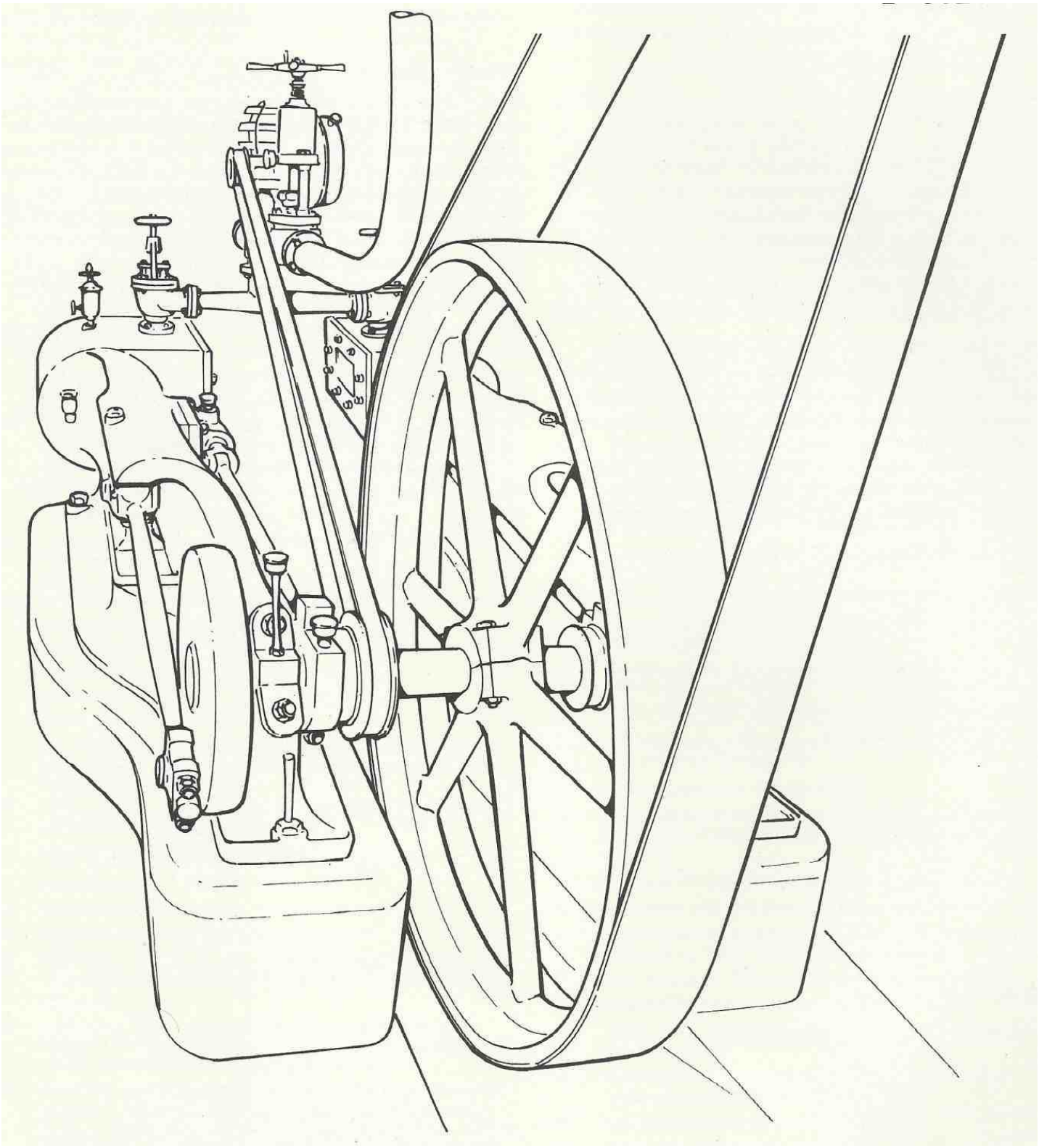
STEAM IN THE UNDERFALL YARD

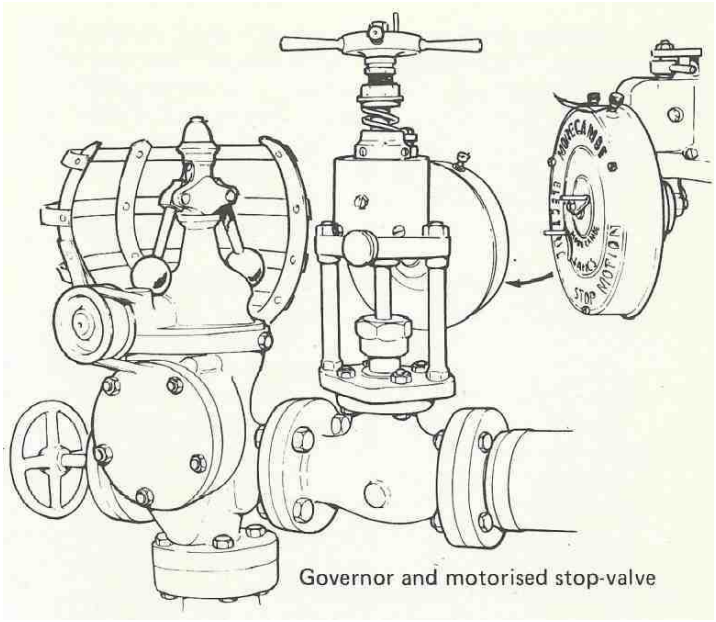
Tom Fisher and David Jones



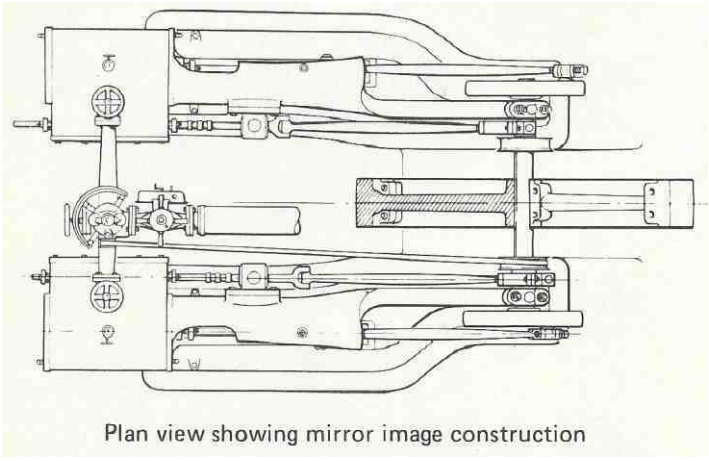
At the beginning of the year some BIAS members felt concern about the future of the steam-powered equipment, dating from the 1880s which remained at the PBA Workshop at the Underfall Yard. David Jones, a technical illustrator in the aircraft industry, offered to help by providing a visual record of some of the features if co-operation could be obtained with the written interpretation of the plant. This was forthcoming from Tom Fisher, a chartered mechanical engineer on the lecturing staff of the South Bristol Technical College and the preliminary results of their collaboration can be seen in this survey of the Tangye Engine.

That part of the Port of Bristol Authority's workshops which is situated at Underfall Yard was used in the maintenance of dock equipment at the City Docks until their transference to the City Council's control. Power for the machine shop was originally provided in 1885 by a twin-cylinder steam engine made by Messrs Tangye Ltd of Birmingham. The drive from the engine to the machine shop is by line shafting and flat belts. The engine drives the shafting via a belt passing around the flywheel.

The engine is basically two single-cylinder horizontal units each mounted on its own bed driving either end of a common shaft through disc cranks. The 59 inch diameter flywheel is of cast iron and is mounted on the common shaft midway between the units. These are of opposite 'hand', ie, they are a mirror image of each other when viewed from above. This arrangement permitted many identical parts to be used with obvious cost economies. The main frames are probably the only components which differ, one frame being the reverse of the other.



Governor and motorised stop-valve


Plan view showing mirror image construction

Cast into the side of both frames is the inscription: **Tangye's Patent Birmingham E Size** and between this and the cylinder is a cast-in circular badge bearing the words: **Gold Medal - Paris 1878**.

Crank pins are positioned at 90° to one another as is usual practice to ensure starting at all crank positions. The flywheel is 'split' on a diameter and is keyed and bolted to the drive shaft by means of eight nuts and bolts.

