Doble

Steam Car

F.30

1982

Hand book

PHYSICAL DESCRIPTION

To start, first open the left side of the hood. The main object filling the space under the hood is of course the steam generator, or boiler as it may be called. This unit is a mono tube, flash type, high pressure steam generator, capable of evaporating over 3000 lbs. of water an hour, or approximately 100 horse power. Its operating pressure is 1300 psi and the steam outlet temperature is 800°F. It is made up of a stack of spiral wound pancake coils of tubing connected in series and enlarging in outside diameter from 1/2" in the economizer zone, 5/8" o. d. in the evaporator zone, 3/4" o. d. in the saturated zone and helical coil surrounding the firebox and combustion chamber and 1"o. d. in the superheater coil and outlet.

1300 PSI
800°F

The steam generator is top fired by a Besler air atomizing burner using Diesel or furnace oil. The flame and hot flue gas is forced down through the coil stack by the combustion air blower, and is discharged through the flue opening at the bottom of the boiler case. The feed water is piped to the bottom coil of the stack and works its way up through the pancake coils, picking up heat from the combustion gas, turning into steam as it gets closer to the fire. This steam is then superheated in the top coil and passes through the thermostat where its temperature is measured and where the boiler is controlled; then out to the scale trap. The steam generator is air jacketed in the area of the firebox and top cover for cooler running under the hood, and the rest of the unit is heavily insulated for heat retention.

FLUID ? LOOPS ?

WATER PUMPED TO BOILER UP LH SIDE OF CHASSIS

STEAM TO ENGINE DOWN CENTER

EXHAUST STEAM UP RH SIDE TO CONDENSER H2O BACK TO TANK DOWN CENTER?

The scale trap is a small cylinder jacketed in bright metal directly behind the steam generator and connected to it by the steam outlet pipe. In the steam outlet pipe is also the outlet steam thermocouple which drives the outlet temperature gage on the dash. Coming out of the top of the scale trap is the insulated steam pipe leading up and then making a U-bend to the throttle valve. Directly below the throttle valve is the valve actuator connected to the pedal linkage.

OUTLET TEMP BEFORE THROTTLE VALVE MEASURED HERE

From the throttle valve the steam line leads back through the sinuous, insulated line to the ball joint at the front end of the engine.

The engine is a four cylinder double acting compound, with two high pressure and two low pressure cylinders. There are two valves which distribute the steam to each pair of high and low pressure cylinders. The valve gear is of the Stephenson link type and the crankshaft is arranged so that the engine is able to start rotation in either direction at any crankshaft position. The crankshaft is directly geared to the ring gear of the somewhat limited slip differential, from there to the axles and the wheels. There is no transmission and the engine runs any time the wheels are turning. For this reason, the car should NEVER be towed for any long distance with the rear wheels turning. The pistons and valves receive

their lubrication with the steam that runs them and when there is no steam passing through the engine no lubrication is supplied and extreme damage can be done to the pistons, valves and cylinders.

Driven by belts from the end of the crankshaft is the electric generator, mounted under the engine, and the boiler feedpump drive jackshaft mounted just forward of the engine. This jackshaft is directly connected to the boiler feedwater pump, located on the left side of the chassis just forward of the engine. The feedwater pump is of the triplex plunger type and is capable of supplying the boiler with all the water needed whenever the car is in motion.

Just ahead of the feedpump is the cylinder oil lubricator. This is driven by a reciprocating arm which is crank driven from a pair of speed reduction pulleys, belt driven from the pump jackshaft. The lubricator pump delivers metered amounts of steam cylinder oil into the steam line to provide lubrication to the pistons and valves. Belt driven off the right end of the feedpump jackshaft is the condenser vacuum pump.

The exhaust steam from the engine is taken through a flexible pipe fitted with two ball joints to an exhaust pipe leading forward to the draft booster unit. This unit is located under the right front floor and toe boards, and consists of the combustion air blower, exhaust steam turbine and an electric drive motor, running on a common shaft. On the rear of the drive motor is a set of breaker points to interrupt the current to the ignition coil which provides spark to the ignition electrodes of the burner. Belt driven from this common shaft, and on a frame next to the draft booster unit, is a small air compressor which provides air to atomize the fuel at the burner nozzle. Driven from the air compressor shaft is the larger fuel return pump which returns any bypassed or returned fuel to the fuel tank. Belt driven from the return pump shaft is the smaller main fuel supply pump. This pump supplies fuel pressure to the burner as determined by the rotating speed of the draft booster common shaft and the setting of the dashboard fuel bypass valve. The relative speed of this pump in relation to the speed of the common shaft driving the combustion air blower is what sets up the air-fuel ratio of the fire, and is fine tuned by the dashboard fuel bypass valve.

The turbo-draft booster then works much like a turbo-supercharger on an internal combustion engine. The more exhaust steam passing through the draft booster turbine, the faster the air blower, air compressor and fuel pump run, causing a much larger and more intense fire in the firebox, keeping the steam pressure up to working pressure regardless of the demand on the boiler by the throttle setting. When little or no exhaust steam is passing through the draft booster turbine, the electric

their lubrication with the steam that runs them and when there is no steam passing through the engine no lubrication is supplied and extreme damage can be done to the pistons, valves and cylinders.

Driven by belts from the end of the crankshaft is the electric generator, mounted under the engine, and the boiler feedpump drive jackshaft mounted just forward of the engine. This jackshaft is directly connected to the boiler feedwater pump, located on the left side of the chassis just forward of the engine. The feedwater pump is of the triplex plunger type and is capable of supplying the boiler with all the water needed whenever the car is in motion.

