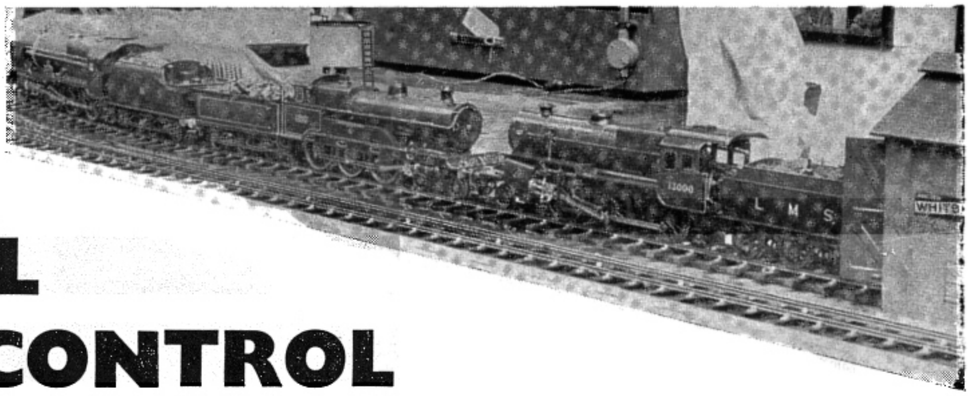


GMT OR ELECTRICAL FIRING & CONTROL

OF GAUGE I LIVE STEAM LOCOMOTIVES by G.M.T.

ON Monday, July 27th, 1959, we staged a special show at the Hollin Lane Railway for the benefit of the chairman of the Toronto Model Railway Club and his good lady. Try as we would, the Claughton would not pull more than ten coaches, and the performance gradually deteriorated as the evening wore on. She finished by pulling only eight. Various theories were put forward, such as condensation, lubrication and a cold night.

The following night the " M " division entertained a staunch Newton Heath driver, " Jock " Irvine, who had emanated from the old L.N.W.R. and had driven real Claughtons. It was normal practice to leave water in the boiler when closing down but the filler cap under the dome was removed to prevent oil being sucked into the boiler as the engine cooled down. This was the state of affairs on closing down on the Monday night.

All that was needed for a short demonstration was for the engine to be put on the track, the electrical leads to be coupled up, the filler cap replaced, and switched on. Jock switched on. After a very short time steam was observed to be issuing from the vent on top of the dome—" Getting steam up fast tonight " —then the thought came that the filler cap had not been replaced and was still lying loose under the dome. The dome was lifted up to correct the omission and was so hot that it had to be dropped immediately; it disintegrated. There was then to be observed much molten solder—switch off right away. Jock said: " You've dropped a lead plug, mate. That'll mean a Form One for you." We thought that boiler would never steam again !

Anyway, the following night the " T " division came along. He was very cross indeed when he heard the news and not a little puzzled, because it seemed to us that we had both seen water in the boiler when closing down on Monday evening. The whole boiler was therefore stripped down to its basic parts, cleaned up and reassembled. In doing this an improved main steam pipe joint was made in a more suitable location, the whole job being completed in two hours. We were now back where we started, with the engine going strong again.

Further tests at Hollin Lane resulted in the engine pulling 12 again, then ten, etc., finally dropping down to three on the occasion of a special display for the benefit of some friends. Again it was a cold day and again the general opinion was that the cause of the trouble was excessive losses due to radiation and condensation. Water was dripping from a point between the frames behind the cylinders like the proverbial bathroom tap and when we finally closed down, " M " division noted that the dripping water was very, very hot.

The boiler was therefore stripped off the engine again, and the cause was readily observed—the leading boiler end had been forcibly shifted outwards at an angle, owing to the combined heat and pressure. There was a very bad leak when the heaters were switched on, from a crack about 1½ in. long where the soldered joint had failed. It was apparent that the boiler could not be made to work with any degree of certainty in that form. Time was getting on towards the exhibition and we would have felt fools if the engine gave up the ghost after the first day's running. It was therefore decided to take the bull by the horns and make a complete new boiler, constructed entirely of copper and using silver solder as the jointing medium. The new boiler would be smaller in diameter than the original, which would be retained but used only as lagging.

In discussion about the previous deterioration in performance it had been suggested that improved lubrication and additional heating were necessary and it was also decided in addition to incorporate the results of experiments along these lines. We had also intended to convert Arthur's Horwich Mogul, as we intended to have two locomotives running on the exhibition layout, but now, at the end of September, this project had to be abandoned.