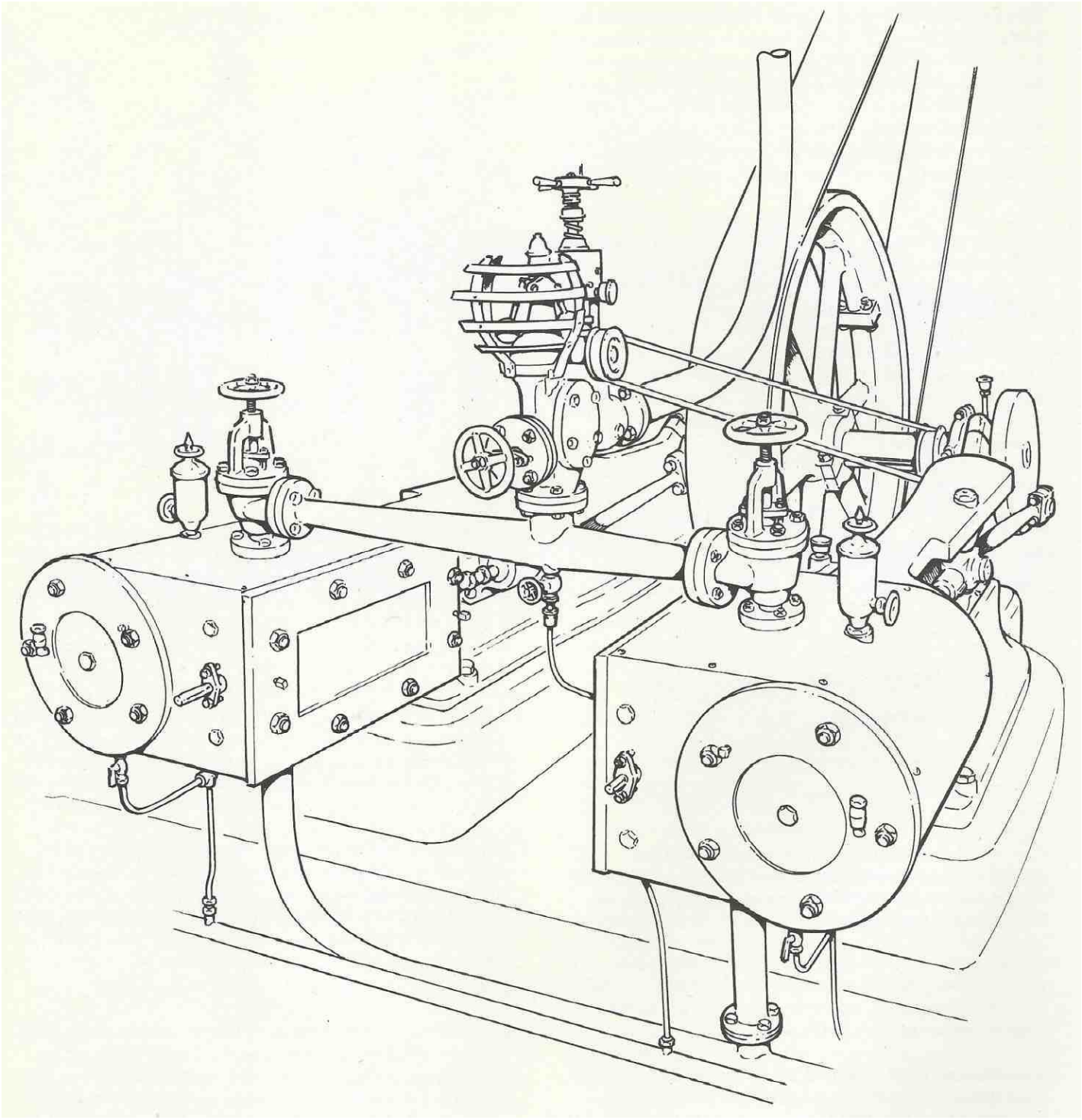
The valve-operating eccentrics are positioned between the main frame castings. Only one eccentric per cylinder is provided due to the absence of need for reversing. No control is provided to enable steam cut-off to be varied during running. Power and speed control is effected solely by throttling the steam through a valve which also performs the function of a stop valve. This valve has four guide vanes beneath it and is known as a wing valve, which is positioned next to a motorised shut off valve. This latter valve was fitted in 1955 to comply with factory inspectorate instructions. It can be remotely activated from emergency stop buttons sited near expected danger spots in the machine shop. After leaving the valves, steam enters a tee junction which feeds it to either cylinder as required. A further stop valve is fitted to each cylinder to enable one unit to be withdrawn from service for maintenance purposes without the need for complete shut down in power.

