Clyde HOT WATER SYSTEMS

Clyde SUSTAINABLE ENERGY

Clyde CVT

Packaged DHW heat pump system

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Engineering Data Sheet 782/3

December 2006

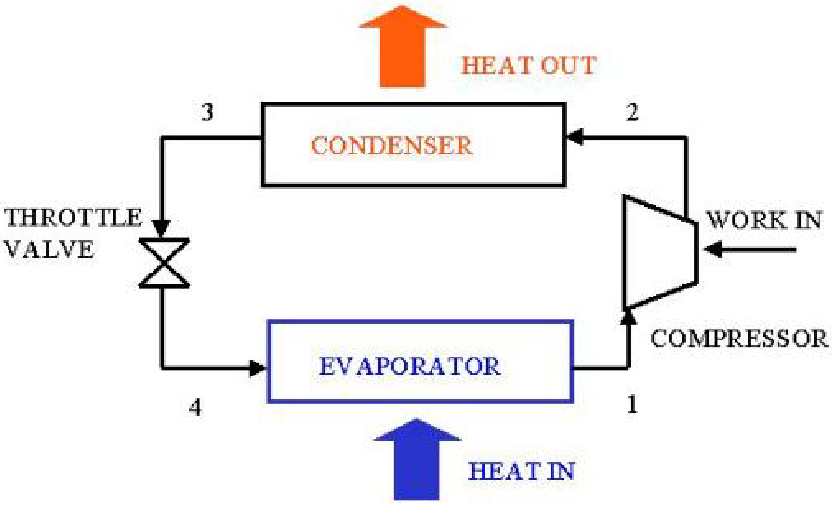


Fig 1 Schematic of operating principles

Application

Clyde CVT is a packaged DHW air source heat pump system. “Free heat” from the outside air is used to raise the temperature of the water in a two layer enamelled steel calorifier, even when the outside air temperature is very low. The temperature can be boosted by an integral electric immersion heater or an auxiliary heat source (eg solar panels or a boiler) via one of the two heating coils.

Operating principles

Refer to Fig 1 above

A heat pump is essentially a vapour compression refrigeration cycle working in reverse, collecting heat instead of rejecting it. Low pressure refrigerant (as a saturated liquid) is boiled at the evaporator by the heat capacity of the incoming air (4 ⇒ 1). The saturated refrigerant vapour is then pressurised by the compressor. The mechanical work done by the compressor is transferred as heat energy that raises the temperature of the vapour (1 ⇒ 2). The high temperature, high pressure vapour is condensed to a liquid at the condenser, thus releasing its heat (2 ⇒ 3). The high pressure liquid is finally passed through an expansion device (3 ⇒ 4) that reduces the pressure and temperature to restart the cycle.

Operation of CVT

Refer to Fig 2

Low pressure R134a refrigerant is boiled at the evaporator by the heat content of the incoming air. The refrigerant vapour is compressed from 6 bar to 18 bar and circulated around the loop of the D-tube condenser coil that surrounds the hot water calorifier. The refrigerant vapour condenses and transfers sensible heat to the cooler hot water store.

