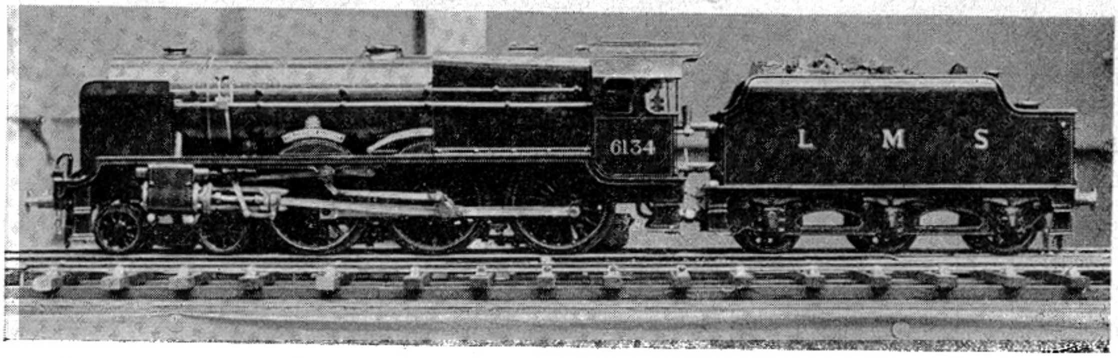


GMT or ELECTRICAL FIRING & CONTROL OF GAUGE I LIVE STEAM LOCOMOTIVES

by G.M.T.

IN the December 1965 issue of the MODEL RAILWAY NEWS the introduction of this series on "electrical steam" appeared.

We now continue the story with the development and details of the system employed on this unique railway. Remember our warning: "THIS IS NOT A SERIES FOR BEGINNERS AND THOSE WHO DO NOT UNDERSTAND THE INVOLVEMENTS SHOULD LEAVE THIS FORM OF POWER STRICTLY ALONE."

Heaters

This was the first thing to be tackled. Marc Drinkwater made his own, but couldn't remember just how, but our attention was drawn to the glowing red ring on the electric stove in the G.M.T. canteen. These Red Rings give one kilowatt each at 240 volts a.c., whilst the amperage is approximately four.

One quarter of 240 is 60, but it was considered after comparison with the O gauge "Duchess" that we should need a maximum of 8 amperes. Red Rings were obtained and cut in four pieces; the two centre pieces were discarded, and the two ends used as they are fitted with wire connectors. The new ends of the usable parts were sealed up with silver solder after drawing the heater coil through to make the earth or neutral connection via the outer casing (Fig. 2). They turned out to be admirable heaters working at approximately 50 volts and taking just under 4 amperes; therefore two were used in parallel.

Controller

The next stage was to construct a mock-up of the control system and couple it to a motor and relay and to the heaters, the latter being inserted in a milk bottle filled with a pint of cold water. Marc Drinkwater used an OO motor to receive the short bursts of half-wave d.c. We had experience with what we call "tram motors," otherwise ex-R.A.F. camera motors, with nine-pole armatures. The mock-up worked. The water in the milk bottle boiled in 12 minutes and was maintained at boiling point for a considerable period until we were stopped by the horrified G.M.T. canteen manageress, who demanded the immediate return of the milk bottle. Our pleas that history was being made were not accepted in the spirit we thought they might be, but we don't blame her. This was nothing to what she was to witness as the experiments progressed!

The temporary boiler was constructed on the lines of a Lancashire flue boiler, with one flue throughout to accommodate two heaters connected in parallel. The reason for the centre flue was to accommodate a superheater in addition, as the 0-8-0 chassis was designed to work with superheated steam. The boiler was constructed of copper tubing, silver soldered throughout and tested to 300 lb. pressure (hydraulic). (Fig. 3).

