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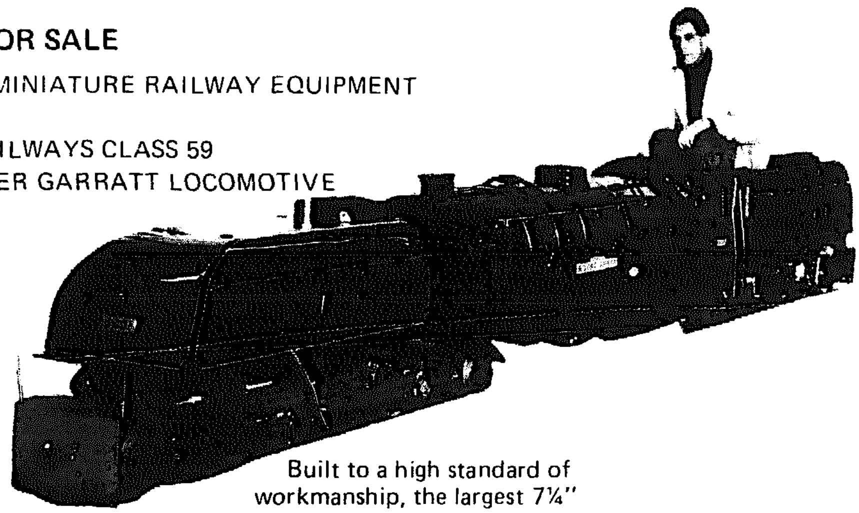

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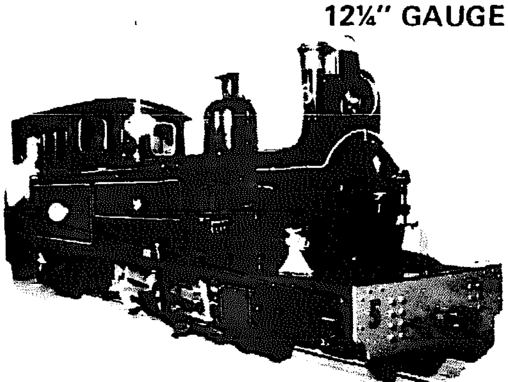

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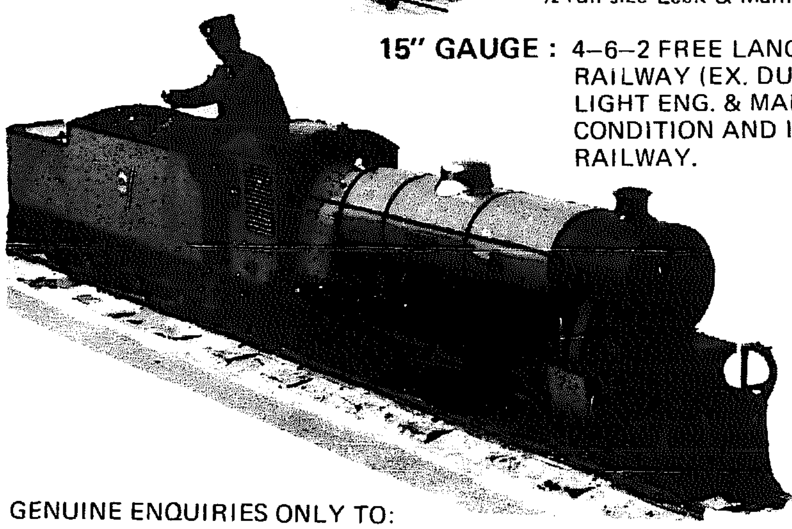

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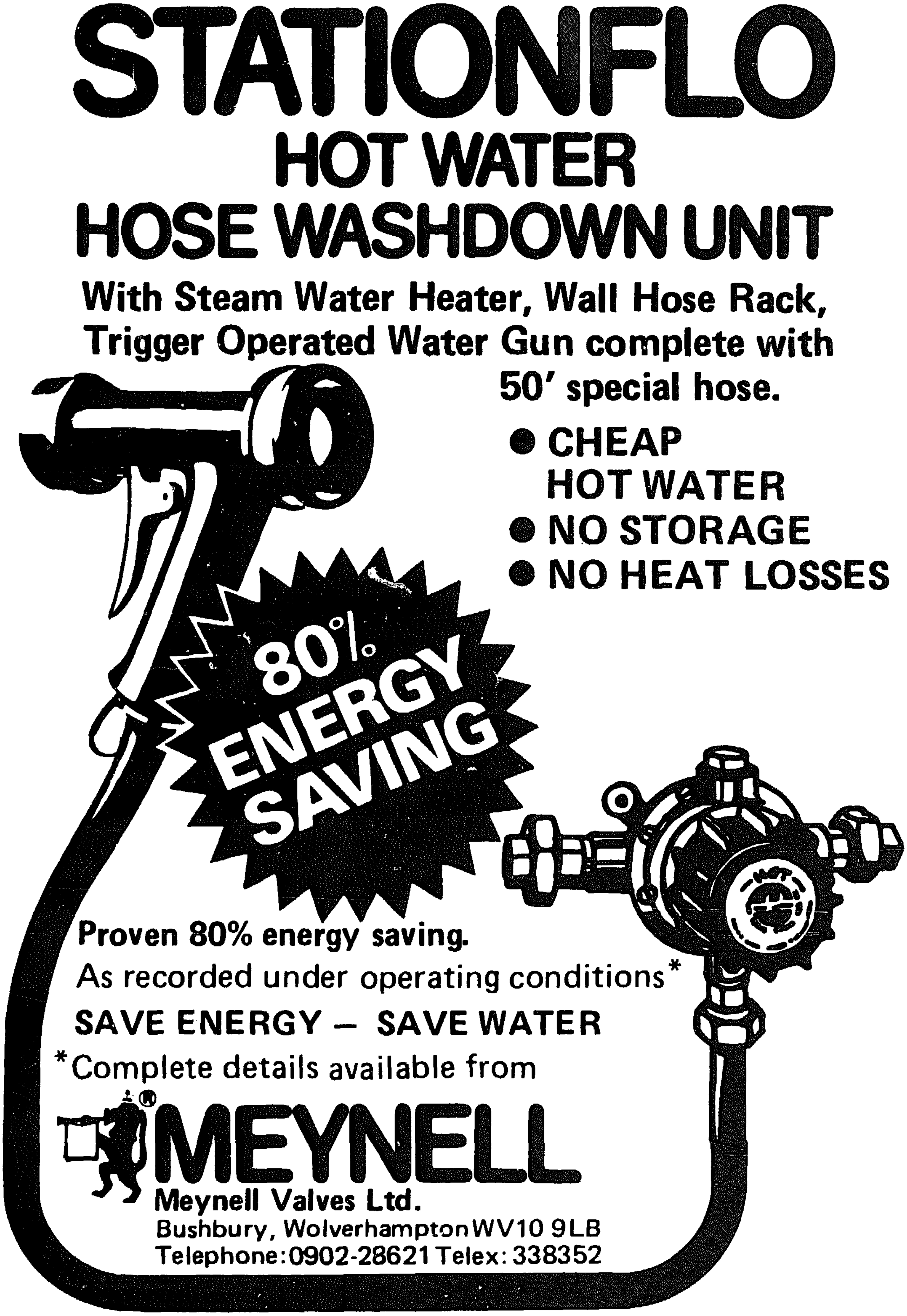
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Vol. XXIX Nos. 1 & 2

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FLUIDISED BED COMBUSTION BY DANKS

The latest of the British Boilers using fluidised bed combustion was demonstrated on 4th June.

Danks of Netherton, the world-famed boiler makers, are looking ahead two to five years. Knowing fluidised bed combustion (FBC) can use very low quality varied coals with efficiency, indeed is adaptable for almost any solid combustible, and is capable of being made nearly fully automatic, they are well prepared to meet demand for change-over from automatic oil or gas firing. Their first commercial application is in the "middle range" for 10,000-20,000 lbs. per hour of steam or 10-25 million B.t.u.'s per hour of hot water, using horizontal shell boilers, based on their Metricoal range.

The Company can also supply vertical boilers with capacity up to 10,000 lbs. steam per hour, if required with FBC to another design and of course, waste heat boilers.

The shell boiler demonstrated is one of the Company's Metricoal range rated at 16,000 lbs. of steam per hour, at 250 p.s.i., though at present in regular use at 125 p.s.i. It is expected that FBC will allow operation at 14 per cent CO_2, compared to the 11 or 12 per cent with chain grate stoker, giving improvement in overall efficiency from 78 to 80 per cent. As the General Manager, Mr Tony Atterbury explained: "The basic technology of fluidised bed combustion is now well established and there are many companies working in this field. However, the amount of work done on full scale industrial boilers, operating under varying conditions is still limited. We felt that to bring fluidised bed fired boilers successfully to the market place we had to know more about a full sized boiler in operation, not just a design." The Danks developments are based on the licence held from Combustion Systems Limited.

As is now quite widely known, fluidised bed combustion (FBC) is created by blowing air up into a bed of inert material, almost universally sand, which then acts as a boiling liquid. This aerated bed is preheated to dull red, approximately 1110 deg.F. (600 deg.C), coals of about the same size are fed in or dropped on to the bed with which they mingle, ignite and burn rapidly and turbulently with rapid heat transfer. By increasing the pressure of the air into the bed it is possible to provide as great a heat release per cubic foot of combustion space as from oil fuel. Such intense conditions of combustion require more complicated filtering of carry over of ash and sand particles. A characteristic of FBC is very stable combustion with high heat transfer and rapid control of heat output.

The Danks boilers use coal of singles size, about 1 in., which is available in suitable quantities. Tests using the 2 in. "smalls" coal are being made. The quite shallow bed about 12 in. deep uses about four tons of silica sand in the demonstration boiler. Sand particles are about 1 m.m. diameter. During use the bed material is violently agitated by the combustion process, causing rapid distribution of the lumps of coal.

The furnace tube is 4 ft. 11 in. (1500 m.m.) diameter. Six inclined water tubes, 4 or 5 in. diameter, passing through the bed, act to keep the bed temperature within the 1110-1740 deg. F (600-950 deg.C) range, thus avoiding softening of the ash with formation of clinker. Since the coal on the bed reaches temperatures of 2900-3600 deg. F. (1600-2000 deg. C), the heat transfer through these tubes is very great, 45-50 per cent of the heat generated being absorbed by the water in them. The demonstration boiler was shown working at 135 p.s.i., using natural circulation in the bed cooling tubes. At lower pressure it may become necessary to use forced circulation to maintain the required minimum of 80 per cent water in the tubes. A circulating pump is installed with the demonstration boiler. This system allows the amount of combustion air to be similar to that for conventional stoking, about 25-30 per cent excess air. The amount of convection heat transfer surface is about the same as in stoker fired boilers.

Contrary to what might be expected, abrasion on the outer surface of the water tubes is negligible, a hard black surface being formed thereon by the action of the coal and sand. This surface, which looks like vitreous enamel, never becomes thick and does not impair conduction of heat.

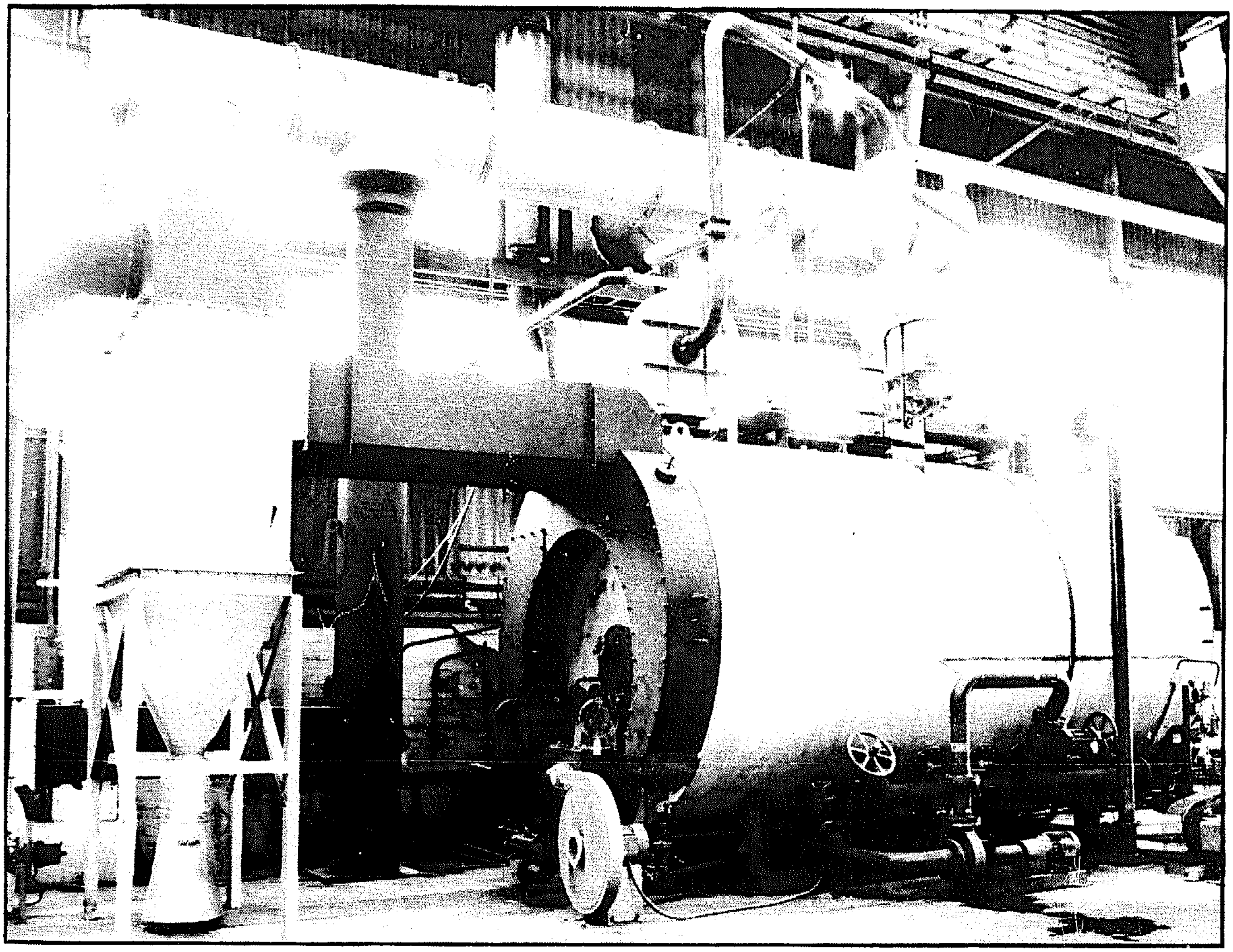
Other methods for control of the bed temperature are:—

(a) The use of 2 to 2½ times the air needed for combustion, which makes necessary a large heating surface.

(b) Supply of insufficient air for combustion ("starved air"), giving a high proportion of carbon monoxide, CO which is burned as a gas. This creates considerable problems.

Bed aeration is through small capped stand pipes, 2.4 in. (60mm) high and 1 in. (25mm) diameter, fitted 4 in. apart on the upper surface of the air supply chamber. Each standpipe has several holes drilled into its cylindrical surface which act as air jets into the bed. The bed sand below the jets remains unfluidised and acts as an insulator, protecting the standpipe plate from excess temperature. Air supply into the bed is blown in at a minimum of 3 and maximum of 9 ft. per sec., which gives a turn down ratio of 2 to 2.5:1. However, the fluidising air supply to the bed can be turned off to allow the bed to "slump". In this condition sufficient heat will be retained for about 30 minutes for re-starting without preheating.

Preheating the bed to 1110F. (600C.) can be achieved



Danks horizontal shell boiler with fluidised bed combustion (FBC) of coal. This example is rated at 16,000 lbs. of steam per hour at 250 p.s.i.

using bed overfire light-up oil or gas burners, or with a post-mix gas fired ignition system. These methods require a heat input of at least 50 per cent of the combustor's normal requirements. The Danks system uses a gas burner for which the combustion air is preheated by gas flames in a refractory lined duct before picking up the gases and igniting on its way to the boiler combustion chamber. This method gives 25 per cent heat transfer to the bed.

One of the problems with any horizontal fluidised bed boiler is carryover of sand and ash etc. The Danks design has a continuous grit recycling system which collects the carry-over material from the two-pass gas flow reversal chamber and smoke boxes and returns it to the front of the bed. Since experiment has shown that long narrow horizontal steel baffle plates in the combustion space of the furnace greatly reduce grit "carry-over", such plates will be fitted as standard. Apparatus for cleaning the bed of the larger ash particles in an ash handling system is included to ensure the bed retains its fluidising characteristics.