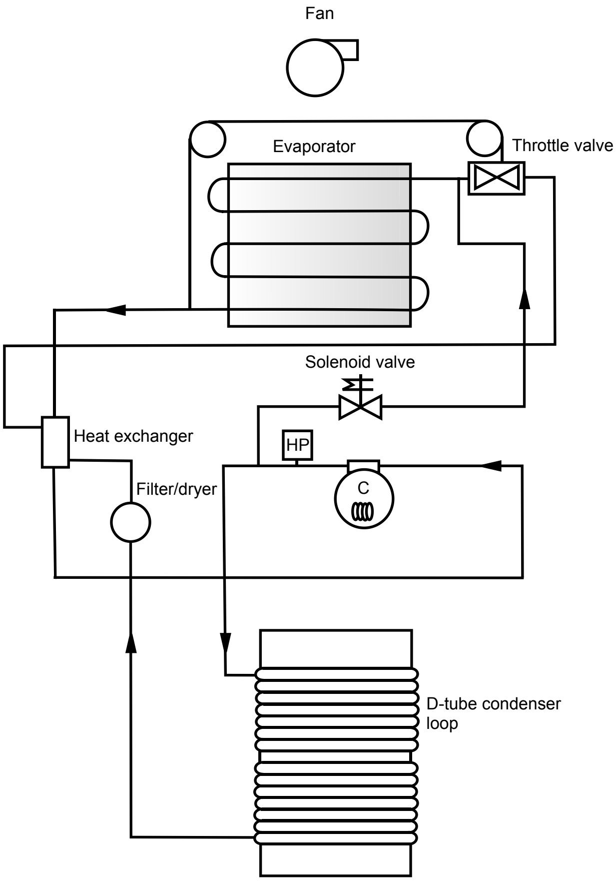


Fig 2 Operation of CVT

The filter/dryer absorbs moisture from the high pressure liquid refrigerant. The cross-flow heat exchanger will provide transfer of any residual heat to low pressure refrigerant vapour leaving the evaporator. Finally, the throttle valve provides the transition of the refrigerant back to a low pressure liquid.

The high pressure switch prevents over-pressurisation of the system.

The advanced design of the CVT gives a CoP of 3.33, exceptional for an air source heat pump.

Coefficient of Performance (CoP)

CoP is a measure of the efficiency of a heat pump. Loosely, it is the ratio of electrical energy input (kWe) to heat energy output (kWth). A CoP of 3.33 indicates an output of 3.33 kWth for every I kWe input of electrical energy. More precisely,

$CoP_{HP} = h_2 - h_3 / h_2 - h_1$

Where h is the measurement of enthalpy (kJ/kg) taken from a ph (pressure-enthalpy) diagram.

Fig 3 is a simplified ph diagram for refrigerant R 134a, which is used in the CVT. Numbers 1 to 4 on this diagram also correspond to the four stages of the vapour compression cycle shown in **Fig 1**.

It is important to note the conditions at which the CoP is measured, since this is not an ideal Carnot cycle. For the CVT, this is an air temperature of 20°C, RH 70% and water heated from 15°C to 47°C. The closer the demand water temperature to the supply air temperature, the more efficient the heat pump operation. This is because less energy input is required during the vapour compression stage. If it is acceptable to reduce the DHW set point from the heat pump cycle maximum of 55°C, there will be corresponding energy savings.

The CVP heat pump will operate when air temperatures range from -10°C to +35°C. In the UK, it is rare for air temperatures to fall below -4°C in winter.

Location

CVT heat pumps must be located inside a building, with adequate space provided for pipework connections and jacket removal. The chosen location must permit servicing and maintenance of the calorifier, anode and auxiliary equipment - refer to page 4 for recommended clearances. A specially built plinth is not necessary, but CVTs should be installed on a level surface that is capable of supporting the weight of the filled calorifier and auxiliary equipment. Use the adjusting feet to ensure the unit is level.

Storage and handling

To avoid damage, heat pumps **must** always be handled and stored upright. They should be stored in a dry, covered and frost-free location.

Electrical installation

All electrical work should be carried out by a competent person and in accordance with BS 7671 Requirements for Electrical Installations and current statutory requirements.

Commissioning

The heat pump must be commissioned in accordance with the manufacturer's instructions. It is strongly recommended that Clyde be contracted to undertake this work. Documentary evidence of correct commissioning will be required in the event of a warranty claim.

Guarantee

CVTs are designed for use in potable water supplies only. The guarantee is invalid if the calorifier is used on other types of water supply, e.g. saline, de-ionised, etc.

Subject to correct handling, installation, use and maintenance, the heat pump elements and electrical components are guaranteed for one year from the date of delivery. Provided that the conductivity of the water supply is greater than 100 µS/cm, the calorifier vessel is guaranteed for 2 years from the date of delivery.