We thought it was about time we started measuring, so a pressure gauge reading from 0-150 lb. was purchased. The boiler had only one outlet, at the top of one end; this was used for connections to the pressure gauge or to a steam engine. On test, 50 lb. pressure was reached in four minutes. When we shut off power, it remained at 50 for a considerable period. As the boiler had been tested to 300 lb. it was decided to switch on again, and 70 lb. was obtained in less than a minute. After this, short bursts of switching on and off would raise the pressure by approximately 5 lb. each time; we stopped when we reached 90. We then waited for the boiler to

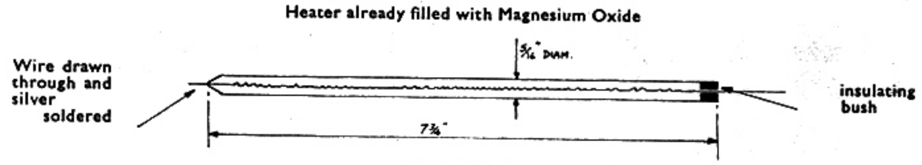


Fig. 2. Heater.

One item marred an otherwise successful experiment; the tram motor did not take kindly to the half-wave d.c. It ran with a throbbing pulsating motion, got hot, yet appeared to have sufficient power to operate the mechanical control. We did not like the look of this. The transformer we were using also showed signs of heating.

Experimental boiler

Despite the above portents, which were eventually to lead us into difficulties, it was decided to try the mock-up control with a boiler.

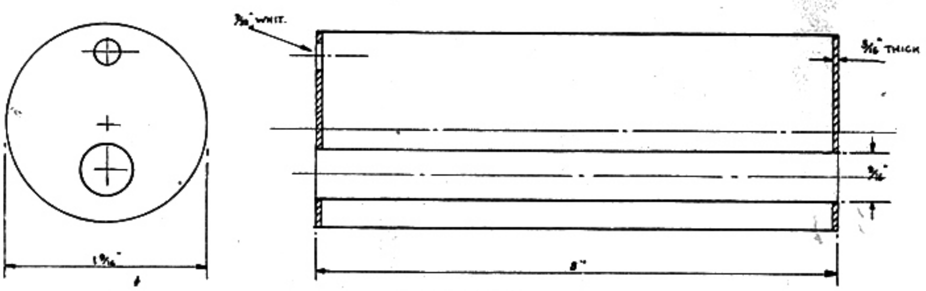


Fig. 3. Boiler.

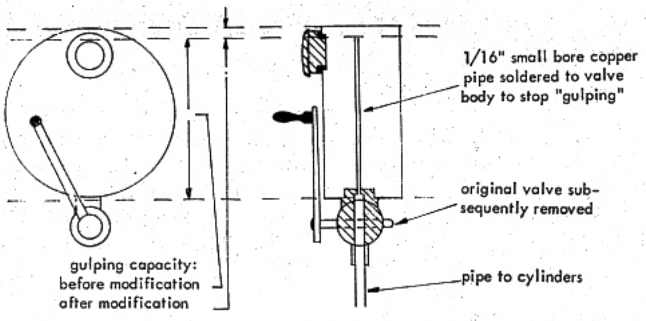


Fig. 4. Lubricator.

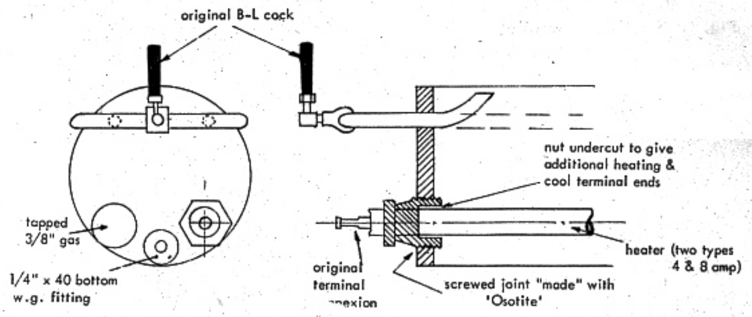


Fig. 5. Heater connections.

cool down so as to connect it to an O gauge *Bat* chassis, but after five minutes the gauge was still reading 70. The whole bag of tricks was, therefore, picked up with tongs and dropped into a basin filled with lukewarm water. That cooled its ardour!