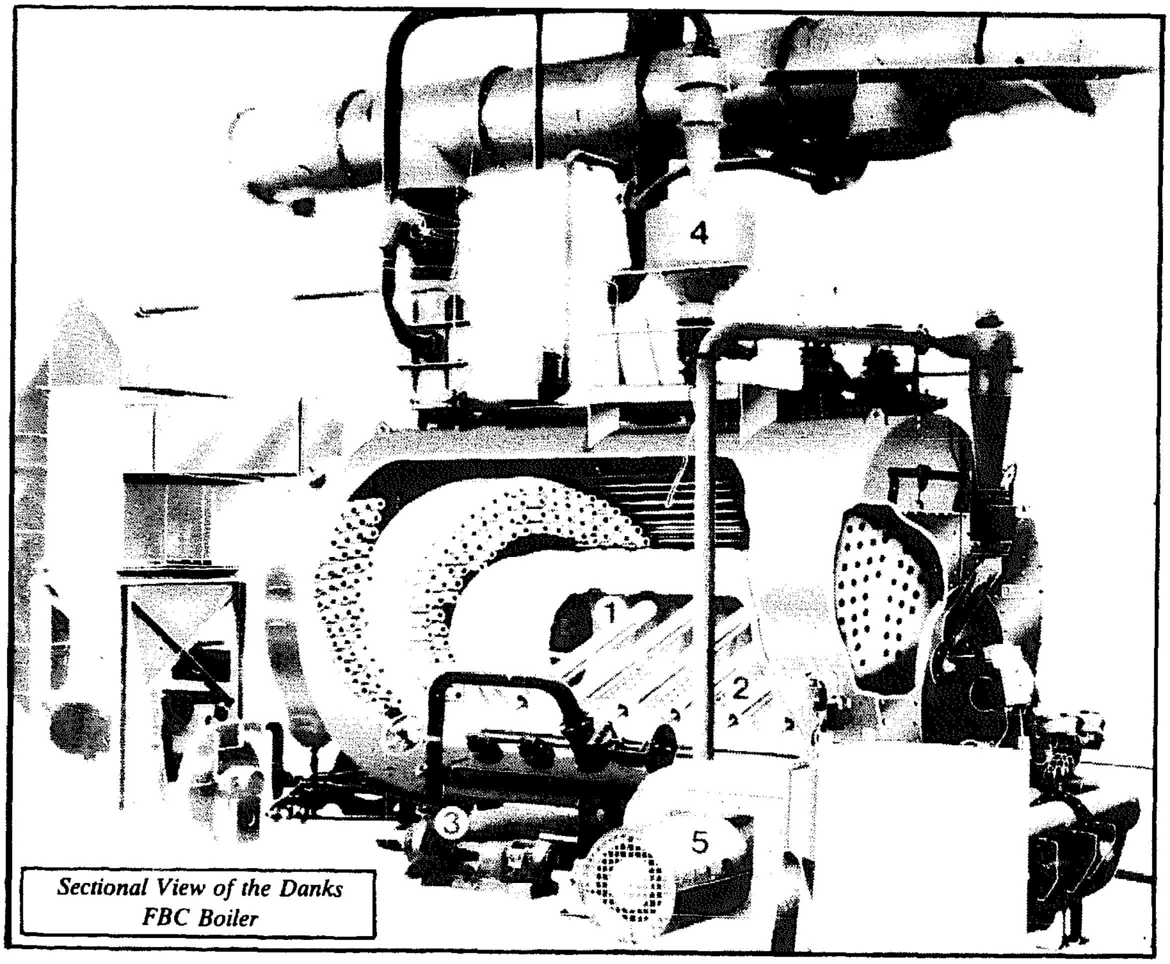
For these boilers, which use a single fluidised bed, the air supply and control system has been simplified giving heat outputs high-low-off with a turn down ratio of 2 to 2½ to 1. A form of modulating control using fluidised bed 'sectoring' and a microprocessor system is being developed. This will make possible a higher turn down ratio.

For the Danks two drum water tube there is a similar FBC design, adapted to accept separated fluidised beds, thus allowing high turn-down ratios. They are based on the existing range of stoker fired water tube boilers, with outputs from 20,000-80,000 lbs. of steam per hour at up to 900 p.s.i.g.

The demonstration boiler is equipped with an elaborate monitoring system from which "in service" test information can be recorded. At the time of our visit combustion air pressures were:—

Over fire 0.5 in. water gauge, exit flue 0.5 in. w.g., front bed 14 in., centre bed 12 in., rear bed 10-11 in.

Further information is available from:—
Danks of Netherton Limited, Halesowen Road, Dudley, West Midlands, England.



Sectional View of the Danks FBC Boiler

1. *the inclined in-bed cooling tubes, 4 to 5 in. bore with finned outer surface.*
2. *the fluidised bed base with airjet standpipes for fluidising the silica sand bed.*
3. *recirculating water pump for in-bed cooling tubes, used at low steam pressures. Natural circulation is found adequate at 125 p.s.i. and higher.*
4. *coal hopper and rotary valve feeder. Coal of "singles" size (1 inch) is used.*
5. *forced draught fan for fluidised bed.*
6. *fluidised bed and boiler control panel.*

A Miniature Scoop Wheel Engine

Much of the fertile land in the South East of England is below sea level. Before steam power was harnessed many thousands of acres were subject to such severe flooding that proper farming was impossible, in spite of the use of scoop wheels driven by windmills. George Watkins in his book, Volume 1 of "The Steam Engine in Industry" quotes Thomas Neale's description of Cambridgeshire in 1748. He noted the ruinous state of the Manea area and that there were in all about 250 windmills in the whole middle area of some 160,000 acres. In one 6 miles stretch he saw forty windmills, working only at the whim of fickle winds. Land drainage brought its own problems since the land sank as it was drained and scoop wheels could not then reach the water. This led to the proliferation of such wheels. Thus the Littleport and Downham area of some 26,000 acres contained seven windpumps in 1770, but by 1820 there were eighty there, and they were costly to maintain and build. Their duties were taken over by only two large beam engines, installed in 1819 and 1830 with scoop wheels 43 ft. diameter, plus a small steam plant. One of the 43 ft. wheels was later increased to 50 ft. diameter.

What are scoop wheels, it will be asked? Briefly, they are rigidly constructed wooden paddle wheels, working close to the sides of a stone trough, which has one end open to a flow of water into which the scoop blades dip. In this way, water is lifted to a level a little below that of the wheel's axle. Clearance in the trough for a large wheel could be as little as ½ in. Wheel diameter varied from about 10 to 50 ft. They worked best with a tip speed of about 8 ft. per second, a 50 ft. diameter wheel being able to raise 213 tons of water per minute at 3 r.p.m. For better efficiency the paddle blades are placed close together and set at an angle of 25 to 40 deg. to the radius, so that they meet the water quietly without splashing. The present tense is used for at least one of these wheels is preserved, at Dogdyke Pumping Station, one mile west of Tattershall Castle. Its 1855 beam engine is in steam on the first Sunday of the month from May to October. A scoop wheel and engine is also reported to be preserved at Stretham in Cambridgeshire.

Some scoop wheels were only used in periods of very wet weather, one such being driven by an engine on which this large working model is carefully based. It was installed at Middleton Towers Estate, near Kings Lynn, to drain a low level area into the main drains. Being normally out of use for long periods, only a very simple installation was needed, without feed-water heater or condenser. The cylinder bore was 6½ in., stroke 9½ in., with flat slide valve worked by single eccentric. The engine driven feed pump was latterly replaced by an injector. Made by J.C. Baker of Kings Lynn in 1877 this engine developed 10 h.p. at 120 r.p.m. using steam at 50 p.s.i. The small scoop wheel was driven through a spur reduction gear at 15:1 engine: wheel. This wheel was 16 ft. diameter at the tip, with forty paddle blades 3 ft. 3 in. long, 5¼ in. wide, and framing constructed from a series of identical castings bolted together along the arms, with slots in the rim for the paddle blades.

As the scaled down engine shows, it was a simple compact machine perhaps specially designed for the purpose, with the unguarded gearing and flywheel supported above the cylinder on two cast iron frames. Exhaust steam was led straight up through the roof. An 8 ft. high vertical boiler, 3 ft. 6 in. in diameter steamed this engine for many years.

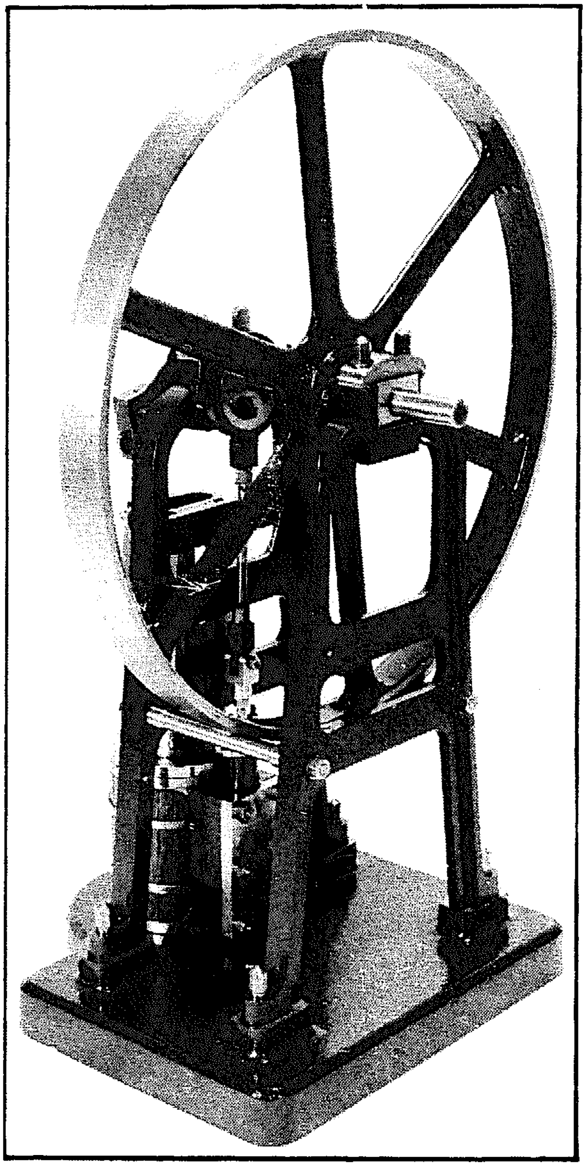
Now to the approximately 1/4 full size replica, which is very carefully hand made. What is more, using steam at 60 p.s.i.g. it will be able to work at ½ horsepower continuously and with efficiency if the exhaust steam is used for heating. It is no toy, yet is small enough to be ornamental, overall height being only 17½ in. On its first tests the flywheel turned round accompanied by even "chuffs" from the exhaust at about 5 p.s.i.g. Here are some constructional details. For this first model the cylinder is brass. However subsequent engines will use close-grained cast iron for the cylinders, machined to close tolerance with piston in meehanite. The motion is in best quality mild steel hand fitted to exacting requirements. Main, crankpin and crosshead pin bearings are split brass, the latter two being adjustable by expertly fitted wedge and cotter. Domed nuts are used on the studs for the frame feet, main bearing keeps and cylinder top cover. The bedplate is 8 in. square, width across frames 4 in., cylinder bore is 1⅜ in. stroke 2½ in., connecting rod 4⅛ in. between centres. The flat slide valve is driven by single eccentric giving ⅜ in. travel. The drive shaft is keyed ready for fitting a pulley or pinion gear as requird.

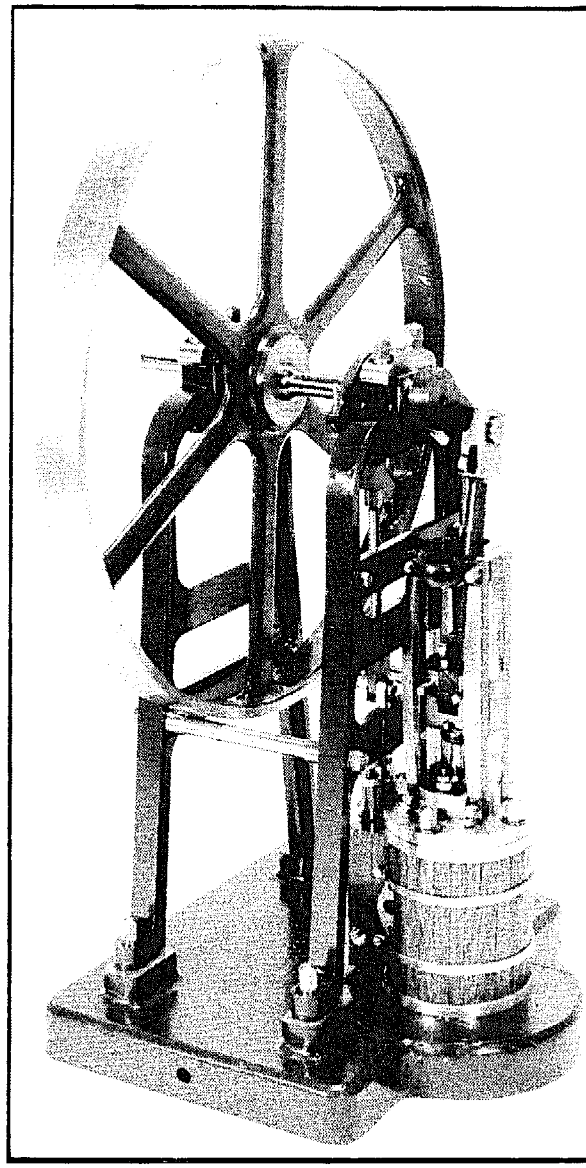
The livery is mid-green for the bedplate and frames, maroon for the connecting rod, crosshead guide edges, eccentric strap and the spokes and inside rim of the flywheel. The cylinder is lagged with brass bound varnished teak strips. The feed pump, not shown in the photos, is in brass driven by eccentric fitted between the flywheel and main bearing. A suitable centre flue type vertical boiler, if designed with adequate combustion space, say 6 in. deep, 10 in. diameter, 17 in. high or more to the top of the smokebox. Field tubes, fitted into the crown plate, would give much improved circulation for continuous hard steaming.

It is understood a limited number of these engines will be made to order each one custom built to exhibition standard, thus creating a rare collector's item. Livery can be to customers' requirements. Shown driving a working scoop wheel, a pump with fountain or an antique type dynamo, these engines become exhibits of enhanced historic interest. Price is expected to be about £495 ex-works, packing and transport extra.

CONCISE DETAILS

Single cylinder, double-acting, slide valve, vertical engine with crankshaft above cylinder. Bore 1⅜ in. stroke 2½ in.,





THE MINIATURE SCOOP WHEEL ENGINE

Hand built to exhibition standards at approximately one quarter scale, this collector's miniature is continuously rated at $\frac{1}{2}$ h.p., overall height is $17\frac{1}{2}$ in. The full size engine built in 1877, drove a 16ft. diam. scoop wheel near Kings Lynn, Norfolk.

$2\frac{11}{16}$ in. over lagging, slide valve travel $\frac{7}{16}$ in., bedplate 8 in. square, width of frames max. $6\frac{1}{2}$ in. min. $3\frac{3}{4}$ in. across frames 4 in.; flywheel $11\frac{1}{8}$ in. diam., connecting rod $4\frac{1}{8}$ in. between centres; steam pressure 8 to 60 p.s.i.g.; estimated continuous $\frac{1}{2}$ b.h.p.

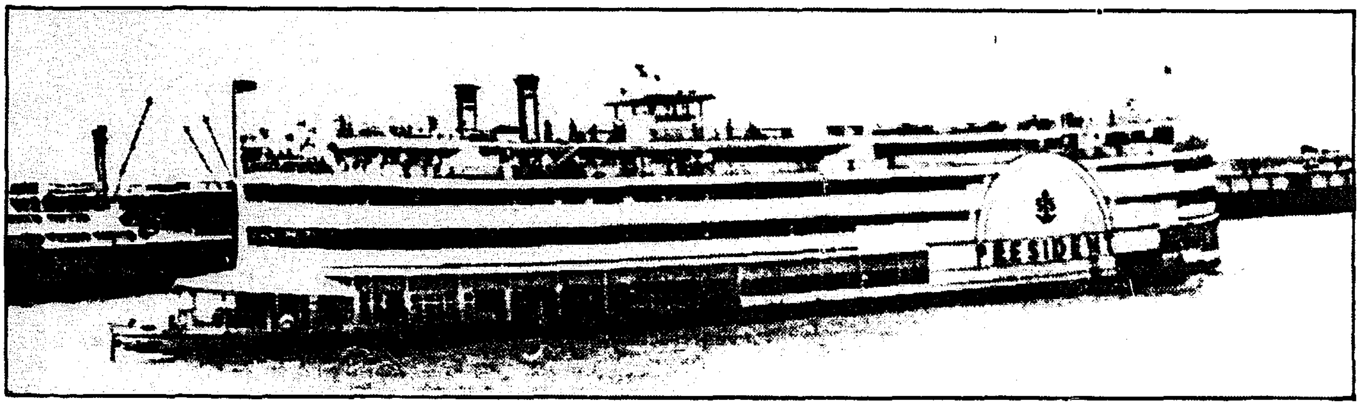
OPERATING A LARGE MISSISSIPPI STEAMBOAT

Describing the day to day routine in the side paddler "President", built at St. Louis in 1925.

Extracted from and with all due acknowledgement to Heating, Piping, Air Conditioning, U.S.A.

By: H.J. Scharres

Much has been written about the romantic period in U.S. history when the paddlewheel steamboat made the Mississippi River a thriving highway of commerce through the heart of the country. The fertile prairies and industrial cities of the central states were united with the cotton producing states of the south and the rest of the world. It was in 1872 that Mark Twain worked as a pilot on the Mississippi steamboats and then wrote the first important historical documentary of this exciting period, Life On The Mississippi.



P.S. "President" on the Mississippi was built in 1925, with two tandem compound engines and six boilers.

A number of paddlewheel steamboats were still running in 1972, one of the largest being S.S. "President" at New Orleans. The description published in 1972 goes on:—

To observe the boiler plant and the engines perform completely under manual control is indeed an experience in this day of automation. The President is a two-engine, side paddlewheel steamship built in St. Louis in 1925. The boat was designed for daily excursion trips and is much the same as when it was built, except for rebuilding of its hull in steel and the addition of radar and modern safety devices. The ship can carry 3000 passengers and is under the command of Captain Verne Streckfus, descendant of the original owner. It has five decks, the first reserved for passenger boarding and the boilers and engine room. The upper decks consist of a large ballroom, a dining room, and two observation decks. The uppermost structure is the pilothouse, where the entire operation of the ship is controlled by voice communication and bells to the engine room. A steam calliope is mounted on the uppermost deck. It is powered by high pressure steam and does not attain its full exuberant tonal quality until all the whistles are warmed up to operating temperature.

The "President" has a water storage capacity of 15 tons, which maintains the ship in operation for four hours or one normal daily excursion trip. If the ship is underway for an extended period or two trips a day are made, there is no opportunity to refill the storage tanks with city water and river water is then used. When the boilers operate on river water, samples are taken directly from them at regular intervals and tested for acidity, alkalinity, and hardness. The kind of water treatment is determined by the tests and varies with the variable quality of water encountered in different parts of the river. Chemicals are injected into the boiler feed water.

