plug and the advance button held in whilst the current is set. Each circuit has dual fuses.

In my view, a flaw with the design is that all of the circuits are in parallel, run from the switch in the master, which has to drive the master movement and up to six slave circuits – and is thus switching over 2 amps.

The unit has a very well made and solid oak case, with a veneered ply rear board and the usual Synchronome latches.

Figure 1 – Front view closed

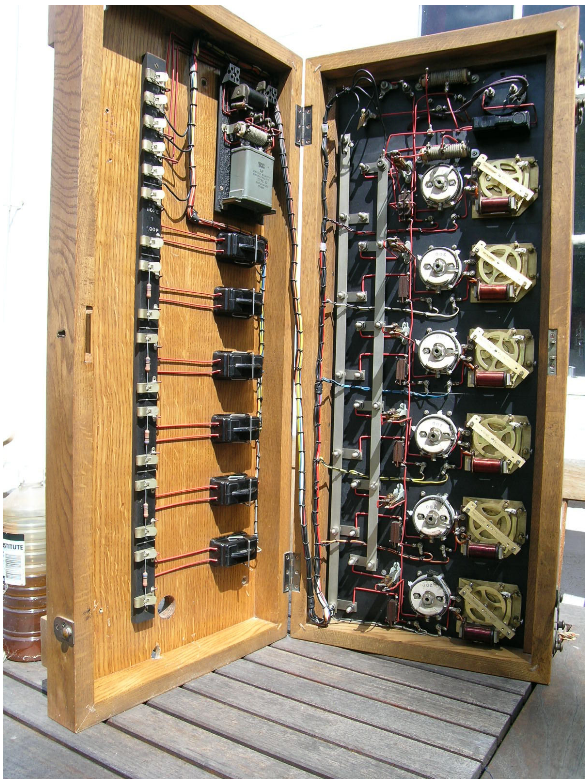

Figure 2 – Back view open

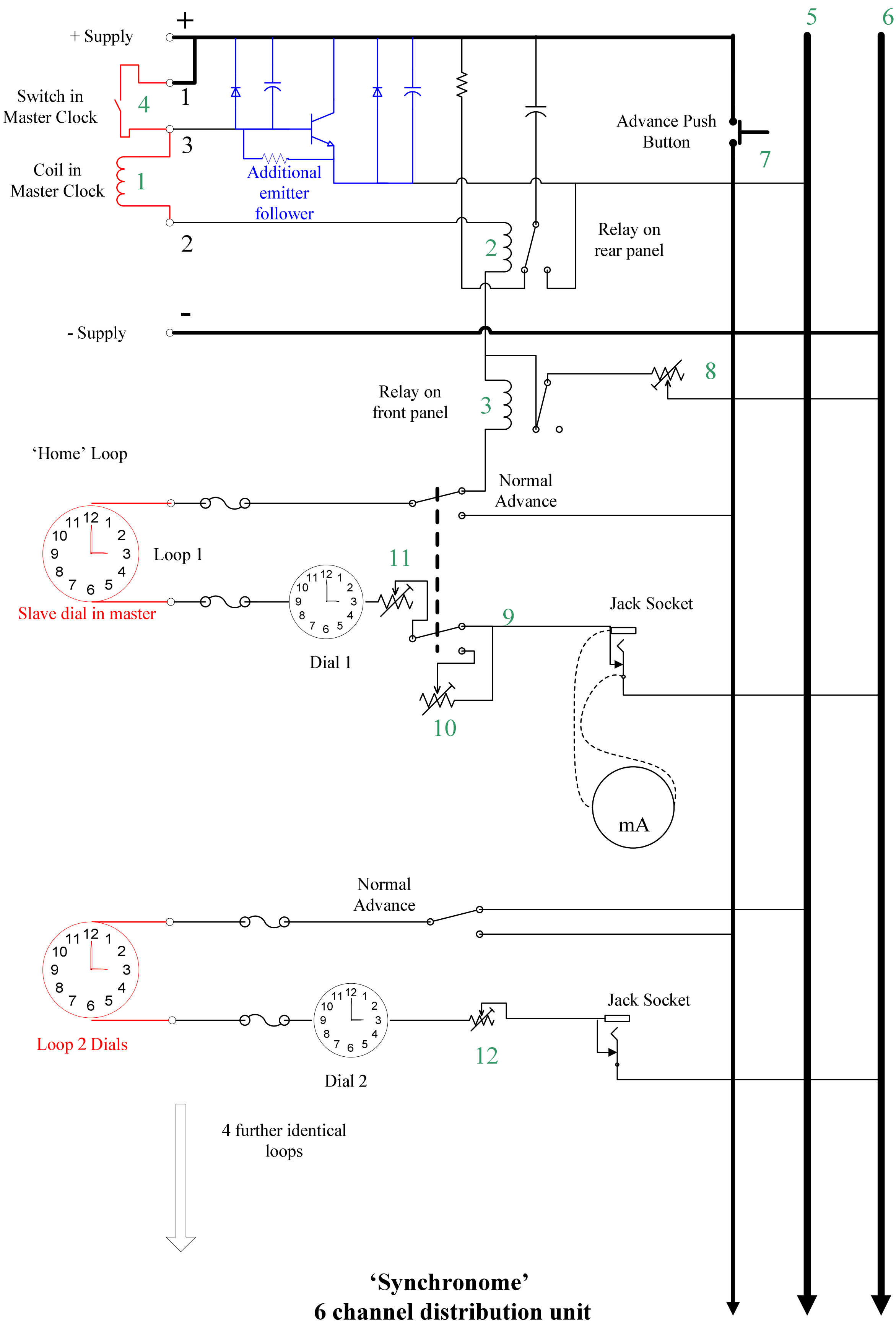

Figure 3 - Distribution unit circuit

1.1 Notes on operation

The figures in green refer to the circuit diagram, Figure 3.

The unit is connected to the master clock such that the master movement coils (**1**) are in series with two relays in the distribution board (**2**) and (**3**). The master movement coils connect between terminals 2 and 3 of the distribution unit. The switch in the master (**4**) connects between terminals 1 and 3 of the distribution unit. Terminal 1 is linked directly to the positive supply line and so the switch (**4**) on closing, connects the positive supply to the master coils (within the master clock) (**1**) and the impulse busbar (**5**). This is the impulse that advances all the clocks in *normal* operation. I have added an additional emitter follower transistor, since the contacts have to switch the current of up to 6 circuits in parallel. This is shown in blue, and reduces the loading on the master contacts to a value similar to that of a single circuit.

The distribution board has two 'busbars' (**5**), which carries the impulse and (**6**) which is negative return. There is also an '*advance*' line (**7**) operated by a push button on the front panel. This supplies the impulse from manual operation of the front panel button when the switch to any loop is in the *advance* mode.

Loop 1 is the 'home' loop and drives the slave dial in the master. Operation of relay (**2**) is related to the spark suppression system and is detailed below. The relay (**3**) operates only in *normal* mode for this loop and ensures that the resistor (**8**) to the return busbar (**6**) is switched out of circuit on each impulse. With the switch (**9**) in *advance* mode, the relay (**3**) doesn't operate and the resistor (**8**) provides a return path for the master movement coil current when the 'home' loop is switched to *advance*. Therefore this resistor should be adjusted to the sum of the impedances of the relay (**3**) coil, the slave dial in the master, the slave dial in the distribution board, the resistor (**11**) and any wiring loss impedance in that circuit. The *normal/advance* switch in the 'home' loop (**9**) is a double pole unit, whereas the