It was quickly disconnected from the pressure gauge and attached to the *Bat*, which, remember, was designed to work with superheated steam. In the circumstances, using saturated steam, it was agreed that the scheme should work.

Current collection

Having got the control, power supply and boiler to work to our apparent satisfaction, the next problem to be tackled was current collection. Marc Drinkwater used stud contact with a skate. We did not favour the idea particularly, as Arthur Bridge had centre-third conductors. It was no use making parts for the engine, only to discover that they would not work, especially as there was quite a simple way to test current collection without making parts at all, and that was by using the complete mock-up with a piece of track inserted in the heater circuit and employing wheels on axles as the switch'

O-gauge brass track was used for this purpose and the wheels on axles tested were brass, cast iron and die-cast.

Single axles were used at first, but the effect was just a shower of sparks and considerable burning. The die-cast wheels would not stand up to this treatment in any respect and on one occasion the brass wheels welded themselves to the track. Cast iron fared best but there was still considerable arcing with them.

It should be stated that at this period we were contemplating picking up the current "two-rail" via the wheels and axles. The 0-8-0 chassis had full Joy valve gear and the connecting links of this gear, the big ends and the water pump eccentric came dangerously near the centre conductor; for obvious reasons we did not require any of these parts to be welded to the track!

It was, therefore, decided to scrap the whole scheme, but David Getgood ("G" Division) came to the rescue with a discarded pantograph insert of the copper-carbon type with a plated copper top. It was tested as above and did the trick, but the locomotive was "out." In its place, we decided to build a steam tram to $\frac{5}{8}$ in. scale, using two-rail collection with carbon brushes to pick up from the running rails, all wheels being insulated. The carbon brushes would, of course, be hidden under the protective apron.

The steam tram

Drawings were made and various parts constructed, including the boiler. This had to be a vertical type as in the prototype and, therefore, could not accommodate the 8 in. length of the heaters. The problem of renewing the heaters was also tackled.

In the previous boiler it was the intention to use a tube for superheating, all the heaters being exposed to air. Space limitations ruled this out on the steam tram and the heaters would have to be immersed in water the whole time. The same length of heater was used, but instead of being straight, each was coiled. The base of the boiler was flanged and faced accurately, the heaters being attached to the base with the terminal ends projecting for connection to the supply. Thus, the whole of the base of the boiler could be detached to withdraw the heaters and at the same time facilitate any necessary cleaning.

This was the state of affairs at the beginning of 1959, but on January 20th, Mr J. H. Scholes, curator of Historical Relics to the B.T.C., gave a lecture in Manchester to the M.L.S., and Stan Thompson went along. After the lecture, our project was mentioned to Mr Scholes, who very kindly sent us full scale drawings of the tram. The drawings which we had prepared had been obtained from photographs and known dimensions but, on receipt of the official drawings, it was seen that, although we were not very far out, the true dimensions offered so many advantages in solving space limitations that the whole project was re-drawn.

When the nice weather came after Easter we again visited Arthur Bridge's garden layout—the lure of the steam engine was on us once more. If we were to do justice to the drawings kindly supplied by Mr Scholes it was obvious that the model would take a very long time to construct and could not possibly be ready for the Exhibition in December, 1959. We asked Arthur if he had any objection to our converting one of his Bassett-Lowke meths-fired steam engines. He said, "No" and offered us the choice of the Claughton or an L.M.S. Mogul. We chose the Claughton, and that sounded the death-knell of the steam tram for the time being.

The Claughton was duly converted. We used the original boiler casing but fitted new ends made from $\frac{3}{16}$ in. copper, solft-soldered in. This was a grave mistake and we ought to have had more sense. We were saved miraculously from catastrophe by sheer luck and the boiler ends just moving out to leak rather than blowing out and exploding —soft-solder at this temperature and pressure can (and did) become plastic.