The steam engines are of the two-stage compound type with the two cylinders in tandem. The piston rod connects to a 30 ft. long wood connecting rod, which turns the wheel through a crank. The "President's" engines are different from most other steamboats' because they are equipped with a variable cutoff allowing more efficient use of steam. Normal operating steam pressure is 200 p.s.i.g. with the safety valves set at 250 p.s.i.g. on the boilers, 245 p.s.i.g. on the first stage of the engine, and 230 p.s.i.g. on the second stage. Most of the steam used in the engines is exhausted through the stacks, which increases the draft on the boilers. The remaining exhaust steam is used for heating feed water, oil, and domestic hot water and for space heating.

The paddlewheels are 32 ft. in diameter and 12 ft. wide, made up of 4 by 16 in. planks for the paddles. Keeping the wheel in operating condition is a full-time job for the ship's carpenter who spends a great deal of time replacing paddles damaged by floating debris. At normal operating speed of 10 to 12 r.p.m., there is no problem with unbalance, but having one paddle missing affects the driving power of one wheel as compared to the other and hence the steering of the ship. Daily inspection and repairs are therefore necessary.

The boiler plant consists of six marine type firetube boilers, with three boilers on each side headered together so that the plant operates essentially as a two-boiler installation. The boilers are of the firetube type with large tubes and operate at 200 p.s.i.g. steam pressure. They have a very low silhouette, with most of the boilers contained below deck and only the front operating portions projecting above deck. A large mud drum, in river terminology called a "possum belly" because of its large mud retaining capacity, is a vital part of the boilers, requiring constant attention. Both New Orleans city water and river water are used. River water is several times harder than city water and contains oil, mud and sand, so the mud drum is blown down roughly every hour. If city water is used, the drum is blown down once in three hours.

Bunker C fuel oil is used and purchased at $4.10 per barrel (approximately 10c per gallon). A fuel oil additive to assist in clean burning is usually added when the tanks are low and just before refilling. There are no facilities for cold startup as sometimes provided on modern ocean-going vessels. Steam must be obtained from shore, or more often a barge must be sent from the local shipyard to heat the oil storage tanks to approximately 100F so the ship's fuel oil pumps can operate. When the fuel oil system is in operation and steam is available at the burners, the boilers are fired. At approximately 30 p.s.i.g. steam pressure in the boilers, the ship becomes self-sufficient and no longer requires a remote source of steam.

Each week one set of boilers is shut down, drained, and completely washed out. Valves and other working parts are dismantled, inspected and serviced at that time. The firetubes are cleaned of soot, and the boilers are then refilled with chemically treated water and put back in operation. Since the ship operates seven days a week, the boiler cleaning is often done while the ship is underway. One set of boilers is cleaned on one day; and if it proves reliable when put back in operation, the second set is cleaned the following day.

The burners are manually operated steam atomizing type. Each has an oil valve and a steam valve, which are manually adjusted for the required firing rate. When the ship is in port or has a low steam demand, some of the burners are shut off and others set for low fire to maintain a constant steam pressure. When it is manoeuvering and underway, the burners are reset constantly to maintain a constant pressure and supply the demand for steam at the time.

The engines, piping, valves and substantially all of the operating machinery is original equipment. The long life is undoubtedly the result of the constant daily preventive maintenance programme that is followed.

COMPACT FUEL FROM STRAW WASTE

Modern harvesting methods leave vast areas of straw to rot in the fields or be burned to wind blown dust. Straw briquettes made by a new machine give useful fuel.

Worldwide, people are becoming increasingly conscious of the cost of fuel. Heating, cooking, travelling and manufacturing are all becoming increasingly expensive. Also the recent large scale demands for higher oil prices has emphasised the need for fuel economy and the use of combustible materials not often considered. One of these is straw left in the field. I can recall the healthy labour at harvest time. Wheat, barley or oats were cut by tractor drawn binder which left a trail of "sheaves" loosely tied by "binder twine", all ready for propping up grains uppermost into tent-like "stooks" of four or six sheaves.

After drying in the field came the job of pitch forking each sheaf onto a trailer drawn by horse or tractor, ready for stacking in the corner of a field or in the stack yard. Later, often much later, came the travelling threshing team with the large threshing machine or mill drawn by a quiet old steam traction engine or later by a rugged oil engined "Marshall". After carefully positioning the "mill" and lining up the long belt looped over engine's flywheel and thresher's pulley, the rig was all ready for hard work. Out again came the pitch forks, the trailer and tractor or powerful cart horse. From stack to trailer to mill went the sheaves — easily lifted if they had been well stacked or the very devil if they hadn't. There is an art in everything. Out from the thresher came the corn into sacks, the "chaff" and the baled straw. It was no easy job to lift these bales into barn or stack, even though they came in lightly compressed rectangular lumps about 3 ft. long. It was hard work, sometimes from early morn almost till sundown. There was a meal at noon and a short break for a mug of cider or tea in mid-afternoon. Just time at night for a wash, change of clothes, a good meal and saunter to the local public house for well earned refreshment. And not so very many years before that, for centuries the corn had been cut by hand scythe and winnowed by hand to separate the chaff.

What a change! By the late 1950's or early '60's, into Britain came the combine harvester, either tractor drawn or self-moving. Off to the ripened corn it goes, to strip it, thresh it and pour a golden stream of grain into a hopper or direct into a separate wagon or trailer. All ready for the miller to dry, if need be, and turn into flour, or for storage in bulk for sale another time. Much easier, much quicker, with negligible risk of spoiling by rain and much more economical. But, these machines leave long stalks of straw not the short stubble as before. These long stalks are nowadays left to rot or are burned on the field, perhaps to produce useful fertiliser, but more likely leaving a dust easily blown into wayward airs.

What a waste! True, straw bales can be slowly burned whole in specially made central heating boilers, giving useful economy if the bulky bales do not have to be carried too far. For more general use the straw must be made much more easy to transport and store. If you compress a bale, it takes so much costly energy as to be not worthwhile. If you chop it up into chaff and compress it, again too much energy is needed and the resultant lump tends to fall apart unless mixed with an adhesive, which is expensive and time consuming while drying. Government run research stations in Britain and abroad have long been investigating the problem without success.

Where they have failed, one man has succeeded His figures show that more practical testing and strengthening where necessary will create a machine able to provide very profitable returns on investment. The principle of operation is proven, the process works well. The straw briquettes or pellets, about 2½ in. diameter and 4 or 5 inches long, are durable and burn very much like coke or hard wood giving very little smoke when used correctly. Heat output per lb. is about 0.66 to 0.75 that of coal.

For most of the foregoing data, we are indebted to Mr Parsons, who has sent the following information:--

"Because of its bulk, straw is not a commodity that is used in any large quantities for burning. Various attempts have been made to compress it to a useful density, which have proved unsuccessful owing to the high energy input required. Other experimenters have used chopped straw without success. I can state categorically that no such process has been able to make a durable straw briquette or pellet so quickly and efficiently as the Parsons machine, which can reduce a 3 ft. long bale to a concentrated lump of fuel not more than 7 in. long. So formed, the straw fuel is easily transported and stored. It burns very much like hardwood or coke, with little or no smoke, when given adequate air supply.

While strengthening of some components of the prototype machine is required, no fault in the process of operation has been found, though some refinement is necessary. The test data shows that less than ¾ of the space is needed to store a ton of the briquettes as is needed for coal of "smalls" size (2 in. down to 1 in.), at 38 cu. ft. compared to 55. With heating value at from 60 to 70 per cent of that of coal, they are sufficiently concentrated to be economically transported by rail or road. Based on a heat output 66 per cent of that coal priced £78 per ton, these straw briquettes could sell at £52 to £54 per ton, which would give excellent profit margin.

Briefly, the Parsons machine can be used in a stationary installation or in the field towed behind a tractor and using the power take off. The straw is picked up as in a baler, loaded by elevator into a hopper, metered into a tube for compression and ejection as a briquette or pellet into another hopper or separate trailer. Calculations based on experimental data using straw of nominal moisture content 11 to 16 per cent, which is the average in Britain for ex-field straw, show that about 150 h.p. will produce 5.4 tons per hour of briquettes 2½ in. diameter and 4 or 5 in. long, at say £5 per ton plus overheads to manufacture. This leaves ample excess for safety margin and profit and makes the process potentially very remunerative with very wide application. The table gives relevant comparative information.

FUEL	STORAGE SPACE CU. FT. PER TON	HEAT CONTENT BTU PER LB.	COST PRICE £ PER TON	RETAIL PRICE GUIDE
Coal ("smalls")	55	12-14000		£78
Wood	106	6- 8000		
Parsons straw briquettes	38 or 86 when in bags.	8- 9800	Estimated £10-£15 approx.	£52 £54

While acknowledging that the machine does need some modifications and further testing before being put into commercial production, R.J. Parsons considers that now is the time for potential manufacturers and operators to take an active interest in development with a view to early production on a commercial scale.

Address: R.J. Parsons, M. Inst. P.I.; New Manor Hall Farm, Mill Street, Gislingham, Eye, Suffolk IP23 8JR, England (Telephone: Mellis (037983) 359.

STEAM ON RAIL IN PORTUGAL

Steam locomotives at work on the extensive meter gauge system in Portugal.
(Continued from Vol XXVIII No. 4)

Returning to the locomotives, this time on the meter gauge branch lines leading up into the northern hills from the Douro valley. Shedded at Livração is very clean E161, one of the 0-4-4-0 articulated Mallet tank engines. It was made by Henschel in 1905. Between the slight showers reasonable photos were taken and the other locos inspected. On a siding was E96, an outside cylinder 2-6-0 T of the same class as E97 at Viseu. These engines have an elaborate system of blast petticoats and spark arrester mesh. In shed for running attention was E164 another 0-4-4-0 T — Henschel & Sohn, Cassel 7022 of 1905, and on another siding E151 of the same class — Henschel & Sohn, Cassel 7221, 1905. All these engines seemed to be in running order.

The 0-4-4-0T articulated engines are about 30 ft. long, 7 ft. wide, 13 ft. high with working pressure 12 kg. per sq. cm. Livery is clean unlined black with polished brass window frames, safety valves, whistle, chimney top and smokebox handwheel, which latter has scarlet spokes. Scarlet buffer beams and polished steel motion help to make these engines handsome in a quaint way. Polished brass oilers adorn steam chest tops and brass relief valves project from near the bottom of cylinder front covers. From chimney aft on the boiler are sandbox and two transverse 'pop' safety valves above the round top firebox. The spherical whistle fitted just forward of and above the cab roof has the valve lever above. Walschaerts valve gear drives 'D' slide valves above all cylinders, the 1.p. cylinder being about 2 ft. 3 in. long overall. Maker's plates are about 16 in. long 6 in. wide with raised brass edges, numbers and letters on a scarlet background. The inside of the cab, from which there is a good view forward through four windows, is quite roomy. With a window at each side and two at the back, there is no excuse for missing signals. The top half and roof of the interior are eau-de-nil green, the lower half being black. The screw reversing mechanism at right has a scarlet handwheel. All the brass handles and wheels are kept well polished. Coal from the bunker accumulates between boards which separate driver and fireman's areas of the footplate.

Before seeking accommodation and a good meal at nearby Marco on the standard gauge, it was confirmed that a steam loco hauled mixed train was due out for C. de Basto at 10.08 next morning. Plans were made to catch it. However, the next day dawned so wet and foggy that the trip was regretfully passed by, the standard gauge 9.11 am. for Regua being taken instead.

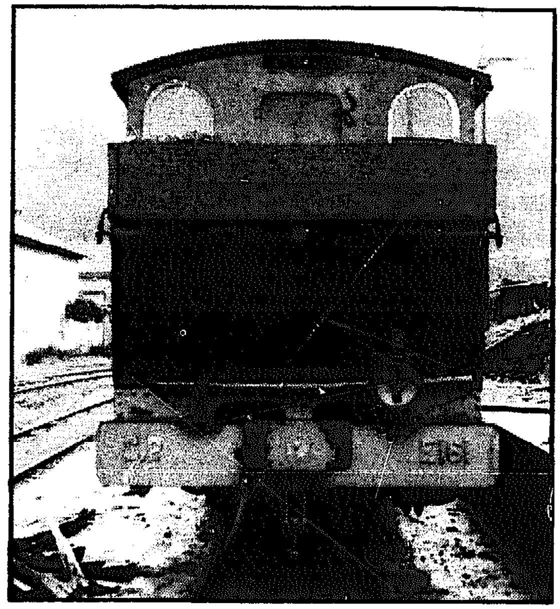
Publishers note:— We apologise — owing to a surfeit of administrative troubles and the disorganisation caused by the move to Loughborough, this instalment is not only late, it is out of place, though not too badly so. In fact it will be seen to continue from the arrival in Porto, the capital city of northern Portugal. By way of compensation, we cannot resist including photos of the trams and trolley buses plying crowded regular routes up and down the hilly boulevards and sometimes tortuous streets. After all, many interested in oldtime steam are also intrigued by smog free trams and silent trolley buses. This is a fascinating city well worth a few days exploration.

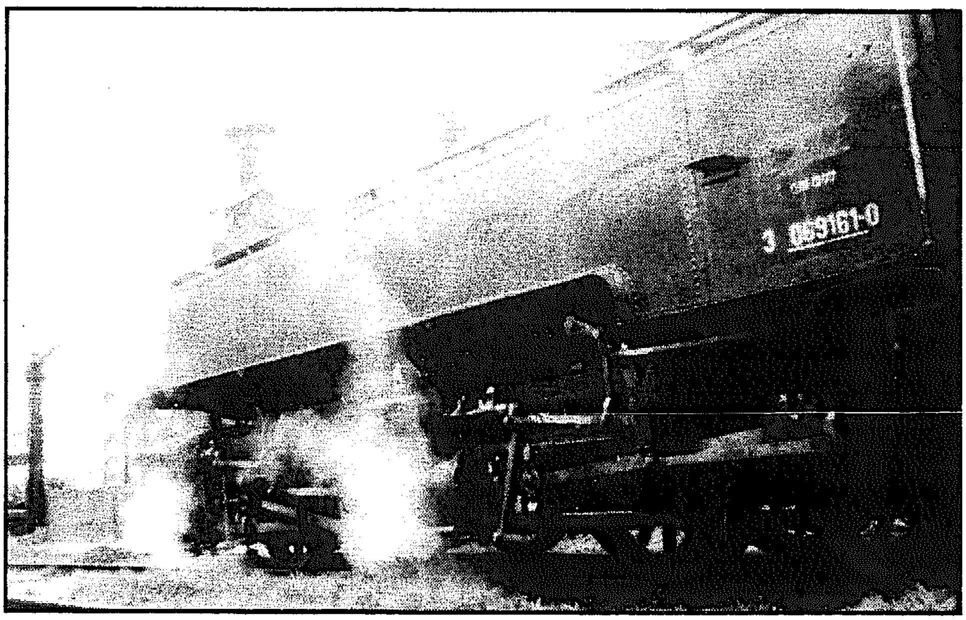
All these photos were taken in January 1978, recent information is that steam locomotives are being rapidly taken out of service, in fact to be safe you would be wise to enter Portugal along the Spanish line from Irun through Medina del Campo and Salamanca right along to Barca d'Alva, just inside Portugal on the Douro line. The station there can put you up if you arrive at night.

A little further on is Pocinho (pronounced Pokeenyo), the junction for a run up to Miranda de Duas Igrejas by meter gauge. Suggest you catch the steam hauled Misto, a mixed train which winds round and up and up, pulled by an imposing 2-4-6-0 compound articulated tank locomotive. The opportunity may never re-occur and you'll never regret it, but it is recommended that you arrive at Miranda during the day-time

All trains stop at Porto Campanha station, some continuing to the Sao Bento terminus station. In any case it is better to find accommodation near Sao Bento, which is close to the magnificent square with pedestrian way gardens along its centre and the imposing town hall at the top. The journey from Campanha gives good glimpses of the Douro river between tunnels and there is one excellent view of the lofty spidery Maria Pia steel rail bridge. Here you are near trams — yes, good old fashioned trams, and trolley buses. Also, up to the right of the town hall is Porto Trindade, which is quite a pleasant station behind the unimposing frontage, and with busy commuter traffic all on meter gauge. Some of the lines, notably to Fafe and the seaside resort of Povoa de Varzim, are quite long passing through distinctive pleasant scenery. Comfortable modern railcars and occasional diesel hauled trains provide good service to many places.

Alas! Though only a few years ago with steam locomotives of many types, Porto Trindade now boasts not one. The nearest is imposing and well kept 2-8-2 T, E144, at the extensive Boa Vista maintenance depot for which you alight at Avenida de Franca, first stop from Porto. These big engines, four only were built, are quite different from those for the Val do Vouga Line. With lovely chime whistles, they were formerly used to pull the heavy meter gauge carriages to Povoa de Varzim. Superheated with two outside cylinders, piston valves and outside Walschaerts valve gear, they are the youngest steam locomotives made for the meter gauge. E144 was built by H. Henschel & Sohn A.G., Kassel (Allemanha) in 1931, works number 21878.





The 0-4-4-0 T E161

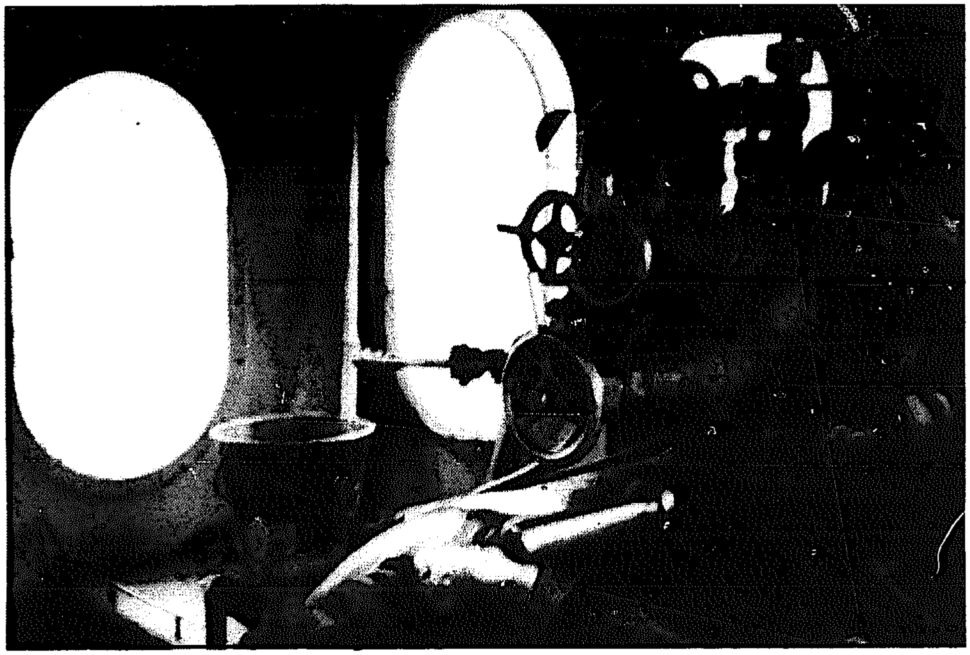
Above left — front view showing l.p. cylinders for the forward engine bogie, which allows these quite long engines to ride easily on sharp curves.

