MASTER CLOCK 22/1

CUSTOMER ENGINEERING REFERENCE MANUAL

INTERNATIONAL TIME RECORDING CO., LTD.
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DESCRIPTION

The Master Clock consists of a precision - made Graham dead beat escapement clock mechanism with a motor-wound main spring.
It has an impulse storage unit which automatically adjusts the equipment on the system after any current failure provided this does not exceed 12 hours duration, it also rewinds the mainspring.

The 24 volt d.c. minute impulse is provided via heavy duty motor driven self-wiping contacts, spark suppression is provided. Switches and a solid state rapid impulse printed circuit make up the self regulation feature, so that at each 59th minute any secondary unit (which could be up to 9 minutes fast or 15 minutes slow) will correct at the hour.

The clock has temperature compensating pendulum with a fine adjusting nut and also contains a power pack consisting of transformer, rectifier, and fuses, and is fitted with a square black dial with white chapters and hands. The case is ABS plastic with a steel back plate. Two wires, identified C&A are connected in parallel to all secondary units.

DATA

TIMEKEEPING	± 20 seconds/month
INPUT VOLTAGE	115 - 220 - 240 volts 50 - 60 Hz ± 15%
RESERVE ENERGY	12 hours +
POWER CONSUMPTION	5 watts off load - 55 watts full load
IMPULSE VOLTAGE	24 - 29 Volts d.c.
MAX. LOAD	0.8. amperes
IMPULSE LENGTH	2.5. seconds approximately
TRANSFORMER & RECTIFIER RATING	2 Amperes
FIXED OUTPUTS	24 d.c. - 24 a.c.
CORRECTION RATE OF I.S.U.	15 impulses/minute
CORRECTION RATE OF H.S.	1.8 seconds/impulse
PENDULUM BEAT	2/3 seconds
DIMENSIONS	660 H x 235 W x 135 D mm
WEIGHT	7.8 Kg

INSTALLATION INSTRUCTIONS

The master clock should be mounted with the dial at eye level on a completely rigid and truly vertical wall which is free from vibration, dust and draughts and where there is no direct or reflected sunlight or rapid temperature changes.

Remove the cover by loosening the two screws on each side of the case and lifting it from its locating pegs at the top of the backplate.
Remove the movement from the backplate by loosening the two screws located underneath and withdrawing the multi-pin plug.

To mount the backplate fix a 1" (25mm) No. 8 woodscrew into the wall 63" (1.6m) from the floor, and hang the backplate on this screw, threading the mains input cable through the right hand grommet and the output C & A wires through the left hand grommet. Tighten the woodscrew.

Hang the pendulum from its suspension spring and using it as a plumb line to indicate that the backplate is vertical, fix the bottom of the backplate with two woodscrews.
Connect the cables to their respective terminal blocks.

Check that the pendulum suspension spring is undamaged (a spare is provided fitted beneath the spare fuses).
Replace the movement on the backplate checking that the verge fork is locating over the pendulum rod, tighten the thumbscrews and reconnect the plug.
Set thependulum into a small swing and check the beat, adjust as required with the adjusting screw on the verge fork.

STARTING THE SYSTEM

Stop the pendulum, switch on the mains supply, remove the 1.6 fuse from its holder, and turn the minute hand forwards approximately 10 hours (never turn the minute hand backwards) from the time indicated by the clock upon delivery. This ensures that the main spring will be fully wound. It takes approximately 40 minutes for the synchronous motor to rewind the clock, during this period all of the secondary units can be connected and set to approximately the time indicated by the master clock.
Replace the 1.6. amp fuse.
Set the master clock to the true time and start the pendulum. Secondary units should now advance to the true time. (approx). Check that every secondary unit has corrected after the next 59th minute.

TIME REGULATION

To regulate the clock proceed as follows:
Holding the pendulum firmly to prevent damage to the suspension spring, turn the adjusting nut downward if the clock is gaining and upward if it is losing.
Each vertical line on the adjusting nut represents 8 seconds/day.

LUBRICATION

The movement does not need frequent lubrication. When lubrication is necessary oil all bearings (NEVER oil the gear wheel teeth). Sufficient oil for each bearing may be applied by dipping a wire .036" (.9mm) in diameter into a good grade clock oil up to a depth of 1/4" (6mm).
Too much oil is more harmful than too little.