Just ahead of the feedpump is the cylinder oil lubricator. This is driven by a reciprocating arm which is crank driven from a pair of speed reduction pulleys, belt driven from the pump jackshaft. The lubricator pump delivers metered amounts of steam cylinder oil into the steam line to provide lubrication to the pistons and valves. Belt driven off the right end of the feedpump jackshaft is the condenser vacuum pump.

The exhaust steam from the engine is taken through a flexible pipe fitted with two ball joints to an exhaust pipe leading forward to the draft booster unit. This unit is located under the right front floor and toe boards, and consists of the combustion air blower, exhaust steam turbine and an electric drive motor, running on a common shaft. On the rear of the drive motor is a set of breaker points to interrupt the current to the ignition coil which provides spark to the ignition electrodes of the burner. Belt driven from this common shaft, and on a frame next to the draft booster unit, is a small air compressor which provides air to atomize the fuel at the burner nozzle. Driven from the air compressor shaft is the larger fuel return pump which returns any bypassed or returned fuel to the fuel tank. Belt driven from the return pump shaft is the smaller main fuel supply pump. This pump supplies fuel pressure to the burner as determined by the rotating speed of the draft booster common shaft and the setting of the dashboard fuel bypass valve. The relative speed of this pump in relation to the speed of the common shaft driving the combustion air blower is what sets up the air-fuel ratio of the fire, and is fine tuned by the dashboard fuel bypass valve.

The turbo-draft booster then works much like a turbo-supercharger on an internal combustion engine. The more exhaust steam passing through the draft booster turbine, the faster the air blower, air compressor and fuel pump run, causing a much larger and more intense fire in the firebox, keeping the steam pressure up to working pressure regardless of the demand on the boiler by the throttle setting. When little or no exhaust steam is passing through the draft booster turbine, the electric

motor drives the unit and the fire is at its lowest setting. Thus the draft booster will modulate the fire automatically to compensate for the steam load placed on the boiler. There is also a solenoid valve in the draft booster turbine which bypasses the exhaust steam around the turbine when the fire is off. This allows the unit to come to a stop and prevents the combustion air blower from forcing large amounts of relatively cold air into the firebox and cooling the boiler coils, thereby wasting fuel. Also, upon re-starting the fire, this will occur at a low speed of the draft booster unit and combustion of the fuel will be re-established before the unit returns to high speed and high fire conditions. A back fire or delayed ignition should be very rare when all the draft booster and burner components are in proper adjustment.

From the draft booster turbine the exhaust steam is taken forward to the inlet of the condenser fan turbine which is located just forward of the boiler. This turbine turns the fan which draws air through the condenser to cool the exhaust steam. From the fan turbine the exhaust steam goes into a feedwater heater. This unit is located on the right-front side of the boiler case just behind the fan turbine. The water delivered from the boiler feed pump goes into this heater, passing through a copper-finned tube coil surrounded by the exhaust steam. This allows some of the heat in the exhaust steam to be recaptured by the cooler feed water and returned to the boiler. From the feed water heater the exhaust steam flows past the condenser pressure relief valve which will vent to atmosphere any pressure in excess of 3 psi. From the relief valve the exhaust steam flows into the fan cooled condenser where most of it is condensed to water and returned to the water tank either by the condenser vacuum pump or the "Besler bypass" check valve.

From the water tank the feedwater is taken by the boiler feed pump. As this pump runs any time the engine is running, the water delivery to the boiler is controlled by bypassing the un-needed water back to the tank through two solenoid valves in parallel. These valves are located just forward of the feedwater pump and are controlled by the boiler thermostat. Also at this location is a gas filled pulse absorber to dampen the impulse of the pump strokes. The feedwater is then delivered to the feedwater heater, warmed bythe exhaust steam and from there delivered to the inlet check valve at the bottom of the steam generator case. This completes our tour of the steam circuit.

THIS DEVICE WAS NEVER FOUND

UNLESS SHOULD BE CLOSED AT ALL TIMES UNLESS HE NOT NEEDED

The priming pump, which is used to fill the boiler coils, is located under the right front splash apron just behind the right front fender. It consists of a 12 volt motor with a speed reduction output coupled to a 2 GPM Hypro pump. It takes suction from the water supply tank and delivers directly to the boiler inlet through a check valve.—

THIS IS INCORRECT — AUX F.W. PUMP DELIVERS H2O DIRECT TO BOILER INLET CHECK FOR CHECK VALVE IN CIRCUIT.

The water supply tank is located under the center of the car and the filler cap is just left of the steering gear box under the left side of the hood.

FUEL SYSTEM

The fuel tank is located between the rear frame horns, has a visual mechanical gage and an electric dash gage and is of approximately 20 gals. capacity. Fuel is taken from the tank to a "Twist-kleen" fuel filter and then to the main fuel pressure pump. Teeing off this line are connections to the fuel pressure gage, dashboard bypass valve, the pressure release solenoid and an external bypass valve, not used. Fuel returned from the hand bypass valve and the pressure release solenoid valve are led to the suction side of the fuel return pump and from there back to the fuel tank. The draft booster-blower and fuel system is activated only when the fire is on; otherwise it is at rest.

The burner head consists of a diaphragm controlled valve for fuel admission to the burner nozzle, air connections and passages for the atomizing air, and the nozzle mount body. Also on the nozzle mount body is a swirl center pressurizer, turbulator vanes and of course the air atomizing fuel spray nozzle. On the burner cover plate is the flame viewing window and the mounting for the ignitor electrodes. The burner relay and fuel pressure release solenoid are located just above the combustion air blower under the right side of the firewall.