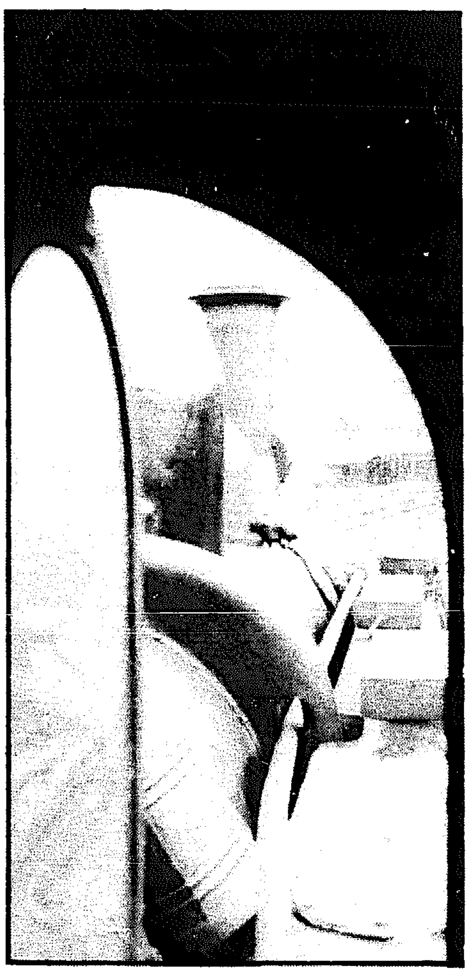
Above right — rear view showing wooden top walls added to the bunker and polished brass cab window frames. Only the front engine bogie swivels.

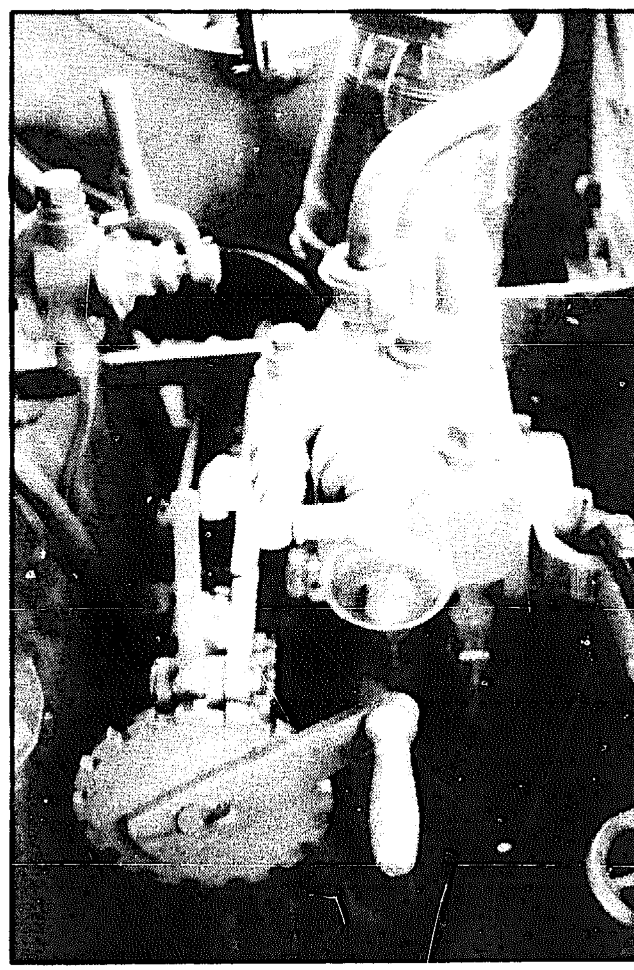
Below — motion in slow action, with Walschaerts valve gear and flat topped steam chests clearly shown.

Before looking round the Boa Vista depot, it is essential to show your authority to the Chefe. Here, also, were a good selection of historic carriages as well as the new Asthom diesel railcars and trailers, made in 1976 and 1977. At the far end is the entry to the new diesel maintenance shed where meter gauge rail cars and locomotives are given major overhauls. To the right here, do not miss the old coal fired loco boiler which supplies steam to the diesel sheds, presumably for cleaning.

I spent quite some time photographing and clambering around 2-8-2 T, E144. Since so far as is known these fine engines have not been described elsewhere, here are some details. All dimensions are paced or otherwise estimated and are therefore approximate only. Length over buffer beams 11 paces, 33. ft — central rectangular buffers project about 1 ft. 9 in — width overall 7 ft. 6 in., maximum height to top of chimney about 12 ft. 6 in. Livery is clean unlined black. Gleaming in scarlet are buffer beams, the flutes on coupling, connecting and valve rods and on the crosshead guides, the ends of all axles and background for the raised brass makers plate on the tank sides, which is about 18 by 9 in., and the C.P. plate on cab sides, about 24 by 12 in. Polished brass are the smoke box handwheel and locking lever, snifting valve, chime whis-







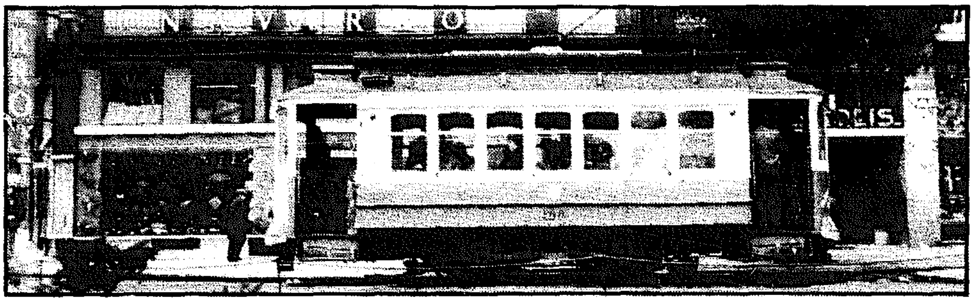
In the Cab of E161

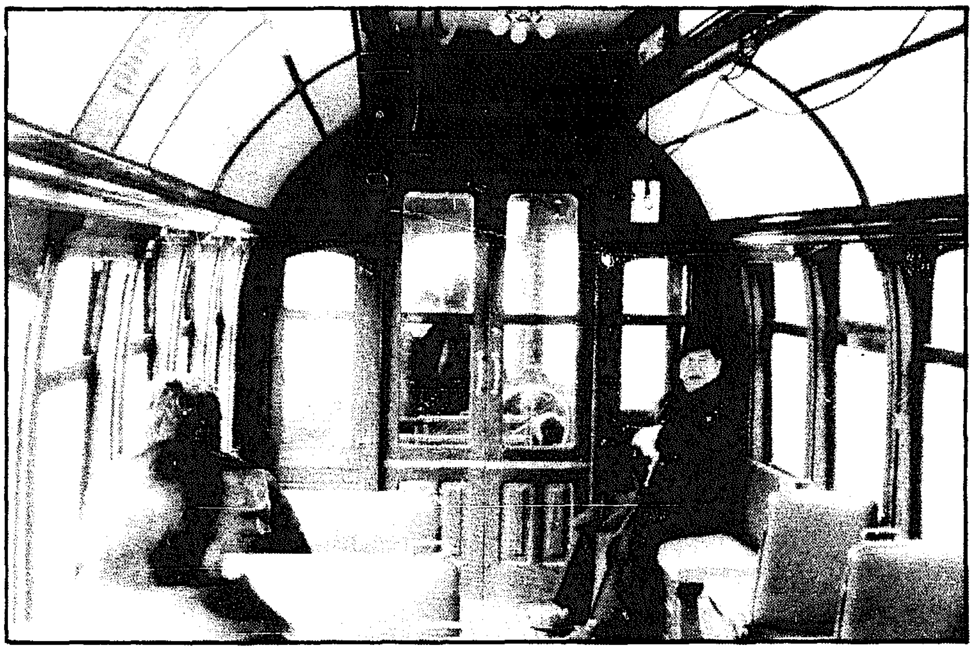
Quite roomy with pale green roof and top half of the sides, the cab has excellent view through four windows forward and to sides and rear. Coal from the bunker is channelled between boards separating driver and fireman.

Above — the fireman's side showing round topped firebox and the top of the regulator level.

Below, left — a good view along the boiler at the driver's side.

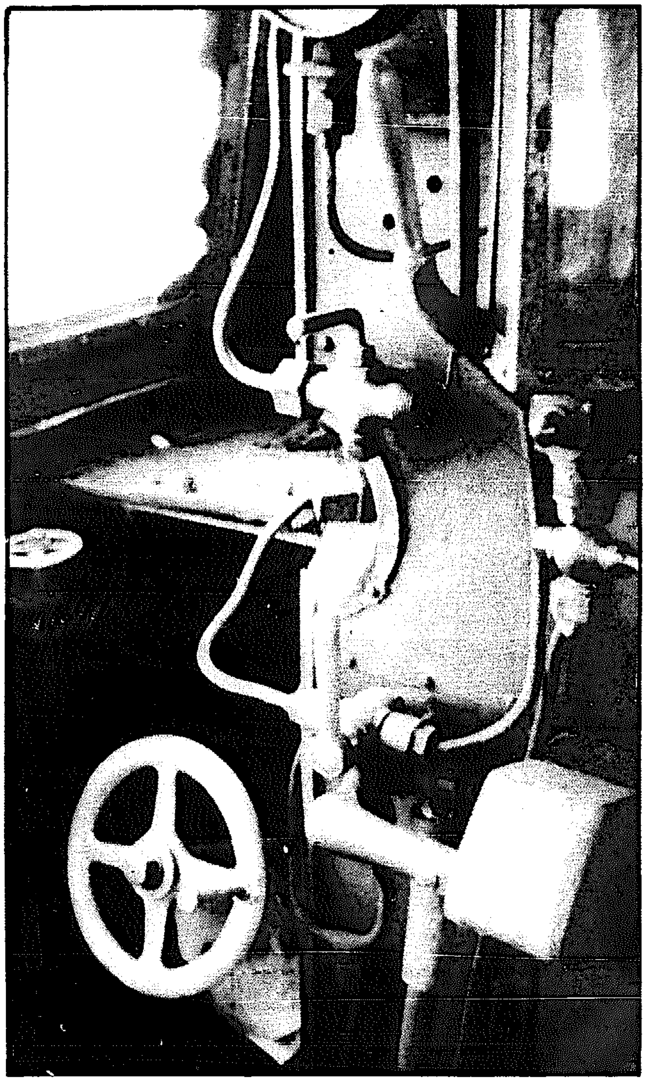
Below, right — notched wheel and handle for the screw reverse with vacuum brake control.

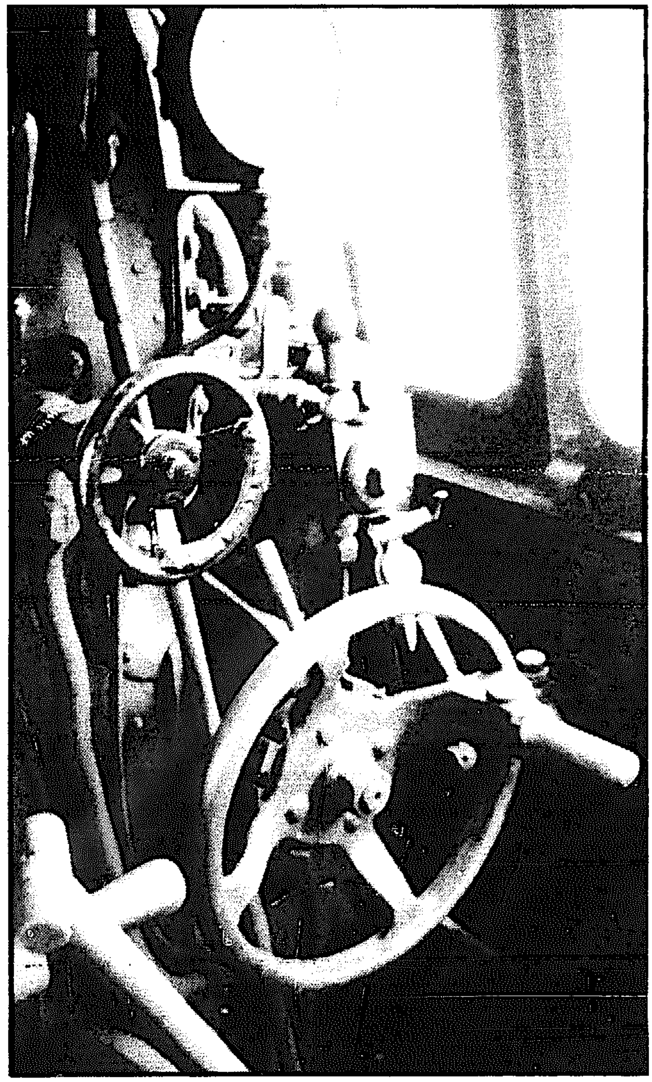


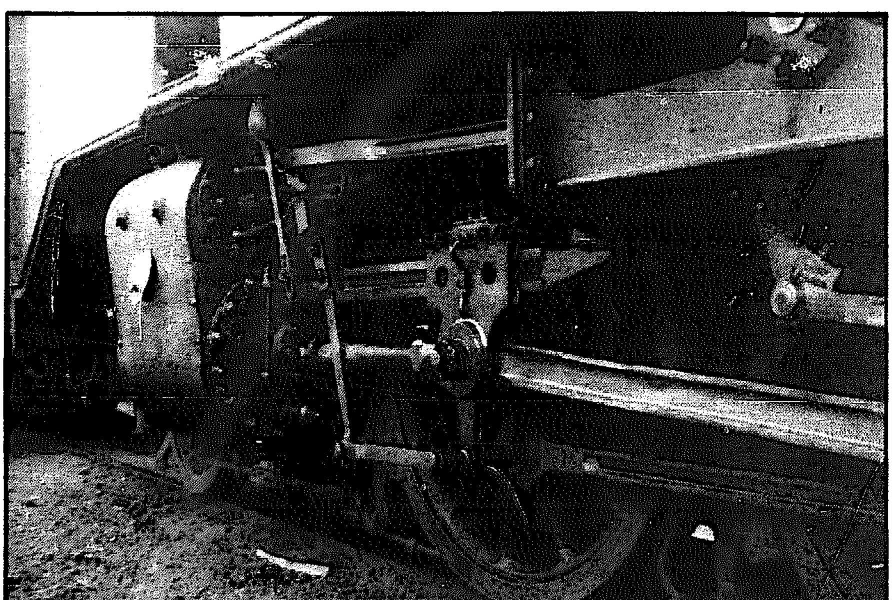


Above — a typical Porto tram. Running on about 4 ft. gauge, these clean four wheelers are in dark beige and cream livery. The interiors have dark varnished wood sides, window frames, ends and clerestorey with white panelling and medium brown upholstery.

Below — a trolley bus quietly climbs steeply near Sao Bento terminus, Double deckers are also in use. Livery is maroon and white.







Inside the Cab of E114 – above

Left — the fireman's side showing the water level gauge and injector controls. The meter gauge engines are all coal fired.

Right — the driver's side showing screw reversing wheel and vacuum brake controls.

View of the Motion on 2-8-2T E114 – at left The large diameter inside admission piston valves with long travel Walschaerts valve gear and superheated steam at 170 p.s.i. give these locomotives a very lively performance with quite heavy trains on the meter gauge. Works number is 21878. These photos were taken on 21st January 1978.

tle, two transverse pop safety valves and raised letters and numbers C.P. E144 about 6in high on front and rear buffer beams. The two injectors fitted at either side below the cab foot-plate have polished copper pipes, which with copper topped chimney give this powerful engine a very

The Imposing Town-Hall of Porto

In the heart of the city, this handsome grey stone building looks down a long central pedestrian way with floral paths in stone mosaic leading to tram stops at the other end.

pleasing appearance. Driving wheels are about 4 ft. to 4 ft. 6 in. diam., pony and trailing wheels about 2 ft. 6 in. diameter.

The boiler with parallel barrel has a large Belpaire firebox extending well back into the cab to about the beginning of its second window from the front. In fact the cab is not at all as roomy as appearance might suggest. Working pressure is 12 kg. per sq. cm, 170 lbs. per sq. in. (p.s.i.). Fittings on the boiler top are from front to rear; superheater snifting valve, dome, sandbox, two transverse 'pop' safety valves with chime whistle to starboard and very slightly to rear of the safety valves. Forward of the chimney is a large electric headlamp with similar lamp fixed centrally on a bracket near the top of the cab rear sheet. A turbo electric generator on the starboard tank top just forward of the cab supplies these lamps. The turbine exhaust steam pipe ends just above the cab top. Oil lamp brackets are fitted near either side of the front and rear buffer beams.

Vacuum brake cylinders are fitted at either side under the footplate to rear of the steps.