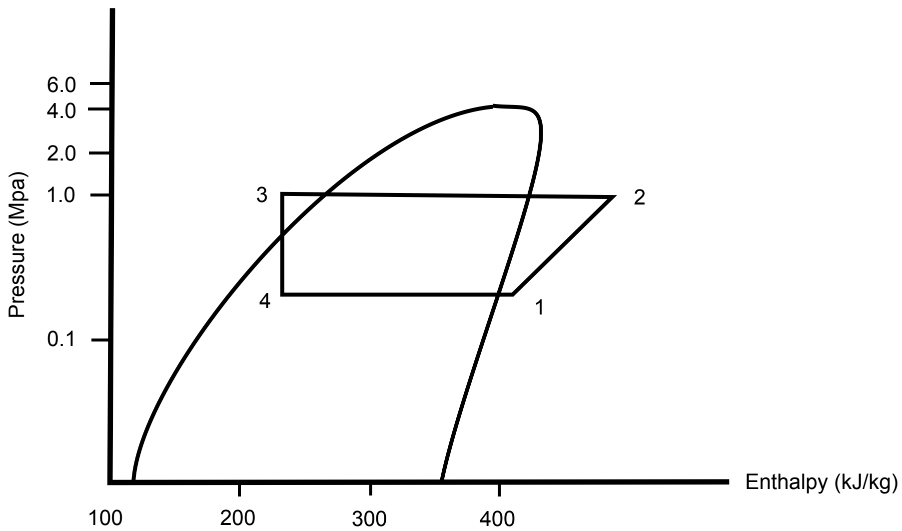


Fig 3 Simplified ph diagram for refrigerant R134a

Dimensions

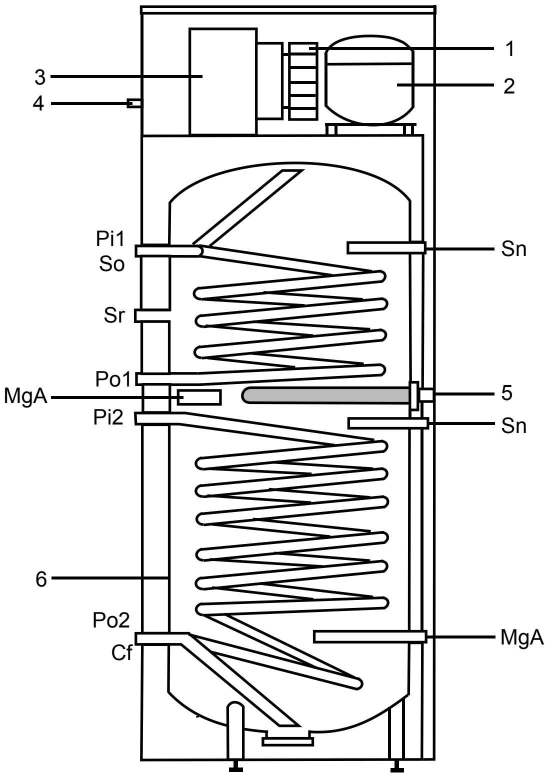


Fig 4 Side elevation

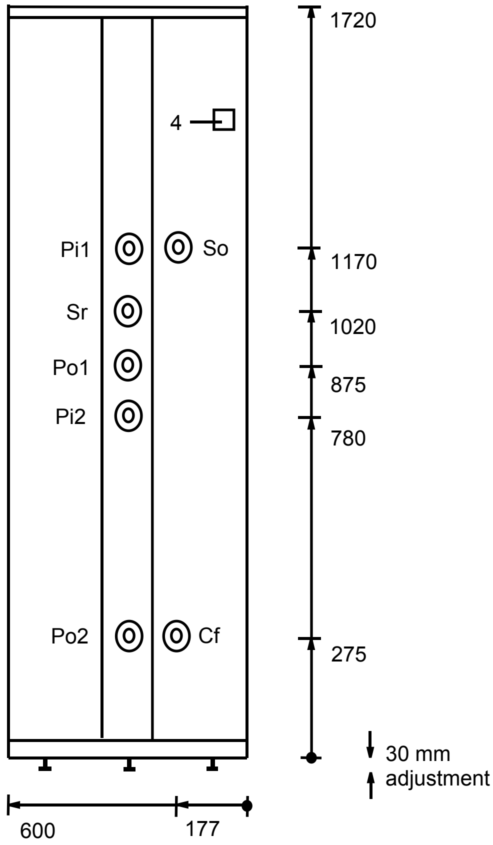


Fig 5 Rear elevation

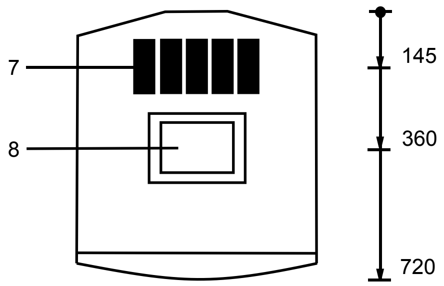


Fig 6 Plan

Key to figs 4,5 and 6

So	Secondary outlet	Rp1
Sr	Secondary return	Rp¾
Cf	Cold feed	Rp1
Pi1	Primary inlet - coil 1	Rp1
Po1	Primary outlet - coil 1	Rp1
Pi2	Primary inlet - coil 2	Rp1
Po2	Primary outlet - coil 2	Rp1
MgA	Magnesium sacrificial anode	
Sn	Sensor pocket	
1	Fan	
2	Compressor	
3	Evaporator	
4	Defrost water outlet	
5	2.0 kW immersion heater	Rp1¼
6	D-tube condenser	
7	Air inlet	
8	Air outlet	

