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THE EAST GERMAN LOWA STEAM-DRIVEN PRIME MOVER DW 65

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Steam-driven road vehicles became important in Germany during and after World War II because of the serious fuel situation.

The VVB LOWA Federation of People-Owned Enterprises for Locomotive and Railroad Car Construction began preliminary work on the construction of steam-driven prime movers in 1950. Although the plant failed to receive proper official support, construction of the first model was started in January 1951 at the Werdau plant. It was exhibited at the Leipzig Spring Fair of 1951, and attracted great attention.

Economy of Steam.

The basic fuel in Germany is coal, either as solid fuel or as the starting point for synthetic gasoline made by hydrogenation. In the latter case, only 7.5 percent of the thermal energy of the coal is converted into mechanical energy, while in the former case 9 percent can be utilized effectively. With the use of coal in generators, a 15 percent yield can be attained, but generators require much maintenance and are short-lived. In terms of economy, steam is superior, since it allows the use of the cheapest kinds of fuel, thus reducing the cost of production per hp/hr. The costs in terms of hp/hr, according to the prices in force in the German Democratic Republic at present, are as follows:

Type	Cost
Gasoline engine	26.6 (pfennig per hp/hr)
Diesel engine	12.1
Wood generator	6.5
Anthracite generator	4.2
Steam engine	3.24

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The economy of steam can also be seen from a tabulation of the fuel cost per 100 km of 65-hp engines:

Type	Cost (DM)
Gasoline engine	24.90
Diesel engine	12.85
Wood generator	8.10
Steam engine, coke	6.12
Steam engine, coal	4.64

Steam-driven road vehicles also have the advantage of long life and ease of operation. Below a certain minimum rpm, the internal-combustion engine develops no torque and requires a clutch and gears, so that a bus driver will have to shift several thousand times a day. In a steam-driven vehicle, this is unnecessary. Once the cutoff has been set, a throttle pedal does all the rest.

Construction (see appended illustration)

The boiler is arranged in an upright position behind the cab. The fuel container, with a capacity of about 750 kg, is located to the right above the boiler. The condensation equipment is at the rear of the entire unit.

The two-cylinder steam engine with flanged-on transmission is located on the left side behind the front axle, underneath the frame. Two boiler feed pumps are arranged on the opposite side, also underneath the frame. One water tank each is located above and below the condenser. The total water tank capacity is 785 liters. The driver's seat is located above the front axle and affords good visibility. All controls can be operated from the cab. Only one operator is required.

1. Details of the Boiler

Double-drum water-tube boiler has a superheater and flue-gas preheater. The larger top drum is connected by boiler tubes with the smaller lower drum, leaving space between the two drums for the superheater coil. The firebox is surrounded by tubes, with space for the door in the right lateral wall. A manifold in which the boiler tubes converge runs around the door. Fuel feed is from above, with the fuel sliding down automatically onto the fire bed. An exhaust-steam blower located underneath this slide supplies the primary combustion air. Better combustion is obtained by means of nozzles located in the upper part of the boiler between the tubes. These nozzles blow in secondary air. The fire bed has no grate and is cooled by water tubing located underneath it. Fuel supply is continuous. Combustion is controlled by a throttle for the combustion air, operated from the cab.

The operator can observe the water level on the indicator directly, by means of a rear-view mirror in the cab which is directed at a window in the rear wall of the cab. The two duplex steam feed pumps can also be operated from the cab. The pump strokes are shown by telltale lamps on the dashboard.

2. The Double-acting Steam Engine

The 65 hp engine has two cylinders and is located underneath the frame. The crankshaft is lubricated by pressure, immersion, and splash lubrication. The engine is valve-controlled, the disk valves operating on rods from a

camshaft driven by the crankshaft over a worm gear. The camshaft can be moved to put different cams into operation for changing the cutoff and the direction of rotation. The compressor and the electric generator are driven by the camshaft over a V-belt. The cylinders are lubricated by superheated-steam cylinder oil supplied by a high-pressure oil pump.

Power from the engine is transmitted to the rear axle over a single-stage gear and a cardan shaft. In difficult terrain and with heavy loads, a 1.56:1 gear ratio can be selected by means of an overriding clutch.

3. The Condenser

The exhaust steam of the engine is condensed in two tube condensers cooled by a fan. The fan is driven by an exhaust-steam turbine. Greater load resistance requires greater steam consumption, so that the output of the exhaust-steam turbine will be higher, and the output of the fan, of the combustion-air blower, and thus also of the boiler, will adapt themselves to the engine load. Bleeding of fresh steam into the turbine can be used to provide an additional boost in its output. An apparatus for removing oil from the exhaust steam is located behind the turbine, and the lower water tank is fitted with oil traps.

4. The Chassis

The chassis is welded of pressed steel. A hydraulic brake is provided for the prime mover, and an air brake for the trailers. There is also a manual parking brake.

Prospects

The steam-driven prime mover is undoubtedly an economical vehicle. Improvement of the steam engine and design of engines of higher output will enable it to contribute to the improvement of local trucking and especially of heavy trucking operations. The steam-driven prime mover of 120 hp which has been planned will be the suitable tractor for heavy trailers. The steam-driven prime movers should make a valuable export item.