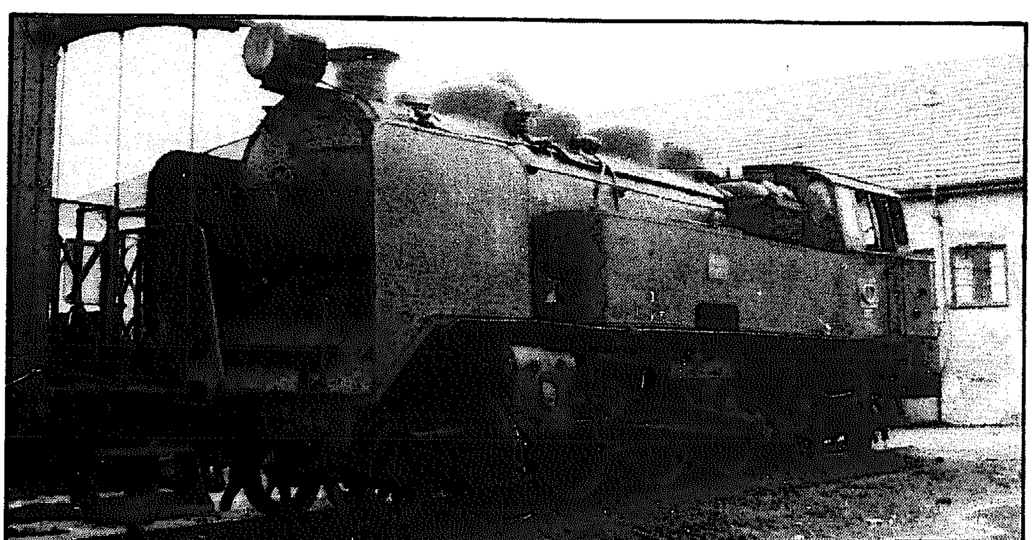
These jotted down details may also be usefully of interest:—

Large diameter overhead piston valves, single cross-head slide bar above crosshead pin, all brasses no roller bearings for the motion, mechanical cylinder lubricator at both sides just forward of the water tanks feeds into the top of the steam chest at two points about 6 in. from cylinder centre and at forward probably into piston valve tail rod, and into the piston tail rod just forward of the cylinder cover. Automatic cylinder relief valves fitted at bottom of front and rear cylinders covers are spring loaded. Manual cylinder drain cocks are at bottom front, centre and rear of cylinders. Jacks are carried on the running plate at either side of the smokebox.

(To be continued)

Below —

Meter gauge 2-8-2 T locomotive E144 at Boa Vista. Used extensively on the line from Porto Trinidade to the seaside at Povoa de Varzim, these superheated two cylinder simple expansion engines have a lively performance. E144 was built in 1931 by Henschel and Sohn of Kassel. In glossy black with scarlet buffer beams, coupling and valve rod flutes etc., polished brass and copper topped chimney, these are handsome engines.



Left — rear view of E144 shows the good cab lookouts electric lights and generous loading gauge.

Right — view from cab on driver's side, showing the turbine driven electric generator on the tank top just forward of the cab. Turbine exhaust is led to just above the cab roof.

1896 LOCOMOTIVE FOR RESTORATION

The 2ft gauge 2-4-0 T locomotive "Sea Lion" was built by W.G.Bagnall of Stafford in 1896, for use on the pleasure railway at Groudle Glen, Isle of Man. Works number is 1484. For many years the engine pulled carriages holding 10 passengers each from near the head of the Glen to cliff side pens for sea lions and polar bears.

Though greased up and stored for the duration of the 1939-46 war, it was never returned to service, becoming gradually derelict as the years rolled by. At long last, restoration of this historic little engine has started with the formation of the "1896 SEA LION LOCOMOTIVE ASSOCIATION" on November 5th. Further information concerning this interesting project can be obtained from S.T. Townsend: 132 Reedley Road, Stoke Bishop, Bristol BS9 1BG, England.

SOME HIGHLIGHTS FROM

The Carter Steam Car

Driven 4,500 miles since March 1972, this converted VW Sedan was in 1974 subjected to stringent air pollutant emission tests by the Environmental Protection Agency, U.S.A. As is to be expected from a good modern steam car the tests were passed with flying colours being on average only 10% of the maximum allowable Hydrocarbon (HC) emission, 17% of the Carbon Monoxide (CO) and 25% of Nitrogen Oxides (NO). As shown by the three-quarter rear view on the front cover the VW's appearance is little changed, the complete power unit remaining at the rear.

Quoting from a passenger: "Moving from cold switch-on takes 30-34 seconds . . . the engine hummed along at just about the noise level of a standard VW i.c. engine . . . in top gear the little car surged up to 70 mph. with more vitality than any VW I'd ever ridden in. I couldn't smell steam, hot cylinder oil or kerosene . . . It would run all day at 70 or 80 mph. with top speed expected to be 90 mph."

Here are some relevant statistics, always useful when impressing the sceptical. Steam blow-down warmed up the engine in 20 seconds. Weight of the complete steam power unit is only 120 lbs. more than the i.c. engine it has replaced. Make-up water was negligible even when running in 100 deg. F air temperature, condensing being so good that the 2 gallon tank of water remained nearly full after 400 miles. The four cylinder radial single-acting engine is 2 in. bore, 2¾ in. stroke. Up to 5000 r.p.m. is possible. Working steam conditions were 2000 p.s.i. at 1000 deg.F., increasable, it was thought, to 2500 and 1200. Fuel consumption of lead free gasoline (petrol) varied from 17 to 24.7 mpg. British (13.6 to 20 mpg. U.S.) with potential improvement to 30 mpg. (British (24 U.S.). It was expected to be able to travel up to a total of 500,000 miles, which is at least twice that expected from i.c. engines.

Who said steam cars are not practical in modern conditions? The Carters, father and son, also claimed starting from all cold could be reduced to 15 seconds. Some steamer! Wonder what happened — no further information has been received since 1975.

THE PRESERVATION OF BEAM ENGINES IN BRITAIN

(Continued from Vol. XXVIII No. 4)

Last March a very unusual twin beam engine was re-commissioned at Kew Bridge Engines, and seen in steam in June by this writer. The twelve fluted Doric columns, base and entablature are cast in iron, as are the twin beams, cranks and flywheel. All are painted in deep red with spoke centres scarlet. Cylinder lagging is varnished wood strips. The engine provides suitable company for the massive 1820 Boulton & Watt with steam cylinder 64 in. bore, the 90 in. bore Sandys, Carne and Vivian and 100 in. Harvey & Co. beam engines, also the Easton, Amos and Sons compound rotative beam engine.

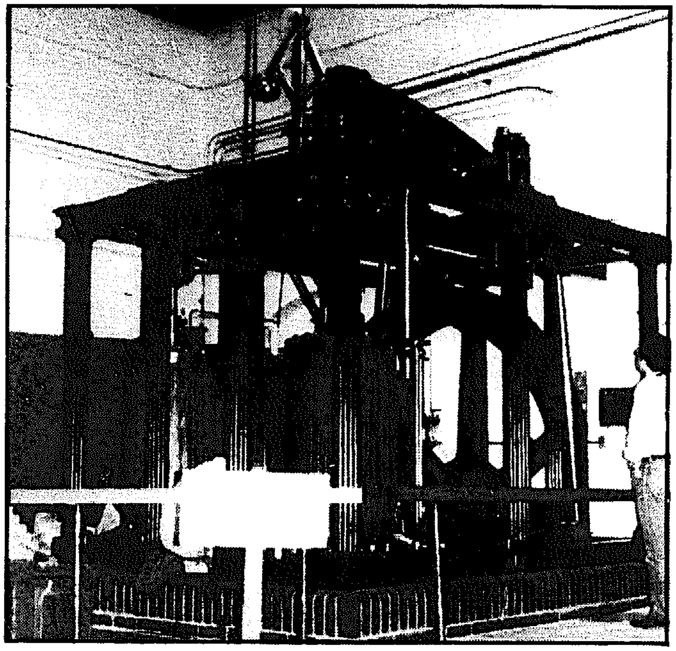
With cranks at 180 degrees, beautifully polished cylinder covers, Watt parallel link mechanism, connecting rod and valve mechanism, the action of this twin engine is almost mesmeric. Of particular interest are the double slide valves of Meyer type for each cylinder, which are moved by twin eccentrics through bell cranks and rods. The smaller expansion or cut-off valve works on the back face of the main valve, thus giving "sharp" valve events. Bore is 18 in. stroke 2 ft. 6 in.

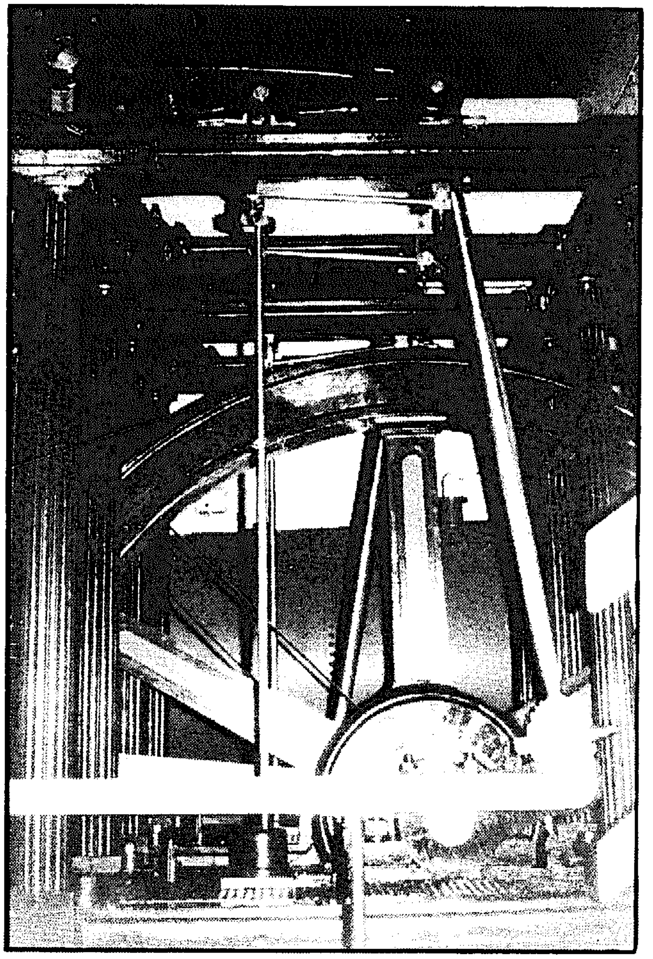
Built by James Kay of Bury, Lancashire in 1867, it was one of the first steam engines supplied to a privately owned water pumping station in a rural area, drawing water from a well at Dancers End on the Rothschild family estate near Tring in Hertfordshire. It was installed on the first floor of a typically elegant Victorian pump house which is still in use, housing electrically driven pumps.

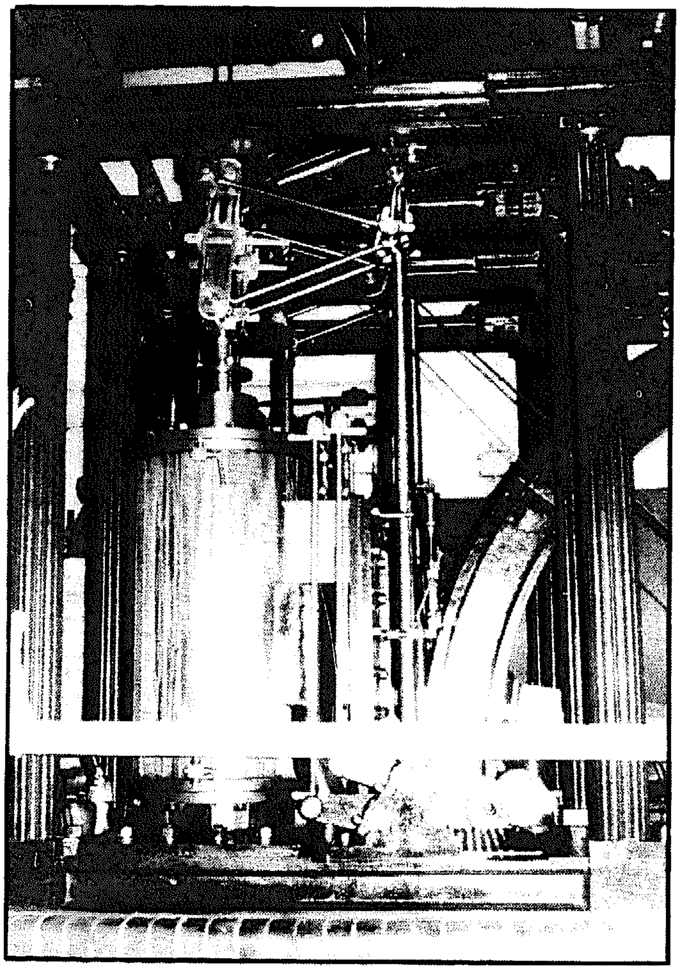
Members of Kew Bridge Engines Trust camped in the pump house for a week, while dismantling the engine. The flywheel is 11 feet diameter, weighing 6 tons. This engine, which has two condensers and two air pumps has been designed to allow the two water pumps to operate alternatively thus giving a more even flow of water. Working pressure was 80 p.s.i.

There is now another large pumping engine at Kew. A three cylinder open crank, triple expansion engine with a flywheel at either side of the centre crank was in steam. This engine, which has reheat between expansion stages, was built by Hathorn Davey in 1910 for the waterworks Company at Newmarket, where it pumped up to 1.44 million gallons every 24 hours from a well to a reservoir 350 feet higher than the engine house. It was taken out of service in 1957 and presented to Kew Bridge Engines Trust in 1979. Steam valves are semi-rotary Corliss type. Main pumps were connected to the crossheads by four rods. Working at 160 p.s.i. on demonstration, the only sound is the rhythmic click of the valves. Such engines bear strong resemblance to contemporary marine up-and-downers (reciprocators). You will enjoy return visits to these machines, which together with two of the four "resident" beam engines and a Bull pumping engine are steamed every weekend.

Illustrations are shown on following pages





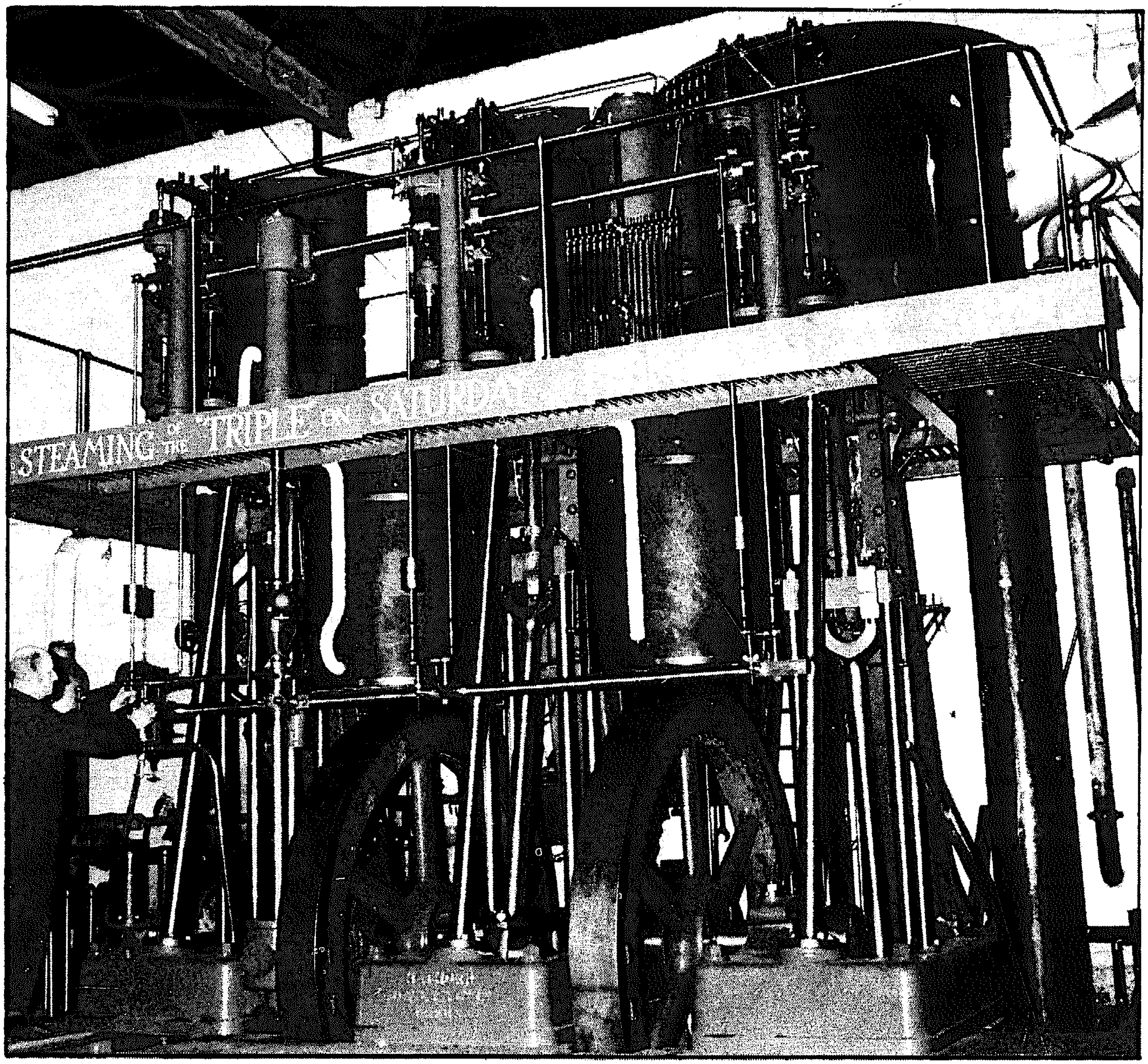


The Double Beam Engine at Kew

Built by James Kay of Bury, Lancashire in 1867, this double-acting engine with cranks at 180 deg. pumped drinking water at Dancers End estate for many years until replacement by an electrically driven pump.

The twelve Doric columns, entablature, beams, crank and flywheel are resplendent in deep red. Cylinder lagging is of varnished wood strips without metal holding bands

Kew Bridge Engines, Kew Bridge Road, Brentford, Middlesex.