Recommended minimum clearances

For pipe connections	At rear	500mm
For access (reversible)	One side	500mm
	Other side	100mm
For access & cleaning	At front	600mm

Technical data

Calorifier

Storage	270 litres
Dry weight	175 kg
Maximum working pressures	10 bar primary and secondary
Maximum secondary flow temperature	55°C
Secondary overheat thermostat setting	65°C
Sacrificial magnesium anode	Standard

Primary heat source - heat pump

Refrigerant capacity	0.78 kg of R134a
Voltage	230 Vac 50 Hz
Heat pump load and current	600 w / 2.6 A
Heat to water exchange	1.8 kWh (1)
Secondary water flow rate	926 litres / 24 hours
Recovery time for 270 litres	7 hours
Supplementary electric immersion heater	2.0 kW / 230 Vac
Total connected load	11.3 A
Air volume	200 m^3/h minimum / 300 m^3/h maximum

Secondary heat source - coil 1

Heating surface area of coil	0.6 m^2
Primary water flow / return temperatures	80°C / 64°C
Primary coil resistance	90 mbar (2)
Continuous rating	14.7 kWh (2)
Secondary water flow rate	280 litres/h (2)
Recovery time for 270 litres	57 mins

Secondary heat source - coil 2

Heating surface area of coil	1.5 m^2
Primary water flow / return temperatures	80°C / 64°C
Primary coil resistance	145 mbar (2)
Continuous rating	36.8 kWh (2)
Secondary water flow rate	707 litres/h (2)
Recovery time for 270 litres	24 mins

Notes;

(1) Based on air temperature of 20°C, RH 70% and water heated from 15°C to 47°C, to EN 255.

(2) Based on water heated from 10°C to 55°C

Supply of air

The heat pump requires a minimum air supply rate of 200 m^3/h. If the supply air is being taken from inside a suitably ventilated room, the room must have a minimum volume of 20 m^3 and a minimum air supply rate of 300 m^3/h will be required. Otherwise, air should be supplied from, as well as discharged to, outside by ductwork.

As optional extras, connectors are supplied that are suitable for either 160 mm or 200 mm diameter round duct. The inlet connection is at the top of the heat pump, but the outlet can be connected at the top or either side (**see fig 7**). To ensure minimum air flow, the combined total length of all duct work should not exceed 7 m for the 200 mm diameter or 3 m for 160 mm diameter, with a maximum of two 90^o bends. This equates to an 80 Pa pressure drop.

Ductwork should be insulated to prevent condensation and be suitably supported.

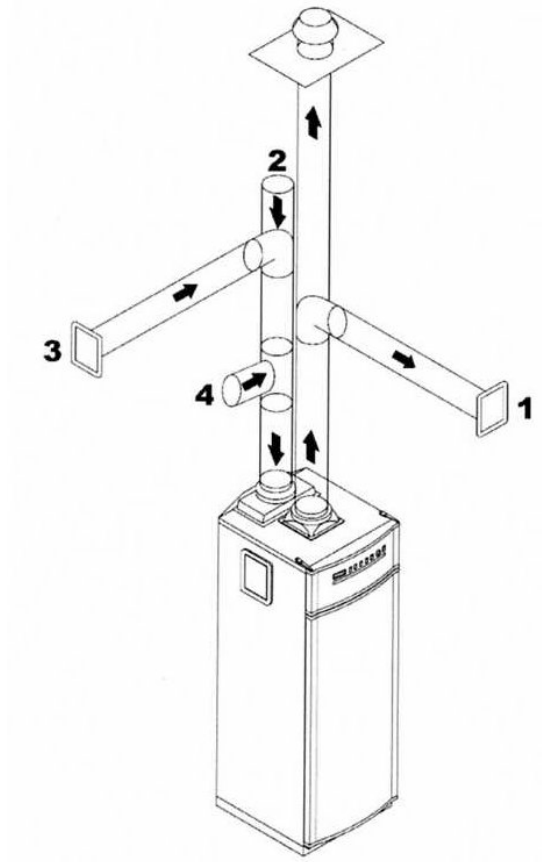
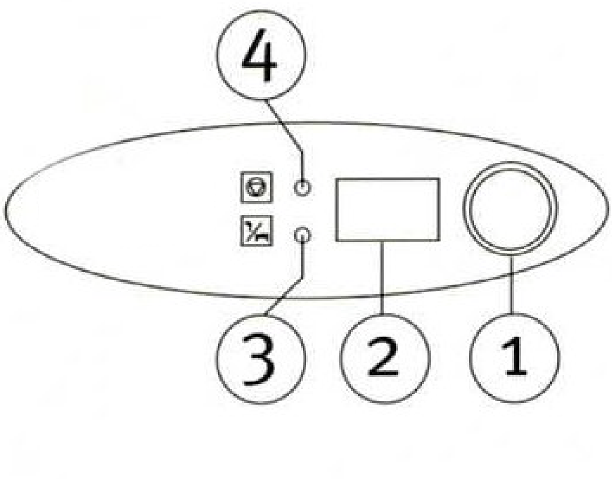