COMPONENT PARTS OF THE MASTER CLOCK

SYNCHRONOUS MOTOR

The synchronous motor which is held by 2 screws to the front plate of the movement has 3 functions to perform at the end of each minute.
(A) Rewind the mainspring, (B) reset the impulse storage unit, (C) send out the minute impulse via the moving cam wiping the contacts. The motor receives its 24 volt A.C. supply via the yellow and blue leads from the transformer secondary winding. A 1 amp fuse protects the motor and an 82 ohm resistor reduces the voltage (see circuit diag page 14) The supply contacts mounted in white nylon have a small capacitor connected in parallel to act as a spark quench. The contacts are closed once per minute by the action of the impulse storage unit.

IMPULSE STORAGE UNIT (I.S.U.)

The unit consists of two cams separated by an intermediate gear, a differential gear drive unit, and two spur gears, and is situated on the left hand side of the movement (rear view). The unit will reset the system to the correct time after a power failure lasting up to 12 hours; it also determines when the minute impulse will go out each minute.
During normal run the sequence is as follows:
After the minute impulse, the cam wiper riding on the outer 1 hour cam starts to ride up the inclined plane on the cam because one side of the differential gear unit is directly coupled to the large spur gear fixed to the main minute hand shaft of the movement. The cam wiper lifts a white nylon contact separator which is holding apart the supply contacts for the synchronous motor.

When the 57.5 second is reached the separator has risen sufficiently to allow the contacts to close, starting the synchronous motor. The motor is coupled, via the large mainspring spur gear, to the other side of the differential gear unit, and the hour cam is driven back to its original position allowing the cam wiper to ride down the inclined plane, releasing the contact separator therebye opening the supply to the motor, which stops.

During a power failure the sequence is the same, except that the synchronous motor will not reset the I.S.U. at the end of the first minute, therefore the cam wiper will ride further around the periphery of the cam each succeeding minute.

It is prevented from riding down the inclined plane after one hour by the inner 12 hour cam which is coupled by its intermediate gear.

It should be noted that if a power failure of say 13 hours occurred then the secondary units would only be corrected by 1 hour.

When the power supply is restored the synchronous motor will start to run and drive the cam back to its original position at the rate of 1 minute in 2.5 seconds. It is therefore evident that the correction impulses are the same length as the normal minute impulses.

Note that if the minute hand is manually advanced round the dial the secondary units will follow at the correction rate, because the I.S.U. cams are coupled to the minute hand shaft.

MAINSPRING

The mainspring, contained in a brass cylinder between the large gears attached to the minute hand shaft, has a reserve of up to 16 hours and is prevented from being overwound because the outer end is not anchored. When the spring is almost fully wound the diameter of the outer coils is reduced therebye allowing the spring to slip round in its housing. As it slips the tension is reduced and the coils increase their diameter to grip the cylinder once more.

To service the mainspring, the following parts must be removed. Printed circuit, rear plate assembly, I.S.U. cams and intermediate gear, minute impulse contact assembly and cam, verge assembly (caution: restrain the escape wheel when removing), and the movement backplate.

The minute hand shaft cannot be removed from the front plate without a special tool to extract the front pinion.

The mainspring assembly is retained upon the shaft by a spider spring and cotter pin: an engineers clamp is useful to depress the spider spring to facilitate removal of the cotter pin.

VERGE ASSEMBLY

To remove the verge assembly mark the position of the verge bridge and remove after restraining the escape wheel. The verge is provided with reversible exit and entry pallets. Before attempting to reverse their positions a careful note should be made of the original positions. Recheck the beat of the clock.

MINUTE IMPULSE CONTACTS

The assembly is held on the backplate of the movement by 2 screws. The 3 contact blades should only be cleaned by a soft card, never use an abrasive material as this would remove the special plating. The two outer blades should press against the stop pins with a force of 7 grs; the inner blade must wipe the cam with a force of 8 grs. All the blades are fitted with a contact pressure adjusting screw. If the cam is removed for any reason it must be reset with its pin midway between the two outer blades after the synchronous motor has come to rest.

SYNCHRONOUS MOTOR CONTACTS

The motor contacts have a gap of .03" (.8mm) when open and an outer contact spring pressure of 10 grs when closed. The operating surfaces of the double sided nylon cam which opens the contacts should be lightly smeared with a fine grease.

DIAL AND HANDS

The dial is attached to the movement by a 3 spring clips.

The hour hand is a friction fit on the hour gear sleeve; when replaced it is essential to ensure that it is pushed fully home, so that there is end shake between the hour and minute hands.

The minute hand shaft has a square milled end, and care must be taken when replacing the hand to ensure

that its position is correct in relation to the H.S. cam. As a rough guide the hand should be approximately 35 minutes ahead of the advance pin fitted to the cam. The hand nut is fitted with its convex side to the outside.

REAR PLATE - ADJUSTMENTS TO M.S.1.