other five loops have a single pole switch. The resistor (**10**) is only used in the *advance* position and compensates for the three coils (**1**), (**2**) and (**3**) being bypassed by the advance button. It should therefore be set to the sum of the impedances of the movement coils in the master, the coils of the relays (**2**) and (**3**) in the distribution board and any wiring loss impedance in that circuit. The resistor (**11**) sets the current under all operation including *advance*.

There are five further loops in addition to the home loop (loop 1), only one being drawn in Figure 3. These loops are identical and the resistor (**12**) is used to set the current.

The jack plug on the meter circuit has only one connection (despite the use of two wires) and can be plugged into any circuit. When out of circuit, the jack socket is shorted.

The capacitor and resistor associated with relay (**2**) on the rear panel are shown in Figure 2 at the top right hand side of the back panel. This operates as a 'spark suppression' aid. I believe it works like this: -

> Between impulses, the relay is relaxed and the capacitor has its negative end coupled through the resistor to the positive supply line, thus in effect having both poles of the capacitor coupled to the positive supply. Hence there is no charge stored in the capacitor.
>
> On the switch in the master closing, the impulse busbar is instantly connected to the positive supply through the switch in the master and the relay (**2**) is energised, switching over and connecting the negative end of the capacitor directly to the impulse busbar (**5**)**.** At this time the impulse busbar is itself connected to the positive supply through the switch in the master, so the capacitor still has no charge. Note that the capacitor is now also connected across the switch contacts in the master. The capacitor still has both poles coupled together to the positive supply whilst the switch in the master remains closed for the duration of the impulse.
>
> At the end of the impulse, the switch in the master, due to the mechanical 'inertial' operation will open very rapidly and the capacitor will now be between the positive supply and the impulse busbar. This state is very short and only occurs due to the relay (**2**) being significantly slower to operate than the switch in the master. Any negative 'back EMF' is therefore applied directly across the capacitor which currently has no charge and so will present it with a low impedance path to charge the capacitor and thus prevent a build up of back EMF voltage. Very shortly after

the switch in the master opens, the relay switches, returning the capacitor negative pole to the resistor, where any charge that has built up is harmlessly dissipated.