New boiler

This is again a simple pot boiler with pressure increased to 60 lb., see Fig. 11. The heaters are put in at the smokebox end to minimise complications in the cab; there has been no trouble with water or hot oil dropping on the live connections. Note the altered regulator and water-gauge position, and the new stop cock for filling the boiler with water. This is the only means of getting water into the boiler apart from unscrewing the safety valves. We do not resort to this latter practice as it has been found possible to utilise the vacuum in the boiler, which occurs when the boiler cools down, to draw water in via a connection to the tender manhole and a " bag " on a parachute water tank. Time taken for this operation from switching off to getting away under steam with a full boiler of water is only five minutes, and a real engine is allowed

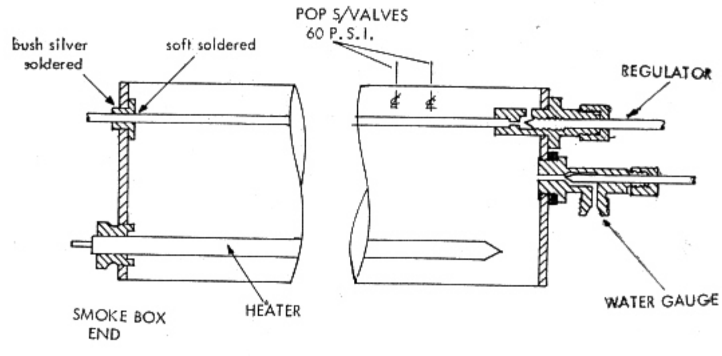


Fig. 11. Simple boiler.

at least five minutes to take water at a column. During the boiler filling, attention can be given to the lubricator.

Lubricator

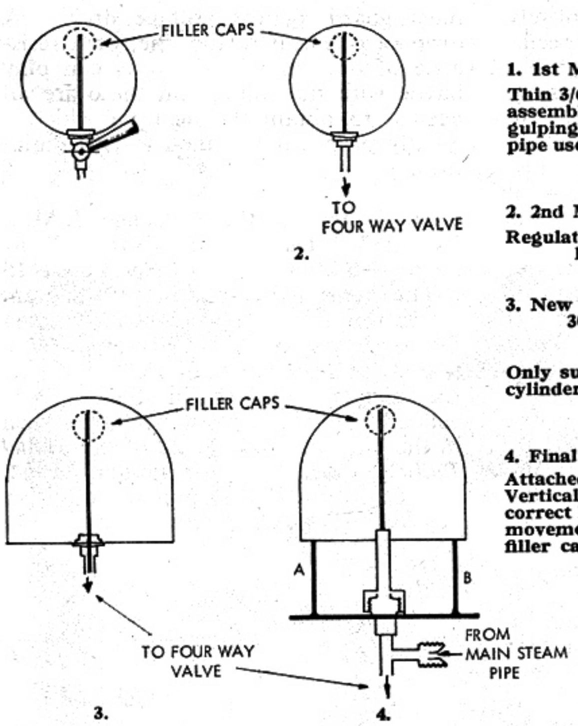
This is an enlarged version of the original Bassett-Lowke lubricator (Fig. 13), but is supported on stout auxilliary brass frames to prevent distortion and breaking of pipe connections when the lubricator filler cap is being unscrewed for filling, or screwed up tight after filling. The oil regulator valve is omitted to prevent damage which would occur if the engine was run with the valve shut.

Heat

In all the previous experiments the engine had generally run on the maximum voltage available from the transformer. There appeared to be little in reserve, and many were the times out of doors when we had to stop to " blow up ! "

The heaters were designed to work in air and it should be borne in mind that although they were operating on maximum voltage they were totally immersed in water. To get more heat from the same units one could only increase the voltage. Tests were therefore carried out, using a booster transformer coupled to the original transformer, and we ascertained that we could raise the voltage to about 65. Current collection at the increased voltage on test did not present any difficulty, but at the same time we discovered heating elements which normally worked at two kilowatts, so that the same length of the new heater would give us approximately twice the heat of the original heaters at twice the wattage, but at the original voltage. In other words, one new heater would do twice the work of one of the originals. We did not like the use of the booster transformer, so the new boiler was fitted with one heater of each type, this giving (in theory) a 50 per cent. increase in heat. When the new boiler was completed it was given an exhaustive time test to ascertain whether the transformer would stand up to the increased output. There was no heating of transformer or rectifiers and the new arrangement is perfectly satisfactory. Current collection was again tested, and no difficulty experienced (Fig. 14 shows the arrangement of the unpopular booster).

Owing to fluctuations in mains voltage, output from the transformers varies, but after many readings the values from each transformer tapping were ascertained, and are given in the tables below.



1. 1st Modification:

Thin 3/64 copper tube (fine bore) soldered to tap assembly then soldered to oil chamber to stop gulping when reg. closed, etc. Original outlet pipe used soft soldered to main steam inlet prior to four-way valve.

2. 2nd Modification.

Regulator tap removed (useless) and to avoid leakage (our pressure 50/60 p.s.i.)

3. New larger capacity oil chamber made of 30-gauge sheet PB (soft soldered).

Only support of 2 and 3 was on the oil pipe to cylinder which occasioned many punctures and leaking joints. (4 cures this).

4. Final Arrangement.

Attached permanently to locomotive chassis. Vertical side pieces A & B adjusted by filing to correct height by trial to avoid sideways rocking movement of oil chamber when screwing up filler cap or undoing all joints never soldered.