Micro switch (M.S.1) is located on the rear plate assembly and is opened by the I.S.U. cam wiper 1½ minutes after the mains power is removed from the clock, thus disconnecting the positive (+) supply to the P.C. impulse assembly and the polarity change relay coil. This disconnection is necessary to ensure that after a mains power failure (when the secondary units are being stepped round to the correct time and the master clock minute hand reaches the 49th minute) the polarity change relay will not operate, nor will the 15 rapid impulses be sent out during the 59th minute.

To set the switch for opening after 1½ minutes movement of the minute hand, disconnect the two white leads and connect an ohm-meter across the micro switch. Ensure that the white nylon contact separator, fitted on the synchronous motor contact end of the cam wiper is in its lowest position, and that the cam wiper is just touching the inclined plane on the cam. The micro switch should be closed at this point.

Move the minute hand forward 1 minute only, this is indicated by the nylon contact separator allowing the contact blades to snap shut. The micro switch should still be closed and should not open until the minute hand is moved forward a further ½ minute. To obtain this adjustment set the micro switch mounting bar.

Tighten the two fixing screws firmly. Reconnect the two white leads to the Com and N.C. terminals of the micro switch.

PRINTED CIRCUIT BOARD TRANSISTOR IMPULSE UNIT

The circuit is fully transistorised for a long-term trouble-free working. The operation of the circuit is as follows:

The raw d.c. from the bridge rectifier in the power supply is passed via diode D1 and resistor R2 to the reservoir capacitor C1 and via resistor R3 further on to the voltage stabilising zener diodes ZD1 and ZD2. A smooth d.c. voltage of approximately 16.5v appears across the series combination of ZD1 and ZD2 (two 8.2v sener diodes in series). This voltage is applied to the astable multivibrator consisting of T1, T2 and associated components. The multivibrator generates a square wave which has a pulse rate determined by the value of R5 x C2 and R6 x C3 (approximately 1 second on and 1 second off). A square wave form appears at the junction of R7 and R8. The signal now drives the amplifier stages formed by T3 and T4 via R8, causing T4 to act like a relay contact and alternatively, make and break the current flowing in the negative side of the line.

The "A" and "C" line polarity change relay has a 24v d.c. coil with double pole change over contacts, a resistor R1 is fitted in series with the coil to reduce the voltage.

The relay cover is a friction fit and may be removed for cleaning or adjusting the contacts.

FRONT PLATE ASSY - ADJUSTMENTS TO M.S.2 & 3 & H.S.CAM

Because the transistor impulse unit is completely silent and has no moving parts it is recommended that, before undertaking adjustments to M.S. 2 and 3 and the H.S. cam, the existing system be disconnected and a secondary clock connected to the A and C terminals on the power unit board.

The instructions are detailed on the assumption that the whole of the front plate and cam settings have been disturbed.

Place the dial in its locating holes, refit the minute hand (do not fit dial clips or hand nut at this stage).

Move the hand forward to 49' 30"

NOTE 1:

The Secondary clock will follow when the master clock minute hand is moved forward.

Remove the hand and dial, lightly lock one of the socket screws on the H.S. cam after turning the cam until M.S.2 (the upper micro switch) just rides up onto the highpoint of the cam thereby closing the micro switch contacts. (The relay armature will snap in).

NOTE 2:

The micro switch can be repositoned within the limitations of its fixing screws; the operating lever may also be reformed if necessary.

Replace the dial and hand, move the hand to 59' 50" when the M.S.2 operating lever will drop from the cam. thereby opening the relay.

Move the hand to 59'05", remove the dial and hand, set the micro switch M.S.3 (the lower micro switch) to just close the contact (this will be indicated by the secondary clock stepping round, providing it is not on its 59th minute). Adjustment is made by moving the mounting bar as required.

Operate the pendulum for approximately 30 seconds to check that 15-17 rapid impulses are sent out before the operating lever on M.S.3 falls from the cam pin.

Lock both socket screws on the H.S. cam, lock all the adjusting screws and then re-check that the H.S. is operating correctly.

First set the secondary clock slow and check that the rapid impulses operate on the 59th minute to bring it into line with the master clock. Then set the secondary clock fast and check that it holds back at the 59th minute to align with the master clock.

Fit the hour gear, dial and hour hand (taking care that the hour hand is pushed fully home onto the hour sleeve).

Fit the minute hand and nut, ensuring that the hand is correctly aligned with respect to the H.S. cam.

PRINCIPLE OF OPERATION (2 wire system)

All units are connected by a two wire paralled distribution indicated by the letters "C" and "A" and from the description of Master Clock contacts previously given, it will be realised that beside the 60 impulses at minute intervals there are also available 15 to 17 rapid impulses transmitted during the 59th minute every hour.