ELECTRICAL SYSTEM

The generator is mounted under the center of the engine and is belt driven from the crankshaft. The voltage regulator is behind the front seat, accessible from the rumble seat or through the golf-club door at the right side of the body. The battery is between the front chassis frame horns, accessible through the door in the gravel shield just ahead of the condenser. The battery isolation solenoid is behind the battery box beneath the condenser. The ammeter shunt is mounted in the right frame rail under the front floorboard.

PRESSURE & TEMPERATURE CONTROL BOX

The boiler control box is mounted on the end of the thermostat at the right rear of the boiler shell. The controls have been set for nominal steam conditions of 1300 psi and 800°F at the boiler outlet, and these settings should NOT be changed. Increasing pressure involves a risk of crankshaft breakage, and increasing temperature will endanger the lubrication of pistons, rings and valves. Reducing either will lead to increased steam and fuel consumption.

THERMOSTAT STICKS INTO BOILER CASE
BOX MOUNTS ON THERMOSTAT

DRIVER'S CONTROLS and INSTRUMENTS

DASH INSTRUMENTS and CONTROLS

First, the dash instruments or gages alone will be considered and their functions explained. Then the same with the switches. See diagram on page nine.

From left to right; the first gage, mounted on the left side kick panel just under the dash, is the condenser vacuum/pressure gage. Normal range is from 5 to 10 inches of vacuum to 3 psi positive pressure.

Cylinder-oil lubricator pressure gage is at the top left of the inset dash panel. This gage shows the operation of the lubricator pump which supplies high temperature steam cylinder oil to the valves and cylinders of the engine. Due to the type of pump employed in the lubricator the gage will not show much fluctuation, usually ranging from just below 200 psi to about 225 psi. This gage will show more pressure during a long sustained climb, where there is a higher pressure in the steam line to the engine.

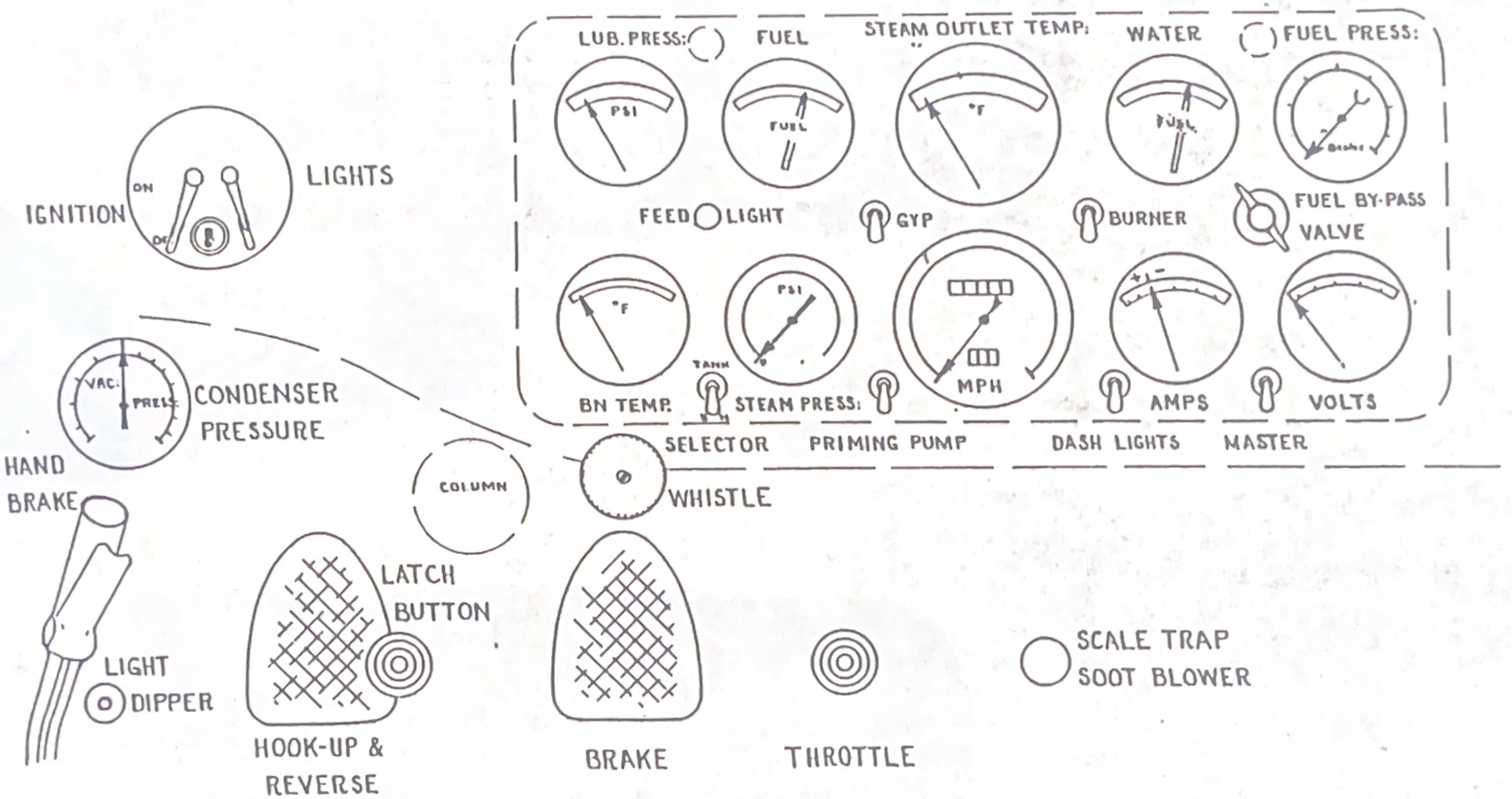
'BN' steam temperature gage is located at the bottom left end of the inset dash panel. This gage shows the temperature of the steam in the boiler circuit at the top outlet of the helical coil surrounding the firebox and combustion chamber of the boiler. This point is just "before the normalizer" jet spray of water into the steam, hence the 'BN' designation. This gage indicates the heat absorption through the main evaporation zone of the boiler coil stack. The temperature range of the 'BN' gage during normal operation will be from 575°F to 650°F.