Fig. 13. Lubricator.

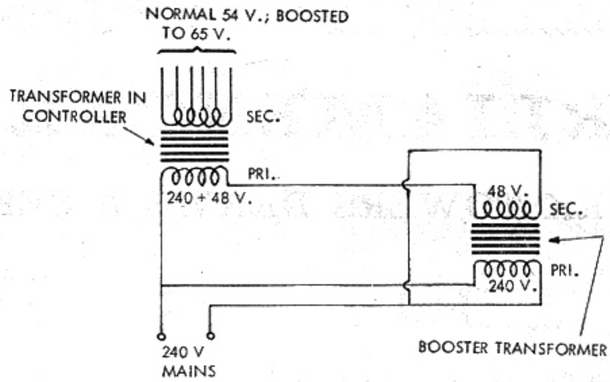


Fig. 14: Booster arrangement.

The values of the steam tram coiled heaters are given to illustrate that it is not possible to guarantee the actual output after cutting the red ring elements.

Position	*Voltage (off load)*
0	0
1	20
2	27 and centre tap
3	40
4	47
5	54 (maximum)

Position of Heat Control Handle	*Original Heaters*		*Steam Tram Coiled Heaters*		*New Heaters**	
	Amps.	*Volts*	*Amps.*	*Volts*	*Amps.*	*Volts*
1	3.0	19	3.6	20	4.45	20
2	4.0	26	4.8	26	6.0	27
3	6.0	40	7.0	40	8.9	40
4	7.0	46	8.0	46	10.4	47
5	7.8	52	9.4	52	12.0	54

* After re-wiring controller with 14-gauge wire.

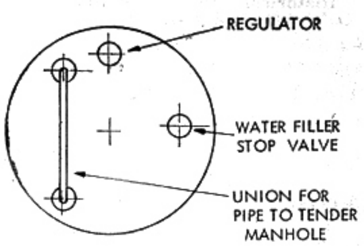


Fig. 12

The final arrangement is entirely satisfactory and exceeded all our expectations. At the exhibition the "full" position was only used for steam raising, the engine running most of the time on position 3. Position 1 is almost useless, but position 2 will keep the engine just simmering. It is, therefore, apparent that the radiation losses are 162 watts for this particular engine.

Using the booster transformer and the original heaters, the following readings were obtained:

Position	*Amps.*	*Volts*
1	3.2	22
2	4.4	29
3	6.5	43
4	7.4	50
5	8.5	56

When boosted up to 65 volts, the amperage increases to 9.75, or an output of 630 watts with the original heaters, as compared with a maximum output of 648 watts with the new heaters. It was decided, however, to standardise on 50 volts nominal, and providing that all running and conductor rails are bonded with 14-gauge wire, this is entirely satisfactory out of doors in heavy rain or dew.

On an outdoor layout in particular one must guard against voltage drop. A drop of one volt in the line, or a resistance of one ohm in the line, can play havoc with the watts, and these are all needed to obtain the heat, of which a goodly proportion is then lost in radiation.

Some Notes on the O-Gauge L.M.S. No 6234 "Duchess of Abercorn," by Marc Drinkwater. See Figure 15

The items numbered in the diagram are as follows: 1. Heat Control, varying the heater power up to 360 watts. Note that resistances are used instead of the transformer tappings in the G.M.T. version. Individual resistances are shown in the diagram on page 22 of the *Model Railway Constructor* for January, 1954.

2. Control Keys. Depression of either key rectifies A.C. supply to half-wave D.C., in direction depending on key selected.

3. Rectifiers. Short circuited when keys are normal.

4. Locomotive Collector.

5. Boiler Heater. See page 21, January 1954, *Model Railway Constructor*.

6. High Inductance Relay. This operates on half wave D.C. but not on A.C. The particular relay used is an ex-G.P.O. 3000 type with two coil windings, 200 ohm-200 ohm. The outer winding is short-circuited to give the required "slugging" effect. The 300 ohm resistance is another old relay coil just added to drop the voltage across the relay.

7. Motor. This drives the reversing gear and regulator. It is a 5-pole OO motor of forgotten make, mounted under the firebox. I'd hate to tackle a "small" prototype!

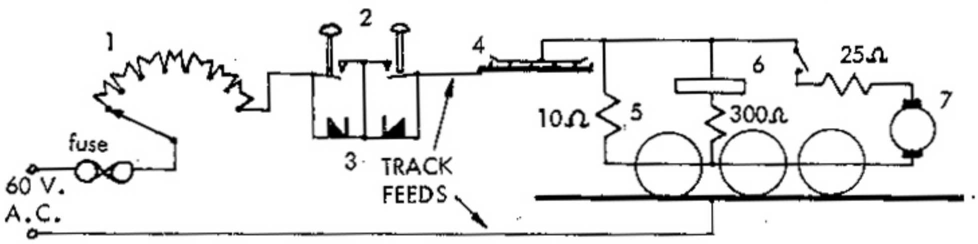


Fig. 15. Marc Drinkwater's circuit.