The polarity change relay previously mentioned is used to reverse, within each hour, the directional flow of current over the two wire parallel distribution, flowing in one direction for the period 49'30" to 59'50"approximately, and for approximately 50 minutes in the opposite direction. This is controlled by the Master Clock stop switch M.S.2 as already advised. Therefore for almost the last 10 minutes of each hour the coil is energised, bringing about the current reversal necessary to complete automatic supervision on 2 lines. ("C" is positive (+) from 59' 50" to 49' 30").

Each secondary unit is fitted with a diode (polarity trap) which permits the current to flow through part of its circuit in one direction only, whilst the other section of the circuit operates from impulses received from both directions.

It must be noted that between 49' 30" and 59' 50" Master Clock time, the current is in the direction to allow Units to advance except between the 59th and 03 past the hour period. Units at these minutes would hold up until the rapid impulses have been sent out from the Master Clock, and just before the hour impulse, when the current directional relay releases, to change over the polarity to that acceptable by the diode.

To understand Hourly Supervision, three examples of its operation are shown.

1. WHEN IMPULSE UNITS ARE IN LINE WITH MASTER TIME

At 49' 30' master time the M.S.2 contacts close and the current then flows in the direction opposed by the diode. Until the 59th minute impulse, the Units advance on that part of the circuit that does not include the diode but on the 59th minute impulse the units are transferred mechanically over to the diode circuit, therefore any impulses including the 15 to 17 rapids are rejected, and not until the M.S.2 contacts break again at 59' 50" or immediately after the rapid impulses and before the hour impulse, does the current change direction to that acceptable by the diode, so permitting units to advance to the hour in line with the Master Clock.

2. SHOULD UNITS BE A FEW MINUTES BEHIND THE MASTER TIME

Again at 49' 30" Master time the current is now established to be flowing in the direction opposed to the diode circuits. In this instance the Units, are say 5 minutes slow at the 44th minute. As in (1) the same sequence happens until the 59th minute Master Clock time, then during the 59th minute the rapid impulses are transmitted at 1.8.second intervals. The first 5 are accepted by the Units and then at their 59th minute they switch over to the circuit having the diode, the rest of the rapid impulses are rejected. On the 60th minute the impulse is then transmitted over the diode section of the circuit.

3. WHEN IMPULSE UNITS ARE A FEW MINUTES AHEAD OF MASTER TIME

Master clock time is 49' 30" as previously. If in this instance the Units are 5 minutes fast at 54 minutes past the hour only 5 impulses will be required to bring them to the 59th minute when they change over to the diode circuit, and then are held until the hour impulse, this being the first impulse acceptable by the circuit. (It will be noted that in this case not only are the rapid impulses not required but neither also the minute impulses after the 54th).

From the examples you will see that the supervising period each hour is within 15-17 minutes behind and 9 minutes ahead. Should more than 15-17 minutes have to be made up, part or whole of the next hours rapid impulses may be necessary. Should more than 9 minutes in advance need correction with some units, up to 14 minutes can be catered for, over 2 hours.

However some units are constructed to change over at the 59th minute and transfer back again at the hour. The limit of correction ahead to these units is 9 minutes only. However it is not likely that units will be ahead of Master Clock Time this is mentioned only to indicate the limits of supervision and to clarify the position should the exception occur.

ALTERNATIVE INTERNAL WIRING CIRCUIT FOR H.S. CONTACTS OF SECONDARY UNITS

There is now an alternative to the circuit previously used when wiring H.S. contacts of secondary units for attachment to 2 wire systems only.

At present the change over is brought about by either a cam or stud throwing the centre blade of the H.S. Contact assembly from one outer contact to the inner and the use of a diode to restrict the flow of current in one direction only.

The new method of connection, which will be followed in future, uses only two of the three contacts, the outer contact, no longer serving any useful purpose, can be ignored.

The alternative represents a straight make and break, so Secondary Units whilst on the "A" line will have their contacts made, and when on the "B" line the contacts will be open leaving the diode to determine whether the coils should be energised or not.

Please note that both circuits are acceptable on any 2 wire system either working togther, or separately.

NOTES

1. If a failure occurs in the printed circuit (PC) impulse unit the system will carry on working normally (but without the hourly supervision (H.S.)).

2. When correcting after a power failure (assuming the correct time to be between 49' 30" and the 60th minute) the system will not hold the secondary units back at the 59th minute as does the existing 25-7 with I.S.U.