1.2 Notes on installation

I have installed the unit in my system much as designed, but have made some small changes externally to take advantage of modern components. The unit is fed from the house 'battery' supply at approximately 36 Volts. This is fed from a 1 Amp fuse in the battery box. The master clock is connected as shown in red in Figure 3. The slave dial is the dial in the 'home' loop. Constant current sources are installed as shown in Figure 4. These are set to desired value, so that different currents can be set in the different loops. A detailed description and circuit diagram of the constant current units can be supplied separately on request.

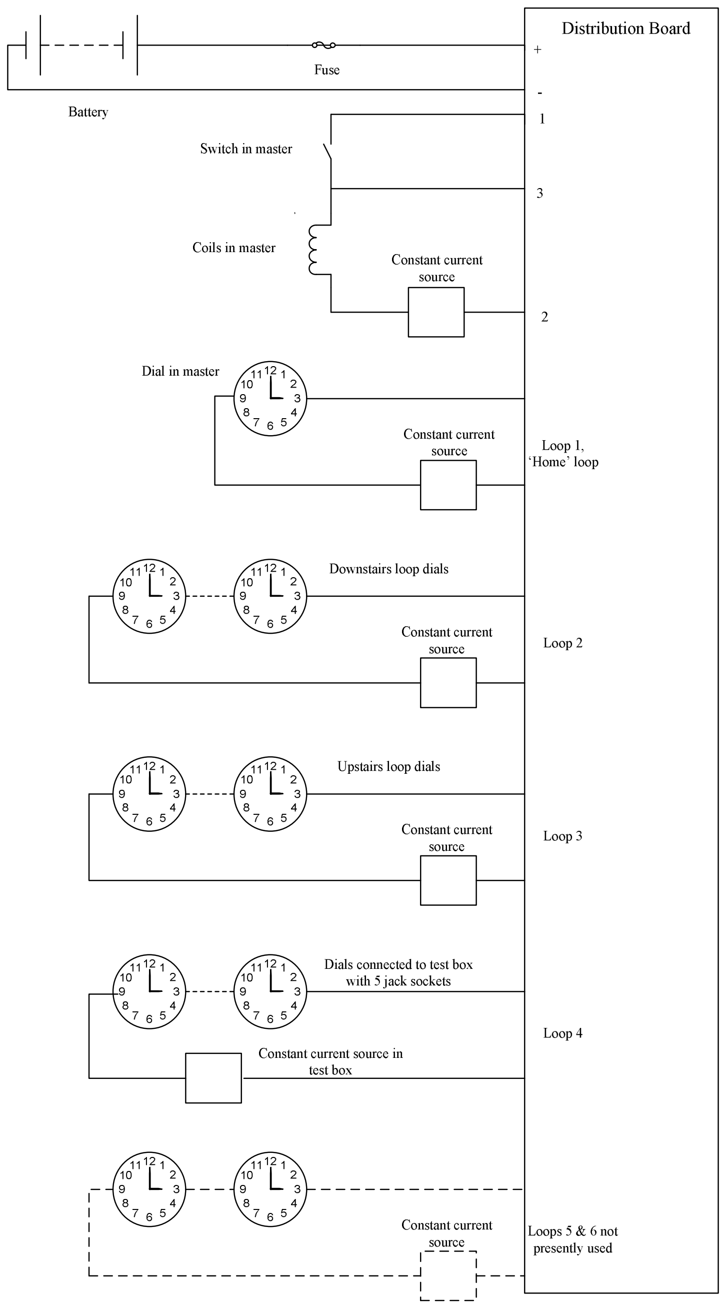

Figure 4 - Installation diagram

1.3 Notes on design

The design is unusual. There is no additional relay, so that will all circuits populated and running (6 circuits plus the master movement, there is a current of 0.33 x 7 = 2.3 Amps to be switched by the switch in the master, which is a tall order for both the switch and the wiring.
The arrangements for spark suppression which rely on the timing of the relay operation are crude, but with the limited component availability, this may have been the best way. The use of a relay made up from parts screwed to the chassis is unusual and must have been more expensive than the purchase of a standard relay – presumably the design is a carry over from much older products. The strange arrangement for keeping the master movement running whilst adjusting the 'home' circuit is a puzzle, as it incorporates a relay, mounted visibly on the front panel, which operates all of the time. It is not at all clear why this complex method was chosen, when an additional pole on the *normal/advance* switch would have achieved the same effect as lower cost and better reliability. Why is the relay made so visible on the front and why is a 'home made' relay used?
The oak case is very well made, but it is strange that the slave dials have no protection for the hands, which can easily be caught by the lead to the current meter. There is a hole provided in the bottom panel to insert the plug when not in use.