'Feed-on light' - left side on horizontal center line of dash inset panel indicates that the feedwater pump and normalizer are "on" when the orange lamp is lighted.

Fuel tank gage - second from left, top of panel, indicates fuel level in tank. Tank capacity is approximately 20 gallons.

Steam pressure gage - second from left, bottom of panel, indicates the pressure in the boiler coils at the scale trap on the steam outlet. Normal working range is "burner off" at 1300 psi. and "burner on" at 1200 psi.

Steam outlet temperature gage - center of panel, top, indicates the temperature of the steam at the boiler outlet as delivered to the throttle valve. Normal temperature range is "feedwater pump/ normalizer on" at 800°F, and "off" at 750°F. When indicating an overheat, or excess steam temperature, the burner will be cut off at 900°F but the feedpump and normalizer will remain energized. When the steam temperature drops below 900°F the burner is re-energized again.



. . . from the driver's seat. . . .

DRIVER's CONTROLS and INSTRUMENTS

Speedometer - center bottom, functions as any automotive speedometer.

Water tank level gage - second from right, top, reads fuel on the dial face but indicates the level in the boiler feedwater supply tank. It is very important to recognise this gage and its function, - keeping the car supplied with water is of the utmost importance.

Ammeter - second from right, bottom, indicates charge or drain on the battery. High charging rate is from 25 to 30 amps. and as the battery becomes recharged the rate will drop back to 10 or 15 amps. It will take from 10 to 15 miles of driving to recharge the battery after a normal start.

Burner fuel pressure gage - top right, indicates fuel pressure as delivered to the burner nozzle. Normal range of this gage is from 25 to 30 psi at a cold start fireup to 80 or 90 psi with the draft booster at full speed.

Voltmeter - bottom right of panel, indicates the condition of the battery.