Technical Specifications

Steam Engine

Type	two-cylinder, double-acting, with cross-head, opposed action
Steam intake pressure	24 atm (gauge)
Steam temp	325°C
Permanent eff output	65 hp
Max output	70 hp
Rated rpm	800
Bore	115 mm
Stroke	150 mm
Cylinder displacement	2,685 l

Total displacement	5.370
Number of cutoff positions	4 forward, 1 reverse
Lubrication	Splash oil for crosshead track, pressure lubrication for other components

Consumption Figures

Steam	8.5 kg per hp/hr (approx)
Lubrication oil	3.6 g per hp/hr (approx)
Superheated-steam cyl oil	2.5-5 g per hp/hr (approx)

Steam Generator

Type	two-drum water tube boiler
Operating pressure	25 atm (gauge)
Steam output	600 kg/hr
Superheated to	325° C
Combustion	semi-producer type, grateless
Fuel consumption (coke)	150-200 kg/100 km
Bunker capacity	approx 750 kg
Range with filled bunker	approx 300-400 km
Boiler feed	2 duplex feed pumps, operating pressure on intake side 30 atm (gauge), max output 45 l/min (Weise and Monski)
Control	manual

Draft

Type	forced-draft blower
Capacity	1200-1500 cu m/hr
Pressure	70 mm water column
Exhaust-steam turbine	2,800-3,500 rpm
Power consumption	0.7-0.85 hp

Condenser

Type	tube condenser
Frontal area of double unit	74 sq dm (approx)
Cooling area of double unit	70 sq dm (approx)

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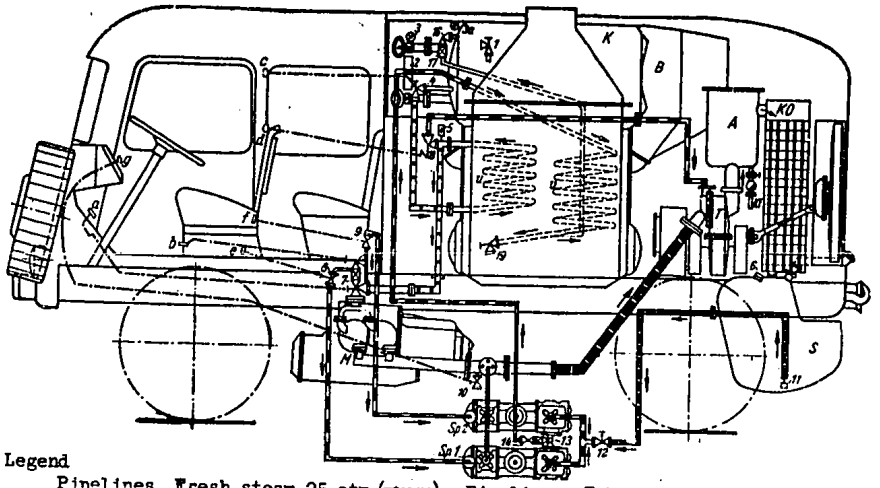
Depth of unit	200 mm
Exhaust steam	500 kg/hr (approx)
State of steam	1.1-1.5 atm abs, 108°C
Thermal load	265,000 kcal/hr
Cooling	axial blower
Capacity	17,000 cu m/hr (approx)
Static pressure	40-mm water column
Rpm	1,250-1,550
Power consumption	4-5 hp

Vehicle

Speed on level ground	35 km/hr
Pull on drawbar	approx 520 kg at 30 km/hr (continuous) approx 2,300 kg at 5 km/hr (upgrade) approx 4,000 kg (max pull during starting)
Max trailer wt on level ground	approx 20 tons at 25-30 km/hr
Operating wt	approx 8 tons

[Appended figure follows.]



Legend

Pipelines Fresh steam, 25 atm (gauge)
- main line
- steam pumps
- turbo blower

Pipelines Exhaust steam 0.5 atm (gauge)
- main line
- steam pumps
- water-feed suction line
- water-feed pressure line

Fittings:

1. Safety valve
2. Water level gauge
3. Remote-indication pressure gauge
3a. Boiler pressure gauge
4. Fresh-steam main and safety valve
5. Remote-indication thermometer for fresh steam of 350°C
6. Remote-indication thermometer for condensate of 120°C
7. Throttle and cross-over valve
8. Cutoff valve for feed pump 1
9. Cutoff valve for feed pump 2
10. Condensate drain and excess pressure valve, 2.5 atm (gauge)
11. Strainer
12. Cutoff valve
13. Three-way valve
14. Cutoff and check valve
/no No 15 listed/
16. Cutoff valve
17. Check valve
18. Excess pressure and turbine starter valve
19. Valve for draining water from preheater

Steam generator:

M - engine
V - water-feed preheater
U - superheater

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K - boiler
T - exhaust-steam turbo blower
A - exhaust-steam oil remover
Kt - condenser trap
Ko - condenser
Sp1 - water-feed pump 1
Sp2 - water-feed pump 2
S - water-feed tank
B - fuel bunker

Controls:

a - for throttle
b - for cross-over valve
c - for safety valve
d - for turbine starter valve
e - for cutoff valve of water-feed pump 1
f - for cutoff valve of water-feed pump 2
g - for condensation drain valve

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