2 Constant current source

2.1.1 Original version

I originally added a simple constant current source based on an LM 317 in a TO 220 case with the resistors, bypass diode and bypass capacitor all 'heatshrunk' together. Current was set to 275mA and it seems to work well, provided enough voltage is present. It needs a minimum of 1.4V across it to work correctly. One slave needed slight adjustment of the spring to work on what is in fact a lower limit current.

2.1.2 Post Distribution Board version

When I installed the distribution board, a single could no longer be used. I therefore decided to have a separate unit in each circuit and at the same time make them adjustable within limits. The design allows adjustment from approximately 200mA to 350mA. Unfortunately – the need for very low resistance requires a 10Ω potentiometer – which is expensive and both series and parallel resistors to get the correct values at the limits of the travel of the potentiometer. I didn't want to install them in the distribution unit itself, so I built the units as identical modules that are attached to a board on the wall above the unit.

Figure 5 – Constant current device

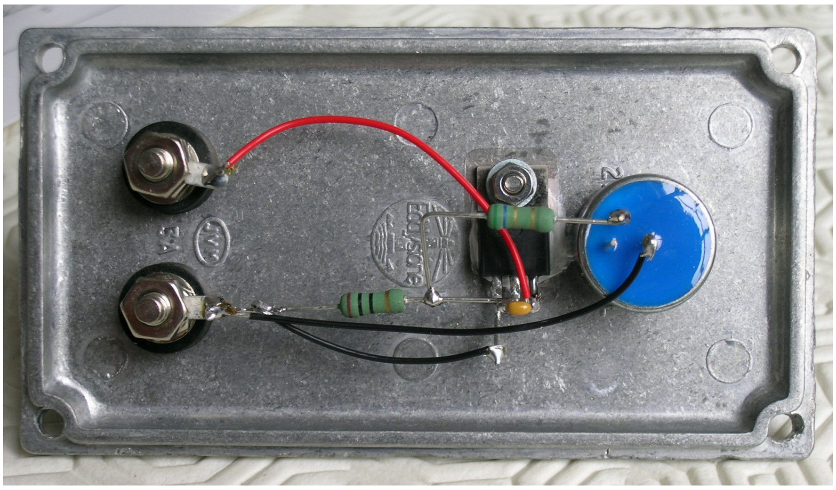

Figure 6 – Constant current device internals, rear view

The unit is based on a standard LM317, with a 10Ω potentiometer. Figure 7 shows the circuit used. The final version added a diode from input to output to protect against reverse voltage and a small capacitor to ensure stability. The unit is simply fitted in series with the circuit supply.

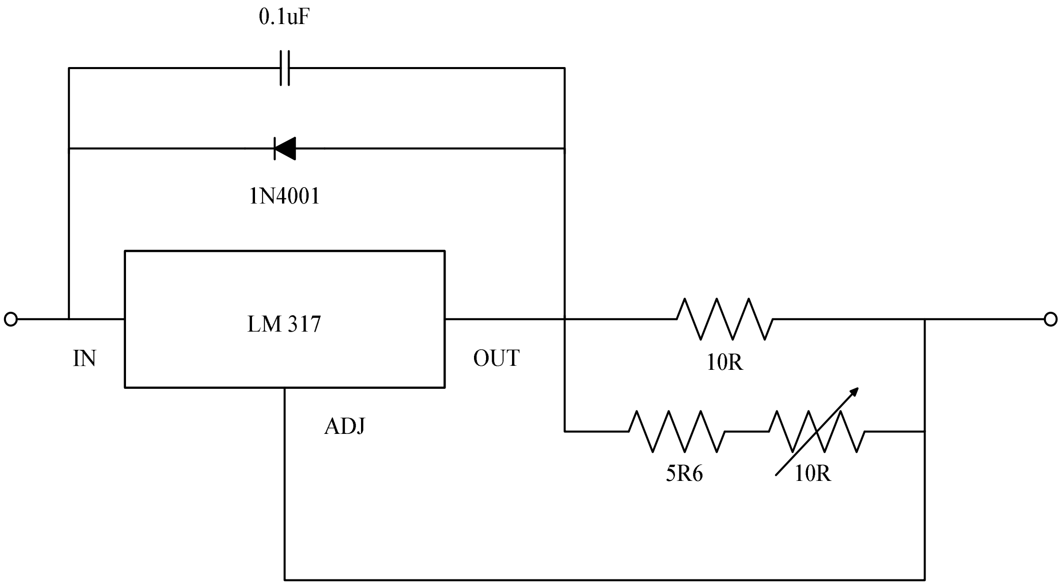

Figure 7 - Constant current device circuit