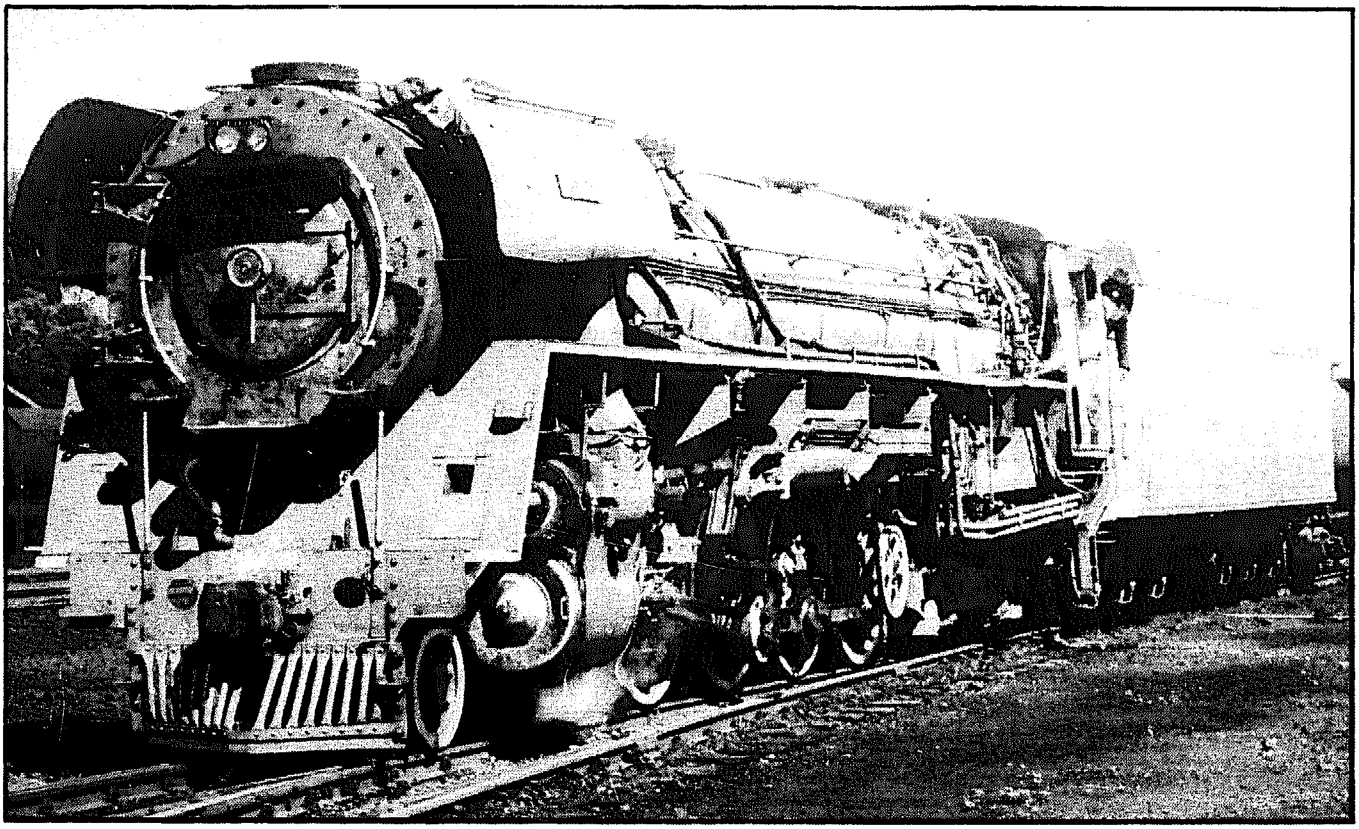
The 1910 Hathorn Davey marine type triple expansion pumping engine at Kew. Inaugural steaming there was celebrated on February 21st 1981.

(To be continued)

Topicalities

MASSIVE STEAM LOCOMOTIVE MODERNISED

The standard 3 ft. 6 in. gauge railways in South Africa, with nearly 12,600 route miles, used over a thousand 4-8-2 tender engines for all classes of traffic, the first of this wheel formation having been introduced in 1904. Subsequently developed to maximum capacity, they were eclipsed in 1953 by 140 of the Class 25 4-8-4 engines, 50 of which, the 25 NC, are non-condensing, the first having been built in 1953.



The modified South African Railways 25NC Class 4-8-4. This coal fired engine now uses a gas producer combustion system, increased superheat, improved steam distribution and a feedwater heater.

Photo: Courtesy South African Railways

Here are some salient dimensions: Wheel arrangement 4-8-4, weight in working order engine 140, tender 67, total 207 tons, 2 cylinders bore 24 in. stroke 28 in., driving wheel diam. 5 ft., tractive effort 51,400 lbs. at 85 per cent of the 225 p.s.i.g. boiler pressure, coal capacity 18 tons, firing rate by mechanical stoker up to 5 tons per hour, normal maximum speed 55 mph.

South African Railways No. 3450 of this class was selected for experimental modifications which have been incorporated. At the time of writing, this engine was being got ready for tests. It is understood the principal modifications are the installation of a gas producer combustion system, double Lempor exhaust, regenerative feed water heater, increased superheat, air sanding, and various improvements to the front end such as new valves, pistons, valve liners, improved lubrication.

HARBOUR LAUNCH WITH VEE COMPOUND ENGINE

Colin Black's on board harbour launch, made by Powles of Wroxham, Norfolk, for a Royal Navy Destroyer is 16 ft. long, 5 ft. 6 in. beam. Fully reconditioned with no expense spared, this handy craft is now a fast little steamboat using the 90 deg. compound engine shown in "Steam Power" drawings Set 2, and the vertical boiler shown in Set 5, with steel water tubes used instead of copper and a nimonic alloy steel over-fire superheater having 2½ coils supplying steam at 350 p.s.i.g. and 750 deg.F. This engine is designed to work economically at 750 p.s.i.g., 750 deg.F, though does well on pressures down to 200 p.s.i.g. with about 250 deg.F. of superheat. At 350 p.s.i.g., 685 deg. F. total steam temperature should be adequate.

The keel condenser is 9 ft. 1 in. long 2½ in. o.d.; condensate air pump and ram type feed pump are driven from the 40:1 worm drive to the Mobil "Delvac" mechanical cylinder lubricator. The feed pump is ⅞ in. bore 1 7/16 in. stroke. The 12 in. diameter variable pitch reversing propeller turns at 1800 rpm. Further information and photos of this lovely little steamer are promised.

F.B.C. IS SUITABLE FOR SMALL BOILERS

Owing to difficulties with the carry-over of ash, sand and some particles of unburned fuel it has been assumed that fluidised bed combustion of coal and other solid fuels is not practicable in short cumbustion spaces. It is, however, all just a matter of scale. If very small coals are used and low air pressure for fluidising the shallow bed of sand and fuel, there is no doubt that the advantages of F.B.C., with its high heat release and controllability, can be available for small boilers.

If used with fast steaming monotube steam generators, it must be borne in mind that there is always considerable heat retained in an operating "bed" even when the fluidising air is switched off, that is the bed is "slumped". Therefore, when the demand for steam can fluctuate from maximum to zero in a few seconds, as in road vehicles and to a much lesser extent in boats, it may be necessary to void excess heat from a temporarily slumped bed into an economiser, space heater or even to atmosphere.

Though, at the time of writing more details have not been released for publication, tests with a small steam generator only 20 in. diameter have proved surprisingly successful using coal dust fuel in a shallow bed with quite short combustion chamber. There is reason to believe that larger coals say pea size, can be used with success and that narrow steel sheet baffles in the upper part of the combustion space will prevent excessive carry-over and encourage complete combustion before reaching the flat spiral water-steam coils. Though so far as is known water tubes in the bed have not been tried, they would probably prove very effective in cooling the bed, thus preventing the formation of clinker (fused ash), and in controlling the production of polluting nitrogen oxides among the combustion gases. The very effective heat transfer in bed cooling tubes would make possible a substantial reduction in the total heating surface, and in the overall size and weight of the steam generator. In this connection it should be borne in mind that "in bed" tubes will continue to absorb heat long after the bed has been "slumped", though owing to lack of turbulence nowhere near as rapidly.

Although the fuel bed and combustion space must be vertical with updraught, there seems no reason why the hot gases, under forced draught, after passing out of the water walled combustion chamber should not be directed horizontally between the convolutions of tube coils and/or along annular spaces between close wound horizontal helical coils.

IN SEARCH OF ECONOMY

The ever increasing cost of oil, has led to more serious investigation of more efficient propulsion for cars and other road vehicles. An interesting type, which shows great promise, is the battery electric with self contained recharging system, termed a "hybrid" vehicle.

Compared to battery cars, vans, milk floats etc., a relatively small weight of batteries are carried, in fact just enough to give adequate power storage, the re-charging motor being run, when the vehicle is stationary or running at low power as well as at high speed. This allows a quite small engine to be used, running always at its most efficient output, with automatic switching off and on according to recharging requirements. Such vehicles will obviously give best economies in congested traffic, such as in towns or on roads subject to "traffic jams", but will show little economy on motorways where the vehicle will be used at high power for long periods.

For certain services, such as for public transport in cities, the expense and weight of a flywheel for additional short term storage of energy may prove worthwhile.

Where a steam engine is used as the prime mover, the automatic control of steam pressure and temperature is considerably simplified, which is an even greater advantage when solid fuel is used. Also, although a well designed reciprocating steam engine has excellent torque characteristics for direct drive, its use under continuous large and rapid fluctuation of power output is inefficient. For battery charging, the conditions are more akin to boat propulsion, for which steam drive can be surprisingly efficient as well as being very smooth and quiet. At present "hybrid vehicles" are licensed as electric, which absolves them from payment of road tax.

On September 15th and 16th, the first international conference was held, at which there was a demonstration of "hybrid" vehicles. London Transport has made its testing grounds available for showing the capabilities of a number of vans, cars and a public passenger vehicle, which will incorporate a new British hybrid system to be seen for the first time.

The preliminary report also states "trolley buses can operate off the overhead wire and for the future, a dual mode system is being tested which is embedded in the road surface and powers vehicles, while at the same time guiding them to their destination". Is this a modern form of tram?

Conference address: Electric Vehicle Development Group, 59 Colebrooke Row, London N1 8AF.

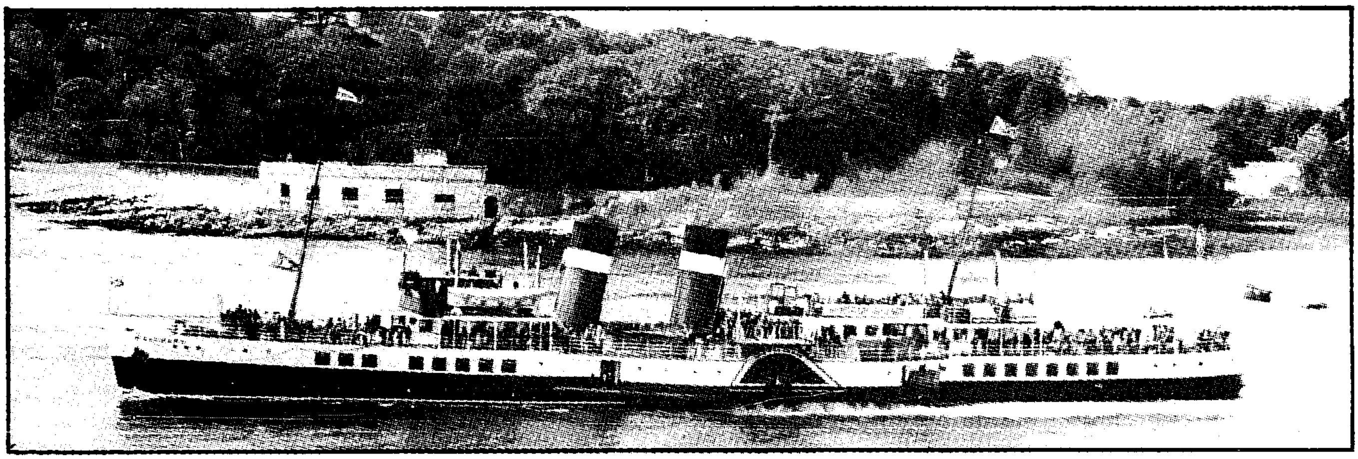
WAVERLEY'S EXTENDED CRUISES

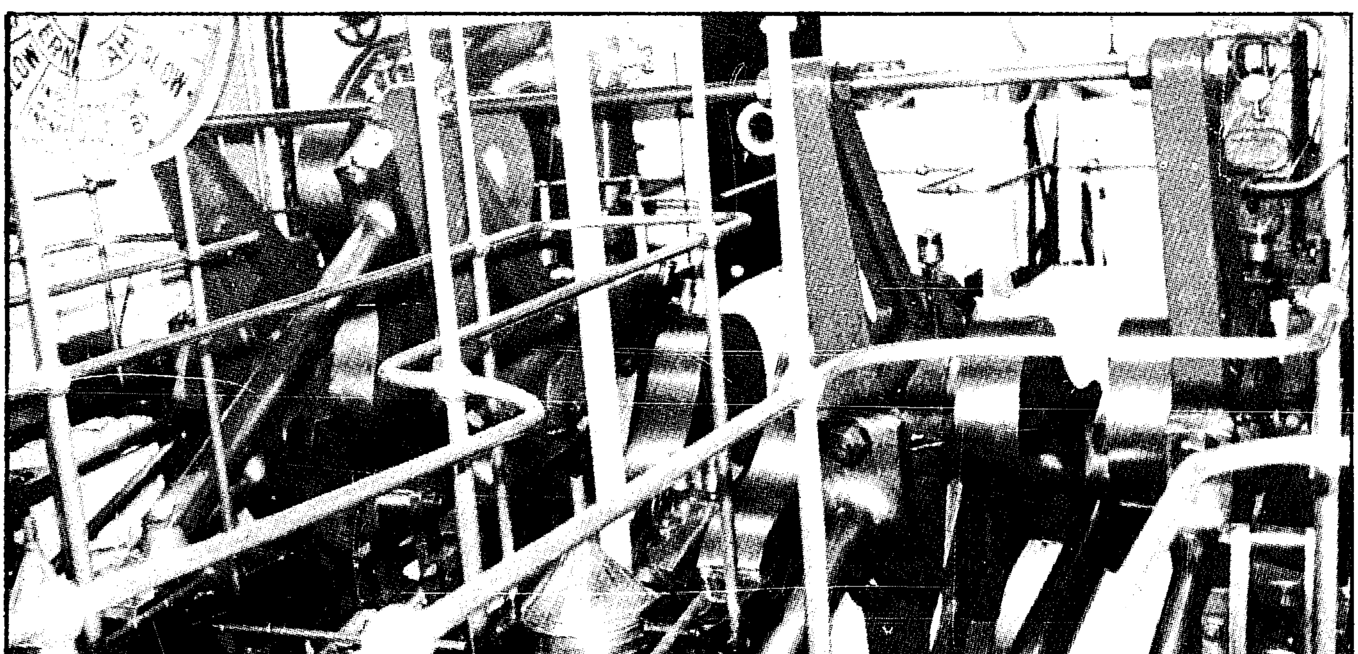
Bred from a long line of Scottish Paddle Steamers and borne on the Clyde, "Waverley" is steaming better than ever. Starting in April this year she has worked her way round from the South coast, along the East coast to Edinburgh, then to Oban and on to the Bristol Channel before returning to the Clyde in late June for a full programme in July and August. From September 2nd to 20th, she is scheduled to cruise from Bournemouth, Weymouth, Southampton, Southsea and the Isle of Wight, thus completing a very full season's steaming, which has included a trip across the English Channel to Cap Gris Nez, France.

Last March her new boiler was hoisted aboard. Supplied by Babcock Power Limited at a cost of £160,000 it is a "Steambloc" TC able to use heavier fuel oil and operate at improved efficiency with expected savings of £40,000 during the first season. Boiler flue gases now use the forward funnel only, leaving the aft funnel for diesel generator exhaust etc. The old boiler has been bought for preservation by the Royal Scottish Museum in Edinburgh. Built in 1947 and the last of the sea-going paddle steamers "Waverley" is expected to steam into the 21st century.

Another vessel has recently joined the company's fleet. She is the twin-screw motor vessel "Prince Ivanhoe" formerly M.S. "Shanklin" from British Rail's Portsmouth to Ryde service. Any profits made by this vessel will help to pay for "Waverley's" refurbishment.

Though substantial contributions have been received from the Paddle Steamer Preservation Society, the Scottish Tourist Board, Strathclyde Regional Council, Glasgow District Council and Babcock Power Ltd., more funds are needed. Donations and requests for further information should be sent to "Waverley Boiler Appeal"; Waverley Excursions Ltd., Waverley Terminal, Stobcross Quay, Glasgow, Britain.





P.S. "Waverley" makes a pleasant picture on the Clyde. The red waterline, white topped black hull, white superstructure and funnels in their old London and North Eastern Railway colours of red, black topped with white band, contrast well on blue waters. She is seen here on a Rothesay-Isle of Bute cruise. With length 240 ft., beam 30 ft. 2in., 57 ft. 3in. over paddle wheels and gross tonnage 693.13, she is able to carry 1,350 passengers. The mighty cranks and connecting rods of the triple expansion diagonal engine give much enjoyment to passengers. Cylinders are 24, 39 and 62 in. diameter, 66 in. stroke. Using steam at 180 p.s.i., 2165 i.h.p. is available at 56.5 r.p.m. A new boiler able to use heavy fuel oil was installed this year. As a result running costs are expected to decrease by £40,000 a year.

(To be continued)

HISTORICAL DEVELOPMENT OF STEAM CARS

Briefly recording some of the more successful applications of steam power to passenger road vehicles.

(Continued from Vol. XXVIII No. 4)

J.D. Richard, the owner of the H-B Steam car, concludes with a description of the electrical system, his maintenance facilities and briefly recorded ideas for his "ideal steam car".

THE ELECTRICAL SYSTEM

The car gives the impression of being an electric vehicle, in all respects except propulsion. A formidable mass of coloured leads sprawls everywhere — even the horn and the windscreen wiper are electric; and what is rather horrifying is that the operation of raising steam is completely dependent on the battery. There is no such thing as winding a handle, or running downhill to get started. The compensation is that the battery is never expended fruitlessly, as with a starter when an I.C. engine refuses to fire. For even if a snag should occur in raising steam (such as the familiar shortage of water) the heat generated up to the time of stoppage remains stored in the boiler, and the battery power expended on the 35 amp blower motor is not lost, provided the stoppage is of short duration.