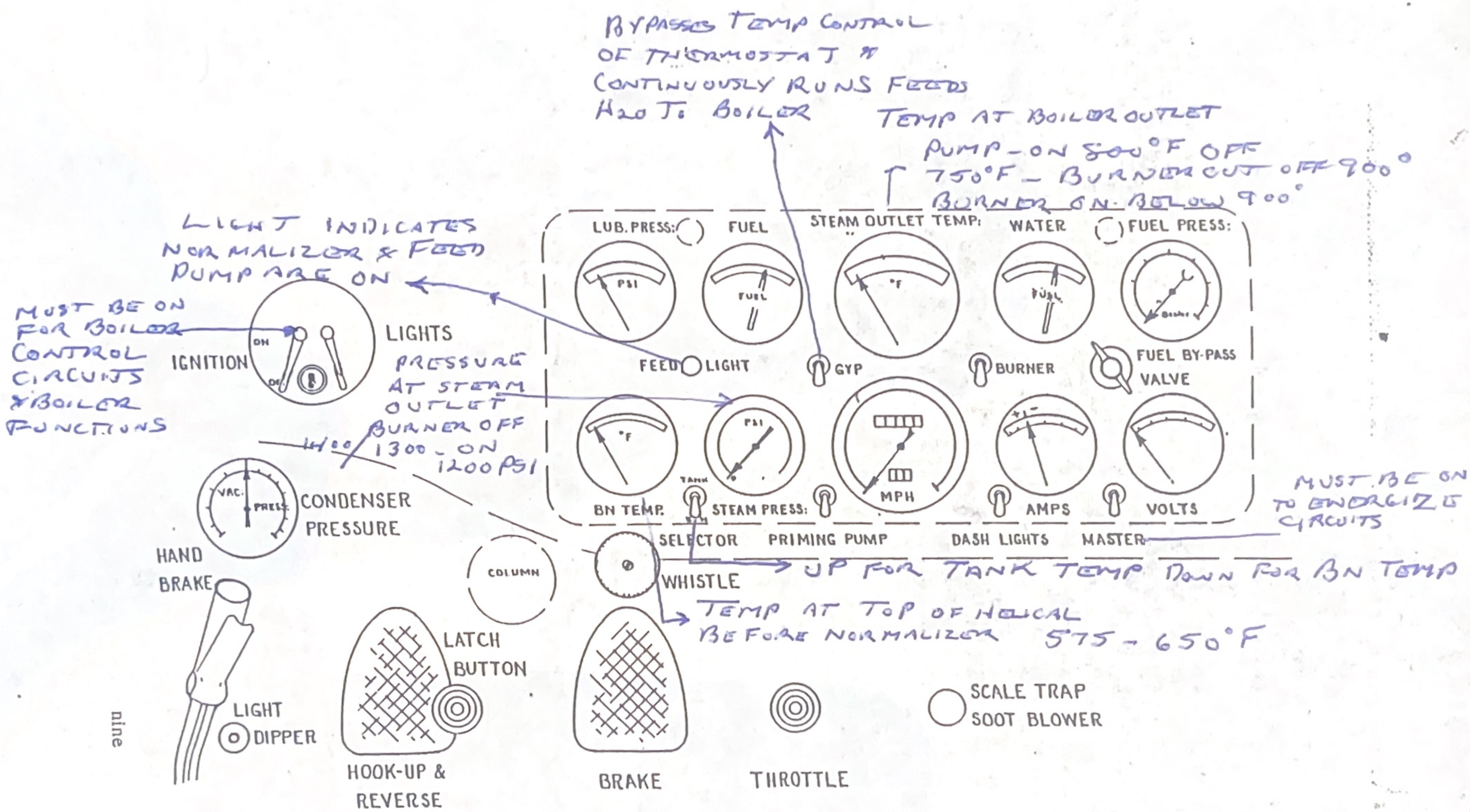
DASH SWITCHES AND CONTROLS

From left to right; the ignition switch is on round switch block on the left side of dash board. This switch energises the boiler control circuits and all boiler functions, however the burner has an additional separate switch which is in series with the ignition.

Light control switch - on round switch block with ignition switch. Controls head and tail lights in the usual manner.

Whistle valve handwheel - right side of steering column under dashboard. This valve controls the amount of steam supplied to the chime whistle and the sound intensity thereof. It may be used for opening a path through pedestrians, scaring cattle or dogs, unhorsing riders, exchanging signals with railroad engines, opening drawbridges or creating other forms of excitement. Discretion in use should be observed: don't sound it in front of the Police Station.

Temperature transfer switch - lower left side of inset gage panel. This spring switch in its normal "down" position transmits the 'BN' temperature to the dash gage. In the "up" position the switch connects the dash gage to the water tank thermocouple and will then show the temperature of the



. . . from the driver's seat. . . .

DRIVER's CONTROLS and INSTRUMENTS

water in the tank. Tank temperature should not exceed 185°F to 190°F. The switch must be held in "up" position against a spring and will return to the more important 'BN' temperature upon release.

Feedwater pump gyp switch - located top left side of speedometer. This switch, in series with the ignition switch, will bypass the temperature control of the thermostat and energise the feedwater pump-normalizer continuously while the switch is on, feeding water to the boiler as long as the car is in motion and water remains in the tank.

Priming pump switch - located bottom left side of speedometer. This switch energises the solenoid that transmits battery power to the priming pump motor. This pump will take water from the tank and force it directly into the boiler coils. It should not be used when boiler pressure is in excess of 1000 psi.

Burner switch - located top right side of speedometer. This switch, in series with the ignition switch and the boiler pressure control points, can start or stop the burner any time the steam pressure is below 1300 psi, the cut off point, but cannot override the pressure control to start the burner if the pressure is over 1300 psi.

Dash light switch - located bottom left side of speedometer, controls the two dash lamps in the usual manner.

Burner fuel bypass valve - located top right side of the ammeter. This valve controls the amount of fuel bypassed from the pressure side of the fuel pump and returned to the fuel tank. It provi des a fine adjustment of the air-fuel ratio of the burner. More fuel is sent to the burner by closing the valve, turning the top of the valve handle to the right, and less fuel to the burner by opening the valve, top of the valve handle to the left. Adjustment of this valve will be reflected in the indication of the fuel pressure gage in the top right hand corner of the dash panel.

Master battery switch - located bottom right side of ammeter. This switch controls a solenoid that energises the entire electrical system of the car and is left in the off position except when the car is in operation.

Horn - in the center of the steering wheel is a conventional horn button. The chime whistle is more expensive to operate and much more fun.

FLOORBOARD AND FOOT OPERATED CONTROLS

From left to right; The emergency brake - far left. This lever controls the brake shoes on the rear wheels in the usual manner but also controls a bypass valve on a steam line running from the main steam line to the engine to a separate nozzle in the draft booster turbine. Thus, when the handbrake is set, the valve is opened and will bypass steam coming from the throttle valve around the engine and into the exhaust steam system. When the handbrake is released, the valve is closed and all the steam from the throttle valve is directed to the engine.

Headlight dimmer switch - located just forward of the handbrake and is operated in the usual manner when the lights are on.

Reverse and hookup pedal - located on the left side of steering column in the position occupied by a clutch on an internal combustion engine vehicle. This pedal controls the valve gear (or linkage) of the steam engine thus allowing the engine to run in a reverse direction for backing up the car, or to control the stroke of the valves in forward motion for starting, climbing, or for economical running. The small button on the side of the pedal is the latch release button so the pedal may be latched into the desired position. With the pedal fully depressed, the engine is in reverse rotation and the car will back up. With the pedal fully out the car will move in the forward direction. Function of the pedal will be explained in the section on driving the car.

Service brake pedal - located in the normal brake position operates the four wheel hydraulic brakes in the usual manner.

Throttle pedal - just to right of brake pedal. This pedal is connected through linkage to the throttle valve which controls the amount of steam fed to the engine and thus the speed and power output of the engine.

Scale trap blowdown - located to the right of the throttle pedal. This pedal controls a valve connected to the bottom of the scale trap on the boiler steam outlet line. This valve will blow out of the scale trap any collected scale, carbon or sediment from the steam passing through the trap. The discharge side of the valve is connected to a perforated tube in the center of the lower boiler coil stack. Thus, when the scale trap is blown out the particles and steam are released into the boiler coil stack and the velocity of this steam helps to dislodge soot build up on the lower boiler coils, dumping it to local atmosphere through the boiler flue outlet.