A modified Watt-type governor is installed to control rotational speed. This is situated directly over the stop valve and is driven by flat woven belt from the drive shaft through pulleys providing a 3 : 1 increase in speed. Apparently this governor was not very effective as a speed control in the range required (50-60 rev/min). Much haste was sometimes needed to close the wing valve in order to prevent overspeeding of the whole driven system when the planing machine drive was disconnected. The governor driving pulley appears to be an addition. It is mounted on what appears to be an original pulley, which is duplicated on the second engine. The ratio given by this pulley is 2.7 : 1. This change may have been an attempt to improve governor sensitivity.

Steam from the Cornish boiler was carried in lagged pipes as far as the emergency stop valve. No further lagging seems to have been used except for the cylinders. These are lagged with asbestos cord contained within a mild steel outer jacket to reduce condensation within them. Steam, exhausted to atmosphere via a 2½ in pipe sunk into the floor. It emerges near water level in the dock side.

Each engine is constructed using a single casting to carry the cylinder, crosshead slides and main bearing. Aligning the two units during installation was therefore relatively simple Each crosshead slides in a groove at the bottom and against a flat surface at the top. Valve chests are placed between the two cylinders and the valve position can be adjusted by simple bottle screws in the valve rod.

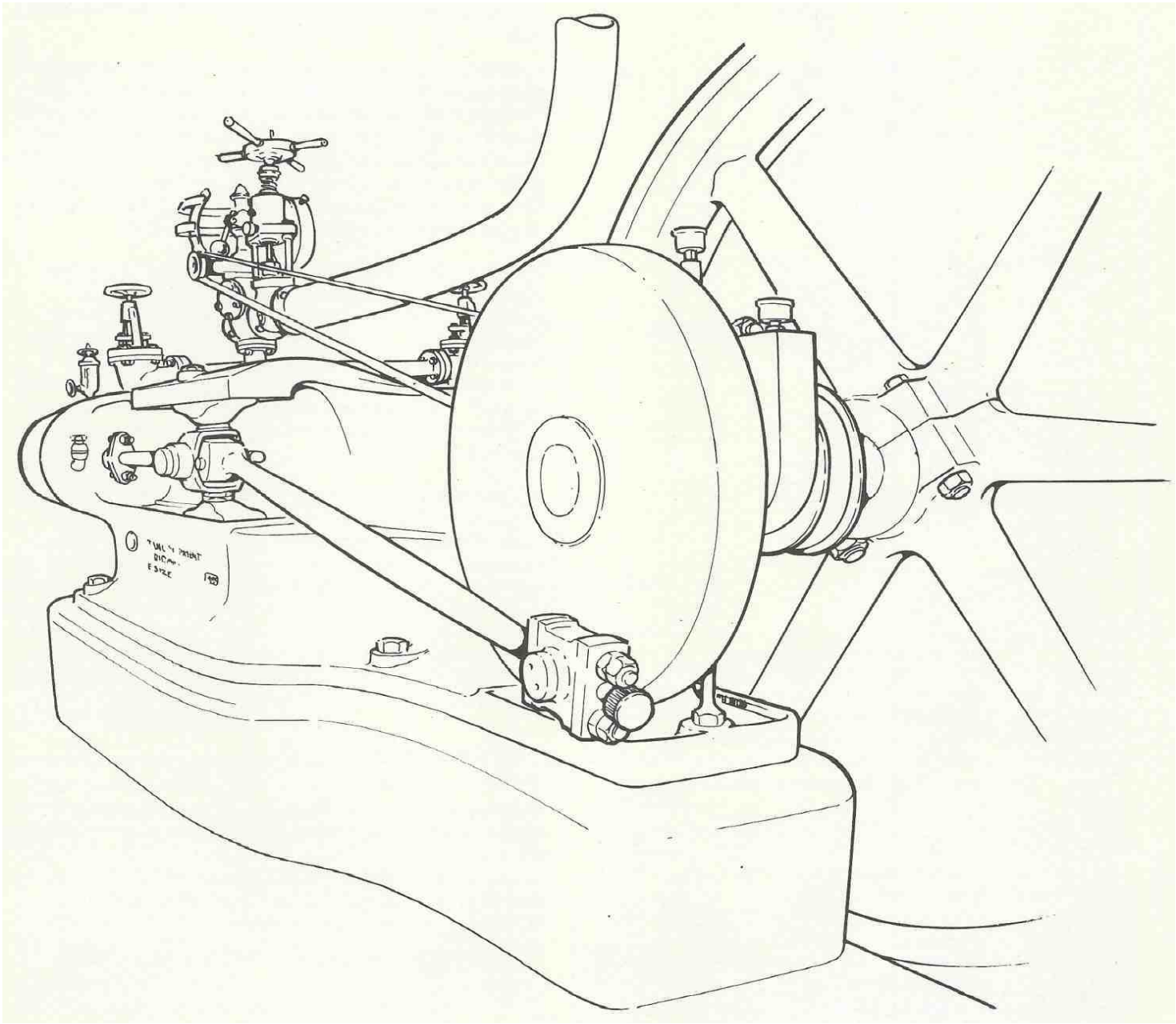
Lubricators: Main bearings, crank pin bearings and eccentrics are lubricated by screw-down or Stauffer greasers which used to be refilled at approximately 2-day intervals. Steam cylinders are lubricated by displacement oilers of about ½ pint capacity, with control by a simple needle valve situated at the bottom of the cylindrical reservoir. They are located on top of each cylinder at about mid-stroke and are made of cast brass. Crosshead lubrication consists of a hole through the frame casting which ducts oil to the top slide. An angled hole and a groove pass oil through the connecting rod to the crosshead pin.