Fig 7 Schematic showing alternative ductwork arrangements

Heat pump control panel

The heat pump is supplied with a micro-processor control that is used to set operating parameters, monitor operation and provide status and alarm indicators (**see fig 8**). Additional control features include;

- Automatic hot-gas defrosting of the evaporator coils when they reach a temperature below -2^{o}C. Alternatively, there is provision for defrosting by air.
- A Legionella prevention programme that will increase the DHW storage temperature to 65^{o}C for one hour once a week.
- Optional Mg anode sensor indicates healthy condition or depletion of sacrificial anode.



Key to CVT controller diagram

1	Control button
2	Display
3	Run / alarm LED for heat pump
4	Run / alarm LED for supplementary heating

Fig 8 CVT Controller

Schematic pipework arrangement

The pipework schematic of **fig 9** illustrates an unvented hot water storage system that generally complies with the Water Supply (Water Fittings) Regulations 1999 and Part G of The Building Regulations. The CVT heat pump has an in-built control thermostat and high-limit thermostat. For clarity, only one supplementary heating coil has been shown.

Although fig 9 shows the secondary circulation (bronze) pump on the return to the calorifier, it is not unknown for this pump to be fitted in a small loop on the secondary water flow, where it can directly assist the flow without restricting the bore of the pipework.