PREPARATIONS FOR STEAMING UP AND DRIVING

In preparing to steam up and drive F. 30 a number of things must be checked and done. First and most important is to fill the water tank until it runs out through the overflow pipe. The water fill cap is located under the hood right above the steering gear box. Never leave for a drive without doing this, as running out of water while driving could cause damage to the boiler feed pump and the boiler coils. Also, keep a check on the amount of water in the tank while driving and always allow a safety margin in picking up water so the tank will not run out while driving. Note that the outside air temperature has a great effect on the efficiency of the condenser. It will not condense the exhaust steam nearly as well on a warm or hot day as it will on a cool or cold day.

After filling the water tank check the fuel. Diesel fuel, #1 furnace oil, stove oil, jet fuel or kerosene may be used as fuel for F. 30, but the burner is set up for Diesel. Consistent use of another one of these fuels may require an adjustment of the burner nozzle orifice. DO NOT USE GASOLINE ON ANY ACCOUNT.

Check the oil level in the cylinder oil lubricator, located under the floor boards on the left side. A sight glass is located on the right rear corner of the lubricator case. If it is under half full, it is suggested that it be refilled. Use only Mobil Super Extra Hecla steam cylinder oil as this oil will stand up to the high temperature. This lubricator supplies oil to the pistons and valves of the engine and an interruption of supply could cause severe damage to the cylinders, valves and pistons of the engine.

Be sure that the battery is well charged, either from previous running or by a battery charger. Priming and firing up the boiler places a heavy load on the battery and it should be well charged to handle this load.

PRIMING AND FIRING UP THE CAR

First, with all the switches off, turn on the main battery switch and ignition switch, but NOT the burner switch. Since the Doble steam generator is a coil type flash boiler, the boiler coils must be full of water before starting the burner. To fill these coils a 12 V motor driven priming pump is piped into the boiler feed water system. The priming pump is rated at 2 gallons per minute and up to 1000 psi output. No valve changing is necessary and if the pump is primed water will be forced into the boiler coils. To check that the pump is putting out water, the boiler blowdown valve, under the right front fender, may be opened and a pulsating flow observed. If the water tank

has been drained it will be necessary to reprime the priming pump. To reprime the pump, loosen the union on the pump discharge line just forward of the Aeroquip hose. When the union is loose but not disengaged, run the priming pump with the dash switch until water sprays from the union. Stop the pump and re-tighten the union. The pump is now primed and ready for use.

To fill the boiler coils, first set the handbrake. Turn on the pump and occasionally tap the throttle valve to release air that will be compressed by the incoming water. Watch the pressure gage and when the coils are full the pump will pull down and pressure will show on the steam pressure gage. Turn off the pump IMMEDIATELY the pressure starts to rise. The throttle should remain closed during the priming period except for the release of air. After stopping the pump, open the throttle once more to bleed off the excess water pressure from the coils. The boiler is now ready to steam up.

STEAMING UP THE BOILER

This should be done when you are ready to drive the car for a few miles immediately after steaming it up. This allows the boiler, engine and controls to reach their proper operating temperatures and conditions. Engine and boiler response will be sluggish for the first few miles until the system is entirely warmed up.

With the boiler coils entirely full of water and with the main battery switch and ignition switch on, turn on the burner switch. This will energise the draft booster motor driving the combustion air blower, fuel pump, air compressor and ignition spark. When the fuel pressure reaches 20 to 25 psi on the fuel pressure gage the fuel will ignite and flame is established in the firebox. This can be observed through the flame viewing window. As heat is starting to be absorbed by the boiler coils, and with the throttle closed, the water in the coils will start to expand and show a hydraulic pressure on the steam pressure gage. This pressure must be relieved before it reaches 1300 lbs. and turns off the burner with the boiler pressure control. To relieve this hydraulic pressure, with the hand brake set to bypass steam from the engine steam line to the exhaust system, step on the throttle pedal to open the valve and hold it open until the pressure is gone. Close the throttle and observe the pressure climb again. Repeat the action a few times. When, upon opening the throttle, the pressure gage does not go back to zero pressure and the draft booster turbine unit speeds up and the steam outlet temperature gage is reaching around 600° F, steam has formed and has displaced the water in the top coils.

Allow the pressure to build up to 750 to 1000 psi, release the hand brake and feed a small amount of steam to the engine. At the same time move the reverse pedal from

fully depressed to fully released a number of times. This helps to clear water from the engine cylinders. When the engine wants to actively respond to these direction changes the car is ready to drive. For the first few times steaming up the car should be done where the car can be started off in a forward direction. As the driver becomes more experienced in handling the car, maneuvering and backing the car right after steaming up will not be so much of a problem.

DRIVING F.30

When first putting the car into motion after steaming up, the feedpump-normalizer "on" light will be illuminated as the steam temperature is above 800° F. The steam temperature may climb to 900° F at which time the burner will automatically be turned off. This is a normal reaction and causes no damage. When the steam temperature drops below 900° F the fire will come on again. It may cycle this way a few times until sufficient feed water is delivered to the boiler by the feed pump. It is important that the car be put into motion as soon as possible after steaming up to start the feedwater pump turning and feeding water into the boiler coils. The boiler is usually in a somewhat overheated condition after steaming up and a half mile or so of driving will serve to return it to its normal operating condition. The 'BN' temperature will also indicate quite high, right after steaming up and putting the car in motion. If the temperature exceeds 900° F it may be advantageous to turn the feedwater pump-normalizer gyp switch "on", which will continuously force water into the boiler, until the temperature starts to drop. Then the pump should be turned "off" immediately and the automatic temperature controls will resume their function.