A simply enormous dynamo able to produce 70 amps, at 12 volts, is mounted on the engine. This, of course, is a modification — the original Stanley arrangement had no electric blower to cope with, and featured a very small dynamo sitting on top of the back axle, coupled to a shaft geared to the main wheel of the differential. The shaft is retained, and drives the present dynamo by a V-belt, which was for a time one of the biggest nuisances in the car. Every ten miles or so it would start slipping and need adjustment. However, that was with the dynamo on full output all the time, a condition that no longer applies, and the belt can now be almost forgotten.

There is a huge automatic voltage regulator in a box the size of three volumes of the London telephone directory. When the first trials of the engine took place, the regulator seemed to be stuck, as no more than 10 amps charge could be obtained; and being one of those modern sealed units, it could not be fiddled with. So as an expedient, the field regulator part was short-circuited, leaving the cutout (which worked) operative; and the dynamo gave 60 amps. This was satisfactory for the short runs initially carried out, as the blower might have been taking its 35 amps for up to 10 minutes while raising steam and messing about, and the battery needed a fair amount of recompense; and it was all very well until a speed of 30 mph. was reached, whereupon the dynamo fuse would blow. It first did it in the dark, just to be convenient, and it was with heart in mouth that an urgent trip of some four miles was completed on an unassisted battery.

On the first long run carried out, the dynamo produced a dreadful smell of hot electricity as well as giving the belt trouble mentioned. The next expedient was to put a resistance in the field circuit and halve the output, and this has proved to be almost the complete answer. The only refinement envisaged is to put in a variable rheostat, as there is still more charge than necessary on long runs. The voltage regulator will not be reinstated, as anyone who contemplates running a steam car will naturally have his mind on his machinery enough to do the small job of regulating the dynamo without requiring automatic assistance. Further, the automatic regulator would mask the evidence of any irregularity, such as the belt-slip that still sometimes happens which shows upon the ammeter.

In steady running, the battery load fluctuates between 30 amps charge and 10 amps discharge, as the blower cuts in and out, several times a minute. When it cuts in, there is momentarily a discharge of over 50 amps, which takes a couple of seconds to recover. At night, the accompanying drop in voltage dims the lights slightly, and, which is annoying, sometimes causes the solenoid operated dipping headlight to undip. One day a double filament bulb will be substituted for the solenoid gear, which will be turned over to the duty of working the butterfly valve in the blower discharge duct, mentioned under "Combustion Equipment". Modifications rarely need involve buying anything new!

The car has once been brought to a standstill by lack of electricity. The dynamo drive failed, and driving was continued, as there were 12 miles to go and there seemed to be a fair chance of making it. Unfortunately, the battery was not fully charged to start with; after 5 miles it began to flag, and after a further 5 miles there was no steam left. It was interesting thus to ascertain the endurance on the battery. Knowing that there is something like 10 miles running stored up, there will no longer be anxiety when traffic conditions keep the speed down so that the dynamo does not cut in for a mile or two.

To be quite safe in all conditions, an additional dynamo, which could be quite a small one, driven by its own independent steam engine, might be desirable. It would also be a blessing when steam is raised for adjustments, etc., without going for a drive. As things stand, the main engine has to be run, with a wheel jacked up, to restore the battery.

MAINTENANCE FACILITIES

The equipment needed to run this car and to carry out minor modifications, doing it nearly all at home, is not vast; with the car it will all fit into an average single garage.

Only one machine tool is owned — a 2½ in. lathe; and this little stalwart has been kept very busy making endless pipe connections, valves bushes joints for control linkages, and so on. Only one turning job — on a feed pump body — has had to be taken to a bigger lathe.

No welding equipment is kept, nor any heating apparatus greater than a 1½ pint blow-lamp. The one welding job that has been required — a new pancake coil for the boiler — had to go to a contractor and incurred vast expense; but otherwise the lack of welding facilities is scarcely felt. Many small jobs, where welding or brazing might have been used, have been accomplished by silver soldering.

The engine can be lifted by one man, and when dropped on the floor under the car it will slide out under the running boards. There is thus no difficulty in dealing with that.

The boiler is not much harder to remove. The top half of it is within one man's capacity, and can be got out of the car single-handed with the aid of a rope over the garage rafters. The bottom half of the casing stays in place, and the main bank of coils lifts directly out. It weighs about 2 cwt. and so needs tackle and an overhead beam of some substance.

For pipework alterations, a set of taper-thread taps and dies, ¼ in. and ⅜ in. B.S.P.T. have been invaluable. At the working pressure concerned, 800 lb/sq. in., screwed pipe joints are perfectly satisfactory. Pipe joints also call for a small Stillson wrench, a couple of bits of tube to slip over the ends of spanners and act as "Samson's" and (for one particular joint, a Stanley legacy) a pair of heavy spanners, 1⅛ in. A.F.

Those are the only special tools required. Otherwise all running maintenance jobs are covered by the sort of tool kit that anyone would have who messes about with a car.

Asbestos lagging in various forms is much in evidence in the garage; a tin of high temperature jointing paste and some rolls of gland packing also give away the fact that a steamer lives there.

The car is economical in packing requirements. One size (⅛in.) covers all the steam glands — piston rods, valve spindles, and throttle spindle; one other type is used by the main feed pumps; and that is the sum total of the glands that need regular attention.

Spanners are carried on all occasions, not so much because the car is a steamer as because it is a "special", full of improperly engineered trial features, and liable to shed nuts. A screwdriver must be kept handy for fiddling with the thermostat, which does not yet keep its setting indefinitely.

On long trips, a filling funnel is carried, as paraffin never comes out of a hose, and water often has to be administered by bucket. A suit of overalls also goes in the tool box, and regrettably has been required in the course of two of the three 150-mile trips that have been made.

THE IDEAL STEAM CAR

From the experience gained with the H.B. Steamer, the ideal steam car is envisaged as having the following points of difference from this car:—

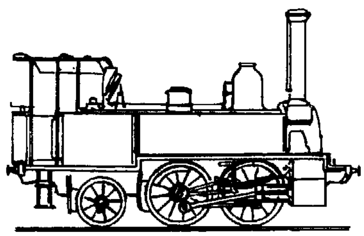
Compound engine, of lay-out similar to the Stanley, but having higher piston speed and large valves; with means of disengagement from the axle for warming up and adjustments.
Feed pumps operated from the engine, even when disengaged from the axle.
Steam auxiliary feed pump.
Feed heater large enough to be effective.
Oil separator in the exhaust steam line.
Hydraulic windscreen wiper.
Steam whistle.
Hand (as well as foot) throttle control.
Throttle valve made of really hard material, with means of forcing it shut if stuck by scale.
Small auxiliary engine, driving a condenser fan and additional dynamo.
Six days a week free to get on with it.

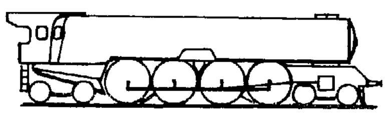
(To be continued)

THE COMPOUND STEAM LOCOMOTIVE

Believed published for the first time in England

Though steam rail locomotives are out of fashion, any superiority of diesel power is often so slight as to be easily reversed by outside influences. Where coal is cheap and water abundant, the diesel is less economical, yet continues to supersede.





The lecture, "The Compound Locomotive: Its Present States. Its Future", presented by Andre Chapelon at the Sorbonne on 18th May 1933, is reproduced from the French text first published in the journal "Science et Industrie", to which all due acknowledgement is given.

By Andre Chapelon

Grateful thanks to G.W. Carpenter, C. Eng, M.I. Mech. E, who has checked the original translation of the French text.

Is it accurate to say that superheating has done away with condensation and, as a consequence the advantage of a reduction of temperature drop in the cylinders?

The entropy diagram (fig. 18) gives us the answer by showing that a perfect engine, following the Rankin cycle, exhausts steam with a high humidity content, even for pressures of 17 h.p.z. (246 p.s.i.) and the already very high superheat temperatures of 400 deg.C. (752 deg.F.).

In the practical locomotive, which involves throttling and incomplete expansion losses, the exhaust steam clearly has increased heat content; but it is obvious that these throttling losses, which one can and one must reduce to the lowest possible pressure, are no reason for totally ignoring the influence of the cylinder condensation and radiation losses even in superheated locomotives with boiler pressures already exceeding 17 h.pz.. (246 p.s.i.).

It is of course, to be regretted that experimental work in this field is still incomplete; but it seems that in some cases, optimum cylinder efficiency was only obtained by a much greater degree of superheat in the exhaust, than one would have anticipated.

Moreover if we try to analyse, even briefly the actual exhaust conditions we make some fairly disturbing findings both concerning the absolute value of the temperatures measured at exhaust and the temperature of the steam remaining in the cylinders at the beginning of the compression phase.

Considering fig. 19, one notices that the temperature varies continuously during the exhaust advance phase. The quantity of steam remaining in the cylinder at any moment is expanded adiabatically either in forcing the piston to the end of its stroke or by ejecting steam to exhaust. The temperature of this steam corresponds therefore exactly to that given at equal pressure by the adiabatic curve. As to the exhaust steam, its temperature becomes progressively slightly lower than that remaining in the cylinder, by reason of *its expansion without doing external work in exhausting to atmosphere. The effect of the heat transferred into the cylinder walls raises these temperatures to a greater or lesser degree, but it is known that readings from thermometers placed in the exhaust column (blast pipe) are difficult to interpret and that the temperature of the steam remaining in the cylinder is seen to be relatively much lower than that measured thus. It is even very likely, as the entropy diagram shows, that the steam thus remaining in the cylinder at the end of the exhaust phase will be saturated steam of fairly low quality (0.95) when the admission pressure and the ratio of expansion are fairly high (i.e. when working at a short cut-off).*

It is known that condensation in cylinders, or more simply the losses due to the action of condensation on cylinder walls, depends on the difference in steam temperature between admission and exhaust, and that from this point of view, there are valuable advantages in the compound system. This system divides the total temperature drop between high and low pressure cylinders and is characterised by the cylinder wall surface areas which are also proportional to the effects of condensation and radiation action, generally about one half of the cylinder wall areas in equivalent simple expansion machines.

In the French text there follows a description of a method of calculating the loss of work due to condensation in the h.p. and the l.p. cylinders of a compound expansion engine and in the cylinder of a simple expansion machine. It has been decided not to reproduce the calculation method here. However, if required by a sufficient number of readers, the calculations will be published in the next issue.

The work of M. Nadal, chief mechanical engineer of the Etat railway, shows that the quantity of heat transferred to the cylinder walls during the admission phase and recovered at exhaust is, especially in the case of locomotives, roughly proportional to the wall surface areas, subjected to the detrimental effects of condensation and radiation and to the difference of temperature between the steam at admission and at exhaust.

The heat loss caused by the cylinder wall action would be therefore, at first approximation, more than 2.5 times greater in the simple expansion engine than in an equivalent compound. The steam quality, notably its wetness or superheat, plays a large part in the absolute value given by this loss, the coefficient (K) having different values according to the dryness quality of the cylinder walls and to the steam quality.

At this point, the considerable advantage of highly superheated steam and in addition the advantage of a sufficient degree of superheat in the low pressure cylinders of a compound, play an important part; so that losses due to the effects of wall action in these cylinders do not reduce appreciably the overall efficiency of the whole engine.

This also shows that in spite of the very high degree of superheat (steam temperature 400 deg.C. or 752 deg.F. for example) which one can use in a simple expansion engine working at 20 h.p.z. (290 p.s.i.), the effects of cylinder wall action can persist if the degree of expansion in the cylinders is sufficiently gréat, i.e. when using very short cut-offs, to cause the abundant formation of water droplets on the cylinder walls at the end of the exhaust phase.

Throttling losses. In a compound live steam is admitted to a cylinder 2 or 3 times smaller than the single cylinder of an equivalent simple expansion engine; it is obvious therefore that for the same overall expansion ratio, the cut-off point of steam admission to the h.p. cylinder of the compound will be 2 to 3 times greater than that in a single cylinder of an equivalent simple expansion locomotive. With regard to the l.p. cylinder, which must receive the volume of steam in the h.p. cylinder, the minimum desirable admission rate (cut-off) corresponds exactly to the volume ratio between the low and high pressure cylinders namely ½ to ⅓ according to the locomotive design concerned.

The average port opening with any system of steam distribution being large when the point of admission (cut-off) is high, one sees that as a result the compound system reduces considerably the importance of throttling losses through the ports compared with what they would be in the equivalent simple expansion engine — the reduction being approximately 50 per cent in the high pressure cylinder with steam port openings of equal cross-sectional areas.

Cylinder clearance volumes — it is known that the undesirable effects on cylinder efficiency of clearance volumes (dead spaces) is counteracted by the use of compression, involving the forcing back into those spaces part of the steam remaining in the cylinder at the moment of exhaust opening. One may thus reduce, by as much as required, the *quantity of steam to be taken from the boiler to fill the clearance spaces at each piston stroke.*

Thermodynamically, compression is thus able to counteract completely the undesirable influence of cylinder clearance volumes. The steam compressed in these spaces expanding during the next stroke of the piston, thus acting similarly to a spring compressing and expanding alternately. The heat produced at the expense of work done during compression is then fully transformed into work during the following expansion phase, if the valve events are rapid enough to permit adiabatic expansion.

This is valid for a machine in which expansion is continued right down to the exhaust pressure. In the actual locomotive where, the cylinder dimensions are limited due to the restricted loading gauge, expansion of steam is always more or less truncated, one must not allow compression pressure to rise to the admission pressure, but must cease compression at a certain point which is an exact function of reducing the point of admission (cut-off). This is shown by fig. 20, from which one deduces that the best degree of compression from a thermodynamic point of view, is that when the horizontal line at the end of the compression phase, cuts from the top of the diagram an area equal to that which is truncated by expansion.

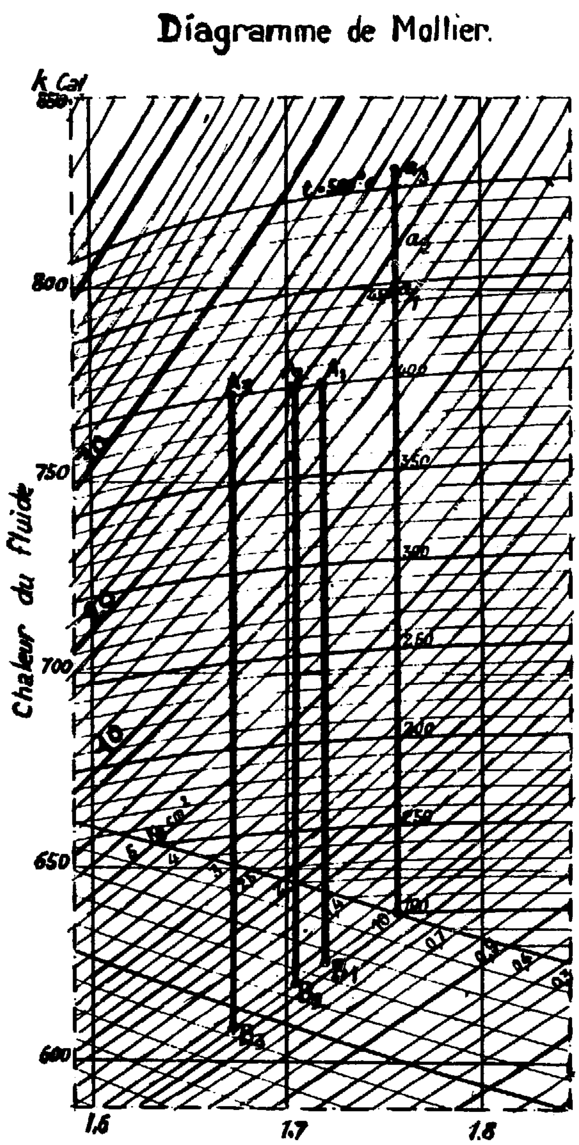


Fig. 18

Entropy diagram for perfect Rankine cycle engine with high superheat, showing high humidity to exhaust.

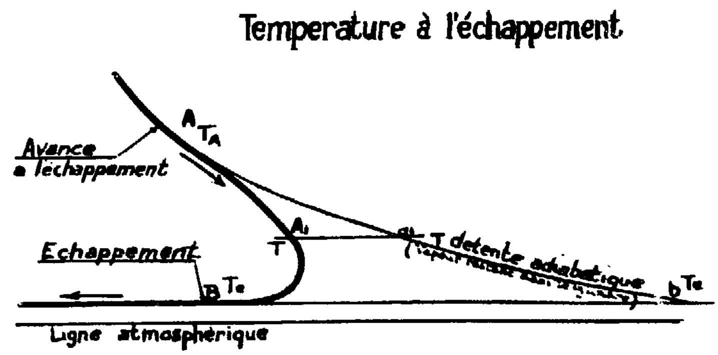
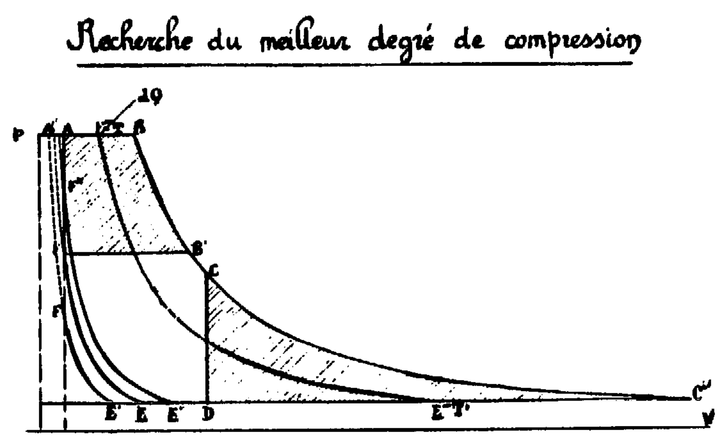


Fig. 19

Steam temperature during exhaust stroke.

Below — showing the best degree of compression.