Bearings: The main and crank pin bearings are of phosphor bronze and are 'split' to facilitate assembly. Crosshead bearings are also of phosphor bronze, but are not 'split'.

Boiler: This is situated alongside the engine, and is a hand-stoked, coal-fired Cornish boiler made by T Beeley. Steam was generated at pressures of up to 70 lbf/in^2 at which figure the safety valve was said to have lifted, allowing steam to escape to atmosphere. The boiler shell is not visible externally except for the front tube plate. It is shrouded by brickwork all around the sides and at the flue end, and is sealed in at the top with insulating material and finished off with a cement mixture.

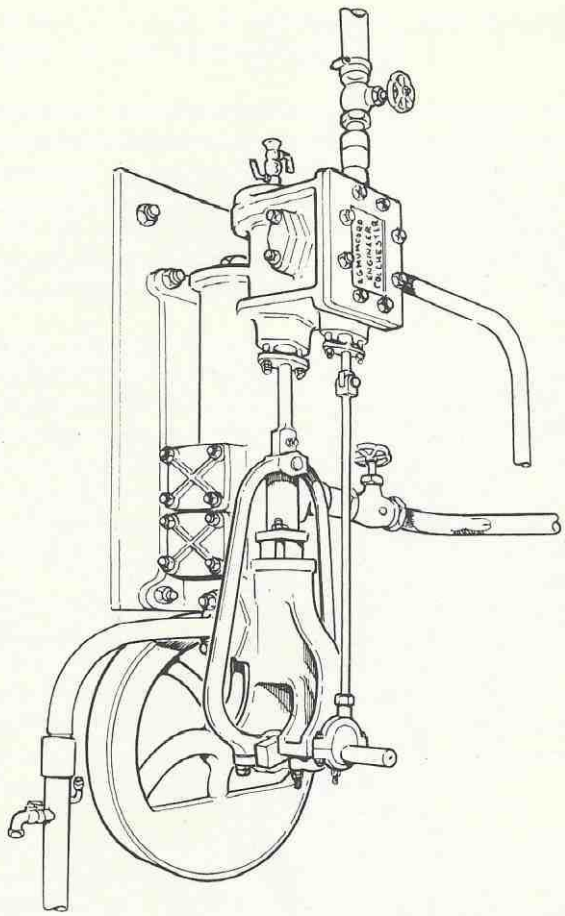
The single fire tube passes through the boiler horizontally from end to end. The front end of the tube is covered by the fire door and the ash door. Combustion air enters via slots in the fire door. The grate bars extend rearwards from the front plate to the firebrick wall, above which there is a fusible plug. This was intended to melt if the water level fell too low, and steam and water would then extinguish the fire. Three Galloway tubes traverse the fire tube. These are spaced over the rear part of the tube, the front one being vertical, the second one angled at about 30° to vertical in an anticlockwise direction and the third at 30° in a clockwise direction. The fire tube is corrugated over the length of the grate in order to reduce thermal stresses and to promote heat transfer,