Care must be used when gypping water into the boiler with the gyp switch not to forget it and leave it "on", as this will flood the boiler, possibly carry over water into the engine and wash lubrication from engine wearing surfaces. It will also reduce steam temperature to the saturation point, causing the engine to run very inefficiently.

In driving the car, only two controls, besides the steering and brakes, are used to control the speed and power output of the car. These are the throttle pedal and the reverse and hook-up pedal. Before starting the car into motion, the reverse pedal must be released to the full out position. This sets the engine valves for full steam admission in forward motion and is used for starting and severe hill climbing. To release the reverse pedal, depress the latch button on the right side of the pedal and the pedal will come out by spring pressure. Then press the throttle pedal gently and start the car into motion. When the speed of the car has reached approximately 10 mph, without depressing the latch button, push the pedal in a short distance until it locks into position. This is the first hook-up notch which shortens the stroke of the valves, decreasing admission of steam to the cylinders and increasing the expansion of the steam to give more economical running. After

the speed has increased to approximately 20 to 25 mph, depress the latch button and the reverse pedal to move the pedal farther in past the first hook-up point. Then the latch button should be released while continuing to depress the reverse pedal to the second hook-up point where the latch will engage and lock the pedal in that position. At this point the reverse pedal will be depressed approximately 1/3 of its total travel. This is the normal driving position of the reverse pedal and from there on the speed of the car is controlled by just the throttle pedal. It is suggested that before driving the car the novice driver practice placing the reverse pedal in these various hook-up positions until he is fairly proficient at it. It is necessary to release the pedal any time the car is stopped and repeat the hook-up procedure upon re-starting.

When climbing a severe grade it may be necessary to let the pedal back out to the first notch position. More power will be the result but will also lead to higher steam consumption. Remember that the steam engine does not provide any "compression" or braking effect when the throttle is closed and the car is coasting, so brake and road conditions must be considered. When cresting a hill or slowing down from a higher speed with the throttle closed, if the feed/normalizer light is "on" water is being fed to the boiler and steam pressure may continue to rise. An override steam pressure switch will then act to limit the overpressure by shutting off the feed pump. Boiler pressure may be manually controlled by using the scale trap blow down valve to discharge excess pressure, which also cools the thermostat element by allowing cooler water to advance from the inlet end of the boiler.

Placing the engine in reverse for braking should NOT be done except in a case of extreme emergency.

When descending a long grade where no power is required and the engine is coasting, every quartermile or so the throttle should be opened for a short interval to allow the steam passing through the engine to carry oil to the pistons and valves and keep them lubricated.

When approaching a point where the car is to be parked for a lengthy period of time or overnight, it is of benefit to the boiler to turn "on" the feed pump-normalizer gyp switch about a city block or two before reaching the parking point. This will add extra water to the boiler, making it easier for re-firing after the stopping period or for re-filling the boiler with the priming pump before the next cold fire-up. When putting the car away after a run it is generally advisable to do the last maneuvering with the burner switch off so the steam generator is cooler and does not carry a lot of excess heat into the garage. After parking, turn off all switches, especially the main battery switch. If the car is to be left standing for a long period before being fired up, after the steam generator coils have cooled, such as overnight, fill the coil entirely full with water by using the priming pump.

When the coils are full the car can be left standing for as long as two or three months without any corrosion damage to the interior of the coils. If the car is to be stored for a longer period or for an indefinite time, the car should be prepared for storage as detailed in the section on maintenance.

Use of the priming pump after the boiler has been steamed up. The priming pump is rated at 2 GPM and up to 1000 psi. It can be used to add water to the boiler if it is felt that extra water would be of benefit, such as after parking for a period of time when the boiler has dropped to low or no pressure. Adding water at this time is advantageous for faster, easier re-firing. Anytime the priming pump is used to add water to a warm or hot boiler the steam pressure must be at 750 psi or less.

The priming pump can be used as an emergency boiler feed pump but should only be used to move the vehicle to a safer stopping place or for a very short distance. During such usage, boiler steam pressure will have to be manually controlled not to exceed 750 psi. Also, caution must be used not to run the priming pump motor over 7 to 10 minutes to avoid overheating or possible burnout of the pump motor.

MAINTENANCE AND STORAGE

BOILER

To improve the efficiency of the heat exchange surfaces of the boiler, the burner-plate assembly should be removed and the coil stack washed down with a garden hose. This will remove soot, which is an unavoidable product of this sort of fuel and burner, from the lower part of the coil stack. This operation should be done in an area where the dirty water draining from the boiler outlet will cause no nuisance or stain. Also, this operation must be done when the boiler is cold. While the burner is out, inspect the nozzle slot and clean if necessary. The nozzle gap is from .005 to .006 inches for furnace oil and Diesel fuels.

If it is necessary to remove the ignition electrodes for cleaning or service, be sure to note or photograph their position and height from the plate before removing. Changing their position and location can cause severe backfires or delayed ignition firebox explosions.

DRAFT BOOSTER

An occasional shot of grease for the turbine bearings is given through the Zerk fitting in the end of the main shaft inside the blower wheel.

The fan turbine bearings are lubricated by the oil in the exhaust steam from the engine.