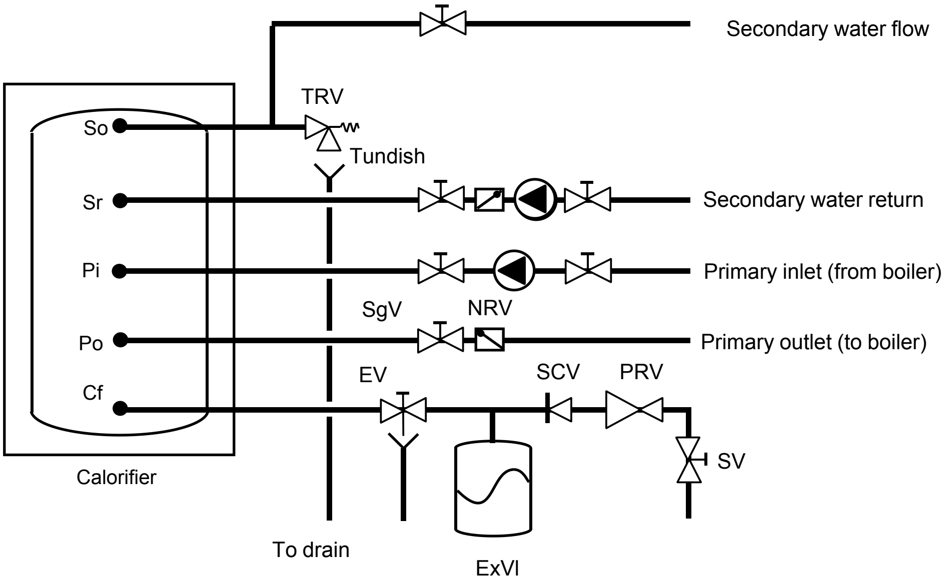
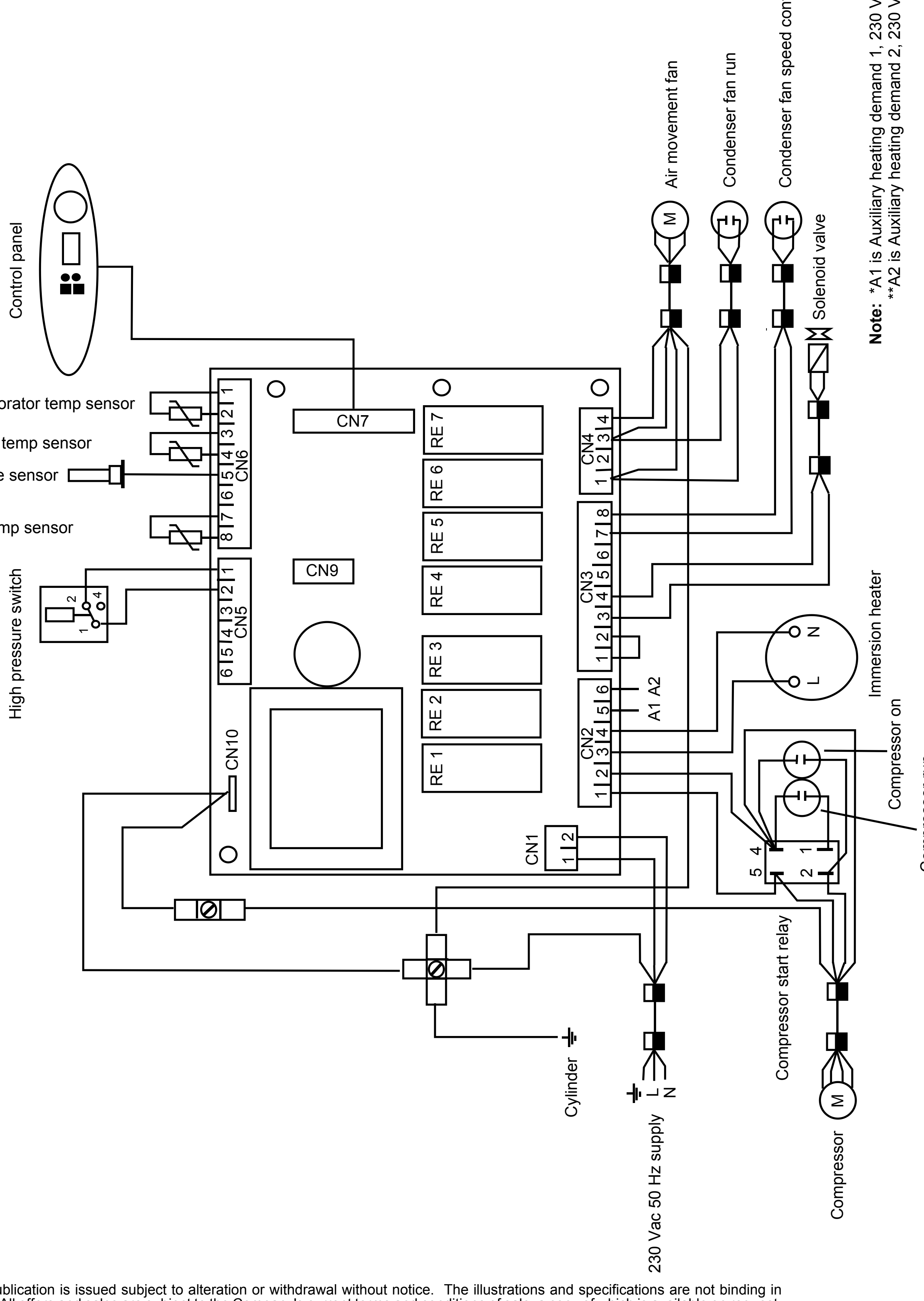


Fig 9 Pipework schematic for an unvented hot water storage system

Key to fig 9

SV	Stop cock with drain tap
PRV	Pressure reducing valve (if required)
SCV	Single check valve
ExVl	Expansion vessel
EV	Expansion valve with discharge to tundish
NRV	Non-return valve
SgV	Service valve
TRV	Temperature relief valve or Temperature and Pressure relief valve with discharge to tundish

Wiring diagram



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EDS 782/3
December 2006