Fig. 20



AIR POLLUTION DIGEST

STEAM VEHICLES USE UNLEADED FUEL

"The departments of Health, Environment and Transport accept that there is an almost unshakeable case that lead in petrol is endangering children . . . Study after study in the 1970s suggested that children were suffering from brain damage, which impaired their intelligence, from relatively low levels of lead . . . Research in Birmingham suggests this might mean that 95 per cent of Britain's city children could be affected to some extent . . . What is at stake is the health and happiness of almost every child living in a British city. As a civil servant said: 'It's about your child and mine!'. . . Dr Herbert Needleman, a thoughtful, heavily-built American physician at the Children's Hospital in Boston (England) . . . measured lead in teeth from over 2,000 children. His conclusions were startling. He found that the children with the highest level of lead in their teeth had lower IQs than those who were least contaminated. The effect of this is to double the number of mentally retarded children in the highest lead group. Even more shocking, those most contaminated children had lead levels much lower than earlier studies had suggested were harmful — levels common among urban children. Dr Needleman went even further. He collected teachers' assessments for all the 2000 children. These assessments set beside results of chemical tests clearly indicated that the children's abilities progressively fell with the amount of lead in their bodies, so that all children, except those with the very lowest levels, were harmed in some way.

Only a year ago a Government working party of 12 experts reported, after a 16 month study, that, in effect, there was little to worry about. But now the Chairman, Professor Patrick Lawther, is himself urging an "early and substantial reduction in lead in petrol", and the oil and lead industries are resigned to it . . . Now, two members of Professor Lawther's working party have themselves done a pilot study, which broadly confirms Needleman's results. It has yet to be published, but it has already caused consternation in Whitehall. Dr William Yule, of the Institute of Phsychiatry at London University, and Dr Roger Lansdown, of the Hospital for Sick Children, London, studied 166 children aged between six and twelve in Greenwich. They had even lower lead levels than the children studied by Dr Needleman — which makes the confirmation of his findings on brain damage all the more alarming.

The Lawther report acknowledged that 90 per cent of lead pollution in the air did indeed come from the 7,000 tons puffed out by car exhausts each year. At the same time, it asserted that air pollution was 'only a minor contributor' to the lead absorbed by most people. It concluded that we get most of the lead in our bodies from food. The conservationists agree, but they say that 80 to 90 per cent of the lead in crops comes from fall-out in the air. They add that the Lawther report also virtually ignored the effects of lead in city dust, much of which also comes from petrol (gasoline).

A recent study by the Greater London Council showed that 25 out of 28 schools examined near main roads had levels of lead in their playground dust up to eight times the E.E.C. (European Economic Community) danger level, last week the Inner London Education Authority called on the Government to reduce lead in petrol substantially and speedily . . . The Government can ban or heavily cut the lead content of petrol to avoid damaging the brains of hundreds of thousands, possibly millions of children or it can decide on a token cut . . . The oil industry could introduce lead free petrol almost overnight . . . It could, for instance, order that all new cars be designed for lead-free, two-star petrol by 1985 — no great hardship, because the motor industry already produces such cars for export to the United States, where nearly half the cars are using lead-free petrol, Japan and Australia are also moving in this direction. The cost to the average British motorist would be about £50 per year.

Everyone agrees that lead is extremely poisonous. Pliny warned of the dangers of breathing lead fumes nearly 2000 years before the internal combustion engine, but curiously, he advised that wine should be stored in lead vats. Too many Romans may have taken his advice, for Roman skeletons often contain high levels of lead. Some scholars have seriously suggested that the Roman Empire declined and fell because the effects of lead poisoning sapped the abilities of its people. Meticulous research shows that we have about 500 times as much lead in our bodies as our primitive ancestors . . . Children are particularly vulnerable to the poison partly because their brains are still growing and partly because they absorb it at least six times as easily as adults." — "The Observer", Sunday 12th April 1981, London.

"In the past 15 years the number of cars in Tehran, Iran, has swelled from 100,000 to more than one million. Packed into the narrow streets like flocks of sheep, they make travelling a misery and pollute the air up to 20 times the permitted levels. City officials calculate the losses, including accidents, at a staggering three billion rials (£12 million) a day. With a population half the size of New York City, Tehran has three times the number of traffic accidents." — "South Wales Echo", 23rd February 1980, Cardiff.

BOOK REVIEW

"GUIDE TO THE RAILWAYS OF BRITAIN" by E. Jones, 377 pages, 7¾ in. by 5 in., 41 photographs, 33 line drawings, paperback. Price £3.55 ($8.50 U.S.A.) post paid. Published by Penguin Books, Harmondsworth, Middlesex, England.

The development of railways in Britain is a fascinating subject, ably traced in this book from the first lines to use mechanical power to the 140-150 mph. Advanced Passenger Train of today. The design of steam locomotives, carriages, wagons, rails, signalling and railway civil engineering is briefly traced, followed by sections describing railways in the London area, Western, Southern, Eastern, Midlands, Wales, North West, North East and Scotland. The last chapter confirms how railways have greatly altered and improved the lives of people and predicts continuous advance as British Rail enters "a new Golden Age". Pleasant reading in the train — road transport is too bumpy for such a pastime — and useful reference is provided at rock-bottom price. An appendix gives the locomotive and carriage liveries of 28 pre-grouping (before 1923) and of the G.W., L.M.S., L.N.E.R. and S.R. systems (after 1923).

"HOW TO DRIVE A STEAM LOCOMOTIVE" by B. Hollingsworth, 152 pages, 9½ in. by 7 in., 118 photographs, 38 line drawings, paperback. Price £3.35. ($8 USA) post paid. Published by Penguin Books, Harmondsworth, Middlesex, England.

This book fills a gap. It is not until an intelligent mother asks for a book which will show her young son how a railway engine works that the scarcity of such a publication becomes apparent. There used to be many not so long ago. Now, although pictorial books with many excellent photos abound, this may be the only book in print describing the steam locomotive's technicalities in non-technical language. And it is a good one at an amazingly low price.

Attempting to simulate viewing through the eyes of the unknowledgeable in locomotive matters, has led to the conclusion that the clear, straightforward, non technical words will explain how a steam locomotive moves, without conscious effort and thereby add greatly to the enjoyment of these "iron steeds" wherever encountered. True there is the occasional minor inaccuracy — Great Western Railway enthusiasts will quarrel with the assumption that Churchward's "Saints" were of "typically American design" — but these do not detract from the author's success in conveying steam engineering knowledge easily. Though a factual description, this book can be read as a novel; You'll want to read the next page and the next and the next . . .

(Also available from "Steam Power")

"NATURAL ENERGY AND LIVING". 60 pages, 8¼ in. by 5⅝ in. Price 85p. ($2.50 USA) post paid. Published by The Natural Energy Association, 2 York Street, London W.1, England.

The use of appropriate or alternative energy and energy conservation receives more and more attention from more and more people as the cost of so-called 'conventional' fuels (oil, gas, coal) continues to increase. This magazine gives information varying from a backyard power station, a small holding, to energy conscious factories, large self-sufficient farms and new fuels for road vehicles. All this and more at very modest cost.

"250 YEARS OF STEAM" by Alan Bloom. 208 pages, 10¼ in. by 8¾ in., 19 colour photos, 95 black and white photos, 50 drawings. Price £11.50 ($26.50 USA) post paid. Published by World's Work Limited, The Windmill Press, Kingswood, Tadworth, Surrey, England.

Alan Bloom has considerable practical experience of working steam engines. He is the well known founder and creator of the extensive Bressingham Steam Museum, near Diss, Norfolk. As the book's title indicates, steam power in many forms is traced from the beginnings to quite recent times. Early pumping engines by Savery, Newcomen, Watt and the Cornish engineers, blowing, winding, portable mill, early turbines, high speed vertical, marine and of course locomotive, traction and roller engines are all given necessarily cursory description, as are steam lorries, cars and steamships from the 56 ft. "Charlotte Dundas" to the colossal "Queen Mary" and "Queen Elizabeth" passenger liners. Ploughing engines, and a digger are included, also a steam hammer, navvy and lawn mowing machine. Curiously there is no picture of the once numerous steam cranes.

The inevitable brevity of this book, which is in very readable language, creates a complete mental picture of steam power in its many forms all "in one go". In a work of this nature some inaccuracies are inevitable — readers will particularly regret seeing the Doble-Sentinel steam lorry described as a Foden! It is well produced with excellent illustrations, all at a modest price. Undoubtedly, well worth a place on the bookshelf.

(Also available from "Steam Power")

"AN INTRODUCTION TO HEAT PUMPS" by J.A. Sumner, 64 pages, 8½ in. by 5¼ in., 4 line drawings, paperback. Price £2.75 ($6.50 USA) post paid. Published by Prism Press, Stable Court, Chalmington, Dorchester, Dorset, England.

Why describe heat pumps in this magazine? Not obvious at first but the reason will be clear. A heat pump can be combined with steam power to cut the cost of heating, lighting and cooking down to 1/20th. In a 3-bedroomed house it could mean a saving of about £260 a year. This booklet is written by a man who has used a heat pump of his own design since 1960. In his words "since then it has been in continuous use and has provided enormous savings in fuel and money".

What is a heat pump? How does it work? What does it save in fuel and money? Where can I get one? These questions are answered. No attempt has been made to explain technical details or advanced theory, which have enabled a heat pump design to give out 3 times the heat needed to generate the power to drive it. Such machines genuinely give something for nothing. Only a general knowledge of physics is needed to understand this book, which as the title indicates, forms an excellent introduction to the working of these uncomplicated machines, which are only just appearing for the very large potential domestic market.

(Also available from "Steam Power")

"FOCUS ON SOUTH AFRICAN STEAM" by R. Siviter, 108 pages, 9½ in. by 6¼ in., 94 photos, 10 maps. Price £6.85 ($16 USA) post paid. Published by David and Charles, Newton Abbot, Devon, England.

Distinguished by excellent scenic photographs of 14 classes of steam locomotives working on the 3 ft. 6 in. and 2 ft. gauge lines of South African Railways, this book is of special value to visitors to South Africa. Sketch maps show "steam" locations at a glance, with brief descriptions indicating what engines may be seen where. Descriptions of each class of locomotive are supplemented by a table showing principal dimensions of all classes in service during 1980.

(Also available from "Steam Power")

"BRITISH LOCOMOTIVES 1894" by C.J. Bowen Cooke, 381 pages, 7¼ in. by 4¾ in., 37 photographs, 137 drawings. Price £8.20 ($19.70 USA) post paid. Published by Gresham Books, The Gresham Press, Old Woking, Surrey, England.

This facsimile reprint of a classic work is of historical and present day interest, since it gives much practical engineering information of use to designers. The author became apprenticed to the London and North Western Railway in 1875 eventually becoming the Company's chief mechanical engineer in 1909. In his early thirties he wrote this book when an assistant to F.W. Webb, the then C.M.E Steam locomotion is traced from Cugnot's 3 wheeled road tractor of 1771, through Trevithick's, Murray's, Blenkinsop's, Hedley's, Stephenson's and Hackworth's early designs, the early steam carriages, G.W. broad gauge engines and many others up to the compound locomotives of the 1890s. There are details of valve gears, boiler construction, brakes locomotive erecting and many other details with practical data on coal consumption. Chapters describe the duties of engine drivers and firemen. This book will be referred to again and again.

(Also available from "Steam Power")

"DOMESTIC HEAT PUMPS" by J.A. Sumner, 117 pages, 9¾ in. by 7½ in., 11 photographs, 31 drawings, paperback. Price £5.50 ($13 USA) post paid. Published by Prism Press, Stable Court, Chalmington, Dorchester, Dorset, England.

The author, who is Britain's foremost authority on the heat pump has used his thirty years of practical experience in recording the practical information contained in this book, which shows how to approach the impossible very closely. It publishes data and design details for the construction of efficient heat pumps, using air or vapour compression cycles with earth, air or water as the sources of heat at the lower temperature (low grade heat). Here is all the information for the design and construction of a heat pump for a house, with photos of the author's own heat pumps, one of which has been in use for more than 25 years.

It is stated a large practical heat pump can give out 3½ times the energy needed to drive it. Very nearly attained is the "something for nothing" so beloved of soap box orators and fictional demagogues. The potential saving of fuel resources and, of course, hard earned money is colossal.

(Also available from "Steam Power")

"THE COUNTRY RAILWAY" by D. St. John Thomas, 192 pages, 8¼ in. by 5¾ in., 94 photographs, 33 drawings, paperback. Price £1.85 ($4.50 USA) post paid. Published by Penguin Books, Harmondsworth, Middlesex, England.

Though giving very little technical information on steam power, this book gives a rare insight into the impact the steam locomotive made on country life, and into the lives of railway staff and other village personalities. Some of the photos are ancient and no doubt very rare. At the very modest price, who can resist a copy — it can always be kept carefully for pristine presentation to a colleague at an opportune moment. Who knows, the wife or girl friend may well find the tale absorbing.

Although, as this book confirms, the country railway very nearly always opened new markets for farm produce and attracted additional business and work to the areas it served, its operation rarely made a profit commensurate with the capital involved in its construction. Partial explanation is provided by the unnecessarily heavy expenditure on stations and other equipment in the expectation of greater traffic than should reasonably have been anticipated. However, the very competitive rates charged, especially for goods (freight) should have allowed profitable operation of well managed lines. Were these railways, even when retaining almost a monopoly of traffic really run for philanthropic reasons, were they in fact too sleepy to attract enough profitable traffic, or were they financed largely by business long established in the area, which expected uneconomical rates?

CORRESPONDENCE

FROM OIL TO COAL IN AUSTRALIA

I have been experimenting for forty years or more. "Steam" is my absorbing hobby. My steam car steam generator has been modified to burn used engine lubricating oil. It is successful. Starting up from cold is by light oil until the combustion chamber is well heated before changing to the sump oil. Coal fired boilers are being installed in many Australian factories. Our local meatworks uses two oil fired boilers and a fairly new coal fired boiler burning local coal at $A38 a ton, which compares with heavy fuel oil at $A138 a ton.

Mareeba G.J. BAKER
Australia

THE JOURNAL APPRECIATED

I have pleasure in telling you that my copy of Vol. XXVIII No. 3 and 4 finally arrived after a 3½ month trip! It must have been quicker in the days of sail! I find the new format very adequate. Personally I prefer the larger size and the quality of the photos remain high. Congratulations on still being able to publish such an excellent magazine on a "shoestring" budget.

Quaama, N.S.W. D. WOOD
Australia

A GOOD STEAM CENTRE

I am very thankful you took so much of your time to discuss with me about steam power when I visited you 1½ months ago. I am still very impressed by your unique exhibition. This very positive impression I have also brought forward to my steam minded friends.

I liked the book "Undertype Steam Road Wagon" by M.A. Kelly, which you sent me, very much. It describes a lot of interest to me. Especially the very good cut-through drawings.

Sweden P. LAUBERTS

THE OLDEST IN THE WORLD

The Southern Pacific Railroad's No. 1, "C.P. Huntington", has been rebuilt with a new boiler, and is now the oldest working steam locomotive in the world. With two rebuilt passenger cars (carriages) it is owned by the State of California, which operates one of the largest collections of old railroad engines and cars. The new R.R. Museum is near the S.P. repair workshops in Sacramento. Installed is S.P.'s last Cab-in-front articulated locomotive.

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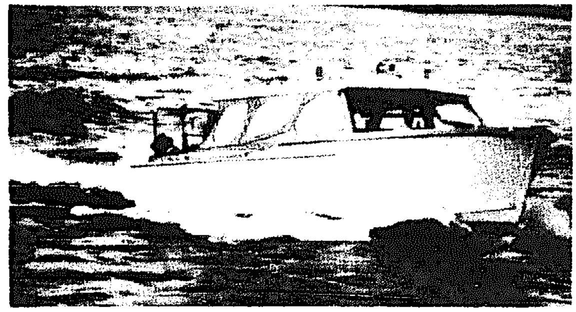

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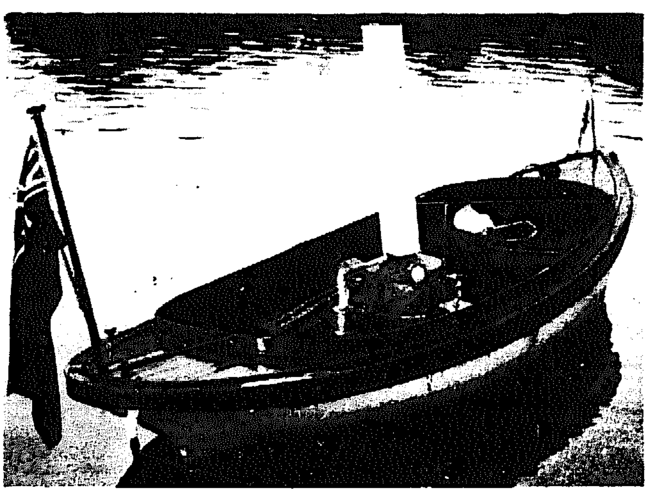

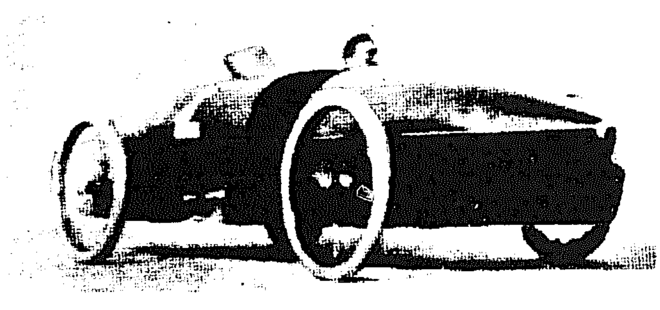

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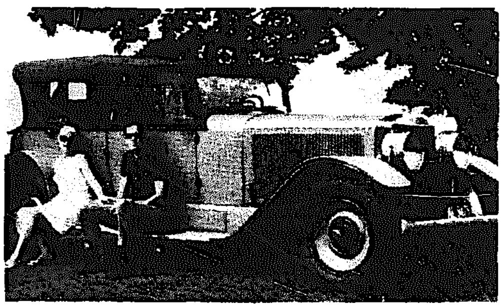

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