BOILER FEED PUMP

Requires no maintenance outside of an occasional check of the oil level in the crankcase, indicated in the sight glass on the end of the crankcase. 30 W. oil is used.

WATER TANK

Should be drained occasionally to remove excess cylinder oil returned in the condensate. This should be done after a run when the water is hot as it will facilitate oil removal.

ENGINE

If excessive steam leakage shows around the piston or valve rods, remove the rod covers and set up the packing glands

until they are moderately tight. If extra packing has to be added, use Garlock style 98 carbon filament square braid packing cut into individual rings and stagger the joints 180° from each other. Be sure to check the packing glands on both the cylinder and crankcase ends. The engine crankcase oil is checked by the dip-stick on the front top of the crankcase. The crankcase oil is Multi-service 140 W.

'THERMOSTAT - Special assembly and disassembly procedures.

Fit copper ring gaskets to large and small ends of thermostat center element. Gasket rings must be annealed and clean. Make new rings if thickness is under .020 Use .032 thick pure copper sheet. Cover gaskets and seats with Never-Seez, also all threads and nuts. Insert center element and make sure the small ring on the fixed end enters its seat and is in the proper position. Do NOT secure the small end at this time. Slip the large union nut over the bellows end and run up by hand on the threads until the bellows is compressed and the large copper gasket is seated. Note that the center element turns freely with the nut at this time. After the nut is snugged by hand run the two control box bracket nuts onto the threaded boss and lock (jam) them together. Use these nuts to hold the center element from rotating while tightening the large union nut. This is to avoid any possibility of twisting the thin stainless steel bellows. Then run up the 1/2" SAE nuts on the small end and hold the center element from turning while tightening the clinch and jam nuts. When applying the control box bracket and tightening the cinch and jam nuts, support the center element against the tightening torque to keep it from turning.

Thermostat disassembly will be just the reverse of this procedure. Either way, the important thing is to avoid any twisting or straining of the thin walled flexible bellows.

PUTTING THE CAR AWAY

After three or four runs it is advantageous to reverse blow the interior of the boiler coil stack. To accomplish this, after a run with the boiler up to full pressure, turn off all switches. Have the car faced into the garage. Open the blow-off valve located under the back end of the right front fender, wide open. Use a glove. Continue blowing out the boiler coils until dry steam issues from the blow-off pipe and the sound changes from a roar to a sharp hiss. Immediately close the valve. There should be

about 500 psi remaining in the generator coils, enough to run the car into the garage under its own power.

Do NOT start the burner after blowing down as there is no water in the coils to absorb the heat and the coils will become rapidly overheated and possible damage may result. The boiler coils should be allowed to cool and be refilled with the priming pump before re-firing. Be careful when blowing down the coils that the spray from the blow-off pipe does not impact on a car or building as this spray contains entrained oil from the feedwater which could damage paint or cause stains.

LONG TERM OR INDEFINITE STORAGE

Procure a tank of high pressure anhydrous nitrogen, 150 cu. ft. should be ample. This should be obtainable at any complete welding supply. After blowing off the boiler coils as outlined in the previous paragraph, remove the blow-off pipe from the ell and screw in the ell fitting with the 3/8" flare fitting. Connect the fittings to the copper tube and the tube to the nitrogen tank. Drain the water tank and when drained place a jack under the rear axle so both rear wheels are clear of the ground. With the blow-off valve open, partially open the valve on the nitrogen tank so that gas is feeding into the boiler coils. Let the pressure build in the coils to 500 - 750 psi. Turn on the main battery switch and run the engine with the nitrogen gas pressure. This should be done while the boiler and engine are still hot from running. As the dry gas passes through the hot coils it will become heated and absorb moisture from all interior surfaces of the boiler, steam lines, engine cylinders, exhaust lines, turbines, feedwater heater and condenser. Since the gas is non-condensable it will escape through the "Besler bypass" around the condenser vacuum pump or the condenser relief valve. Use a good amount of gas, at least 100 or 150 cu. ft. as this will remove almost all the moisture in the steam system and leave it filled with nitrogen gas , excluding atmospheric oxygen from these areas. Remember that the boiler coils are 1018 and 4140 steel and will rust, corrode or suffer electrolysis attack if not properly prepared and protected.

The car should be stored where there is no danger of freezing as there is still water in various pumps and tubes. If the car is to be stored in an area that can go below freezing, all water and steam lines should be opened and blown out with compressed air or nitrogen gas until it is certain that no water remains in any line, pump or fitting. This should be done by someone who is familiar with steam and water circuits, valves, pumps and fittings.

The battery should be disconnected and removed to avoid acid corrosion. If Diesel fuel is used, the fuel system can be left

alone. If any fuel with an additive has been used (it shouldn't be) the fuel system should be drained and purged to avoid any residue buildup in any of the system components.

Storing the car on jack stands with the tires off the floor will greatly increase their longevity.

Do not tow the car with the rear wheels turning at any time. The engine will be running any time the rear axle turns and the pistons and valves will not have any lubrication. The car may be pushed or rolled by hand at a walking speed without any damage.

To return the car to operation after storage, make sure that all pipe joints are remade tight, then follow the starting-up procedure in the front of this instruction book.

All these many instructions and procedures may seem unnecessary or over complicated. Please keep in mind that the vehicle is over 50 years old and embodies the technology of that era. Much personal work and control will have to be used to insure the proper and safe operation of this vehicle. These instructions are the result of many years of experience with Doble and other makes of steam propelled vehicles and are intended only to help the owner of F. 30 to understand and enjoy his cup of happiness.