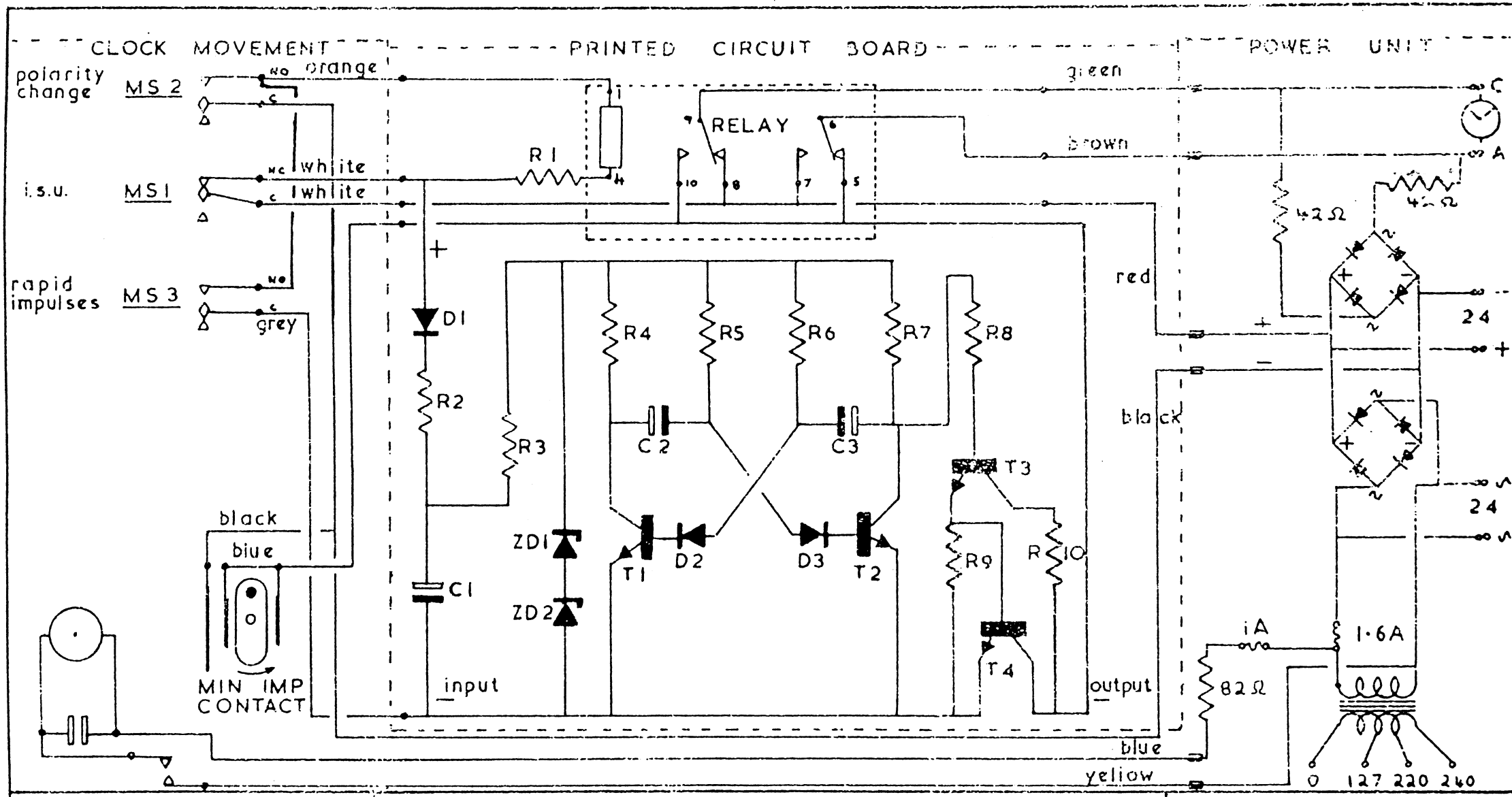
3. If a short circuit is present across the C & A lines the 1.6 amp fuse will blow but the master clock synchronous motor will still be in circuit on the 1 amp fused 24v AC supply, and therefore the master will carry on and keep correct time. The system of secondary units will have to set to the correct time manually after the short circuit has been removed. To do this proceed as follows:-

   (a) Stop the pendulum.

   (b) Disconnect the 1.6. amp fuse.

   (c) Turn the minute hand of the Master Clock forward to the time indicated by the secondary units, allowing time for the I.S.U. to be reset.
   Move the hour hand on the master to the secondary unit time (the hour hand is a friction fit on the hour gear sleeve).

   (d) Replace the fuse, reset the Master Clock hands to the correct time, restart the pendulum.



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