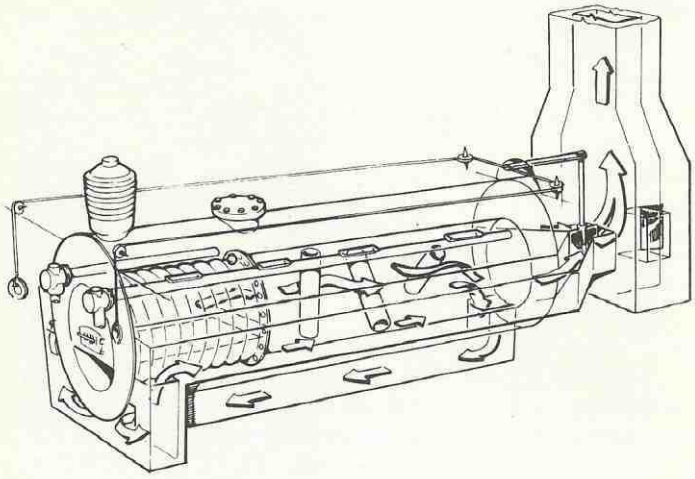
the corrugations running circumferentially round the tube.

Feed water is supplied by a wall-mounted donkey engine pump made by A G Mumford of Colchester. It is on the wall adjacent to the boiler front plate at the left-hand side. The pump has a 'banjo' type connecting rod which enables overall dimensions to be kept to a minimum, whilst at the same time keeping connecting rod angularity to a minimum also. Steam exhausts from the donkey engine downwards into a trench across the front of the boiler, and is 'teed' into the main blow-down exhaust. Surge pressures from the pump are absorbed by an air vessel placed between the unit and the wall. Feed water supply is from the main via a treatment and a storage tank situated in the boiler room. It is not known whether this is the arrangement installed in 1885.

Feed water enters the boiler via the front plate through a connection just below water level on the left-hand side. At about the same level on the right-hand side there is a scum blow-down connection; this is fed by a tube running along most of the length of the boiler shell. The tube has a number of holes spaced along the top through which scum was ejected A trough is formed on the top of the tube with holes at its bottom, and the trough edges form weirs which enable the scum to be separated before being ejected. Troughs are not continuous along the whole length of the pipe, as the



Wall-mounted feed-water pump



Flow diagram showing passage of flue gases in boiler

illustration shows. Scum therefore passes over the trough edges, through the holes, along the tube and out of the boiler via the blow-down connection and valve to exhaust

Scum was blown down weekly. The main blow-down cock is placed low down on the right-hand side of the front plate. The two blow-down exhausts are connected together by a tee connection and leave the boiler house in a common pipe.

The flue arrangements are unusual in that the routing of the gases is similar to that used in Lancashire boilers - ie. after emerging from the fire tube, the gases are taken downwards through brick-built ducts and passed under the boiler shell to the front; they then divide and pass back to the rear of the boiler between the sides of the shell and more brick-built ducts. At the rear, the ducts re-connect and pass the gases in one passage past a damper and into the chimney.

The soot door at the foot of the chimney opens into the blacksmith's workshop, and bears the following cast inscription: **J. Dawson & Sons, Steeple Jacks and Boiler Setters, Clutton, Bristol**. The boiler supplied steam to the Tangye engine and to the blacksmiths' shop where it powered a steam hammer, shears, a punching and a nibbling machine. The condition of both engine and boiler is good at present and it is hoped that this state of affairs will continue.

An interesting feature of the steam supply is that during the period up to 1955, steam was often obtained during the Summer months from the BD4 dredger which was moored alongside the workshops because dredging at this time of the year was not permitted due to smells emanating from the mud etc. In view of the smells which continued in the nearby 'new cut' in the summer one can only speculate about the wisdom of this action. However, it did provide an alternative steam supply thereby enabling the Cornish boiler to be serviced without the need to shut off power.

Leading dimensions:

Engine:
Steam cylinders - 8 in* bore diameter x 16 in stroke
Overall length of engine (flywheel rim to cylinder head studs) 9 ft 4 in
Overall width of engine 5 ft 1 in
Running speed 50-60 rev/min
Maximum steam pressure 70 lbf/in^2

*Accurate verification was unfortunately not possible.

Boiler:

Diameter 5 ft 0 in outside nominal
Length 16 ft 0 in outside nominal
Grate length 6 ft 0 in
Fire tube diameter 2 ft 8in inside
Drum plate thickness ⅜ in
Maximum steam pressure 70 lbf/in^2

Construction: rivetted throughout. End plates strengthened by four gusset plates placed assymetrically around the upper half at each end.

Acknowledgements: The following have been of great help in providing information: Mr Evan Warren and Mr J J Sandall of the Port of Bristol Authority, Mr Warren, foreman at Underfall Yard, also John Hall, who is well known for his work on the Crofton Engines.