The arrangement of boiler, heaters and collector shoes was as shown in Figs. 4, 5 and 6. (The boiler arrangement was subsequently scrapped for our new standard boiler.)

The arrangement of the control motor in the tender, the coupling to the engine and the four-way reversing valve is given in Figs. 7, 8 and 9.

The four-way reversing valve was retained as it gave the quickest solution to a combined reverse and regulation requirement to be derived from a simple forward and reverse motion of an electric motor.

It should be noted that the arrangement cannot overrun; it makes a click-

Fig. 6. Arrangement of collector shoes.

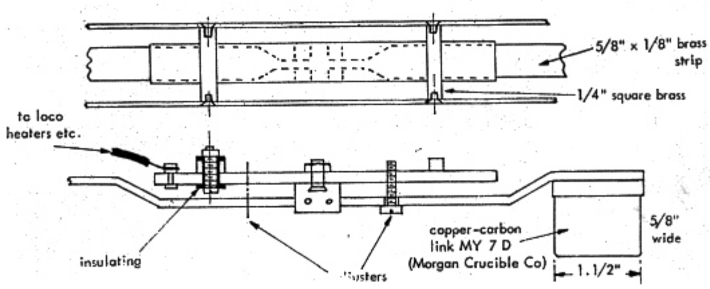
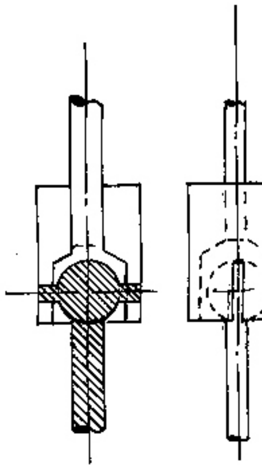


Fig. 7. Universal coupling.



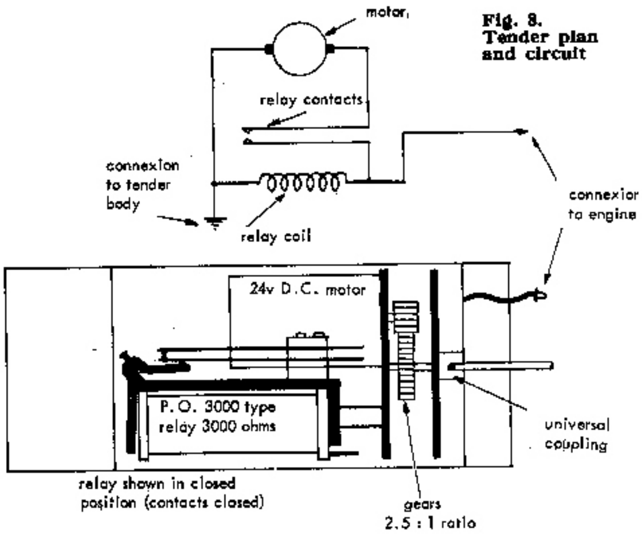


Fig. 8. Tender plan and circuit

ing noise in the full reverse or forward positions denoting that these have been attained.

The indicator lamp in the cab also serves the following purposes:

1. Illuminates the water gauge.
2. By illumination indicates that heater current is available at the engine.
3. By degree of illumination indicates the approximate transformer tapping.
4. If light goes out when the control buttons are pressed, indicates that control (d.c.) current is available at the engine.

About this time we were given an old heavy duty transformer from a battery charger which gave 54 volts a.c. at 12 amperes (with little heating) and tapped at 20, 27, 40, 47 and 54 volts, 27 being the centre tap. This became our standard transformer and we have since had two more specially made to a similar specification.

This transformer was renovated and incorporated in a new controller wired (Fig. 10).

The transformer tappings were connected to a rotary tap changing switch with 10 positions designed to deal with high current, using alternate connections to avoid shorting the transformer windings.

As mentioned previously, the control motor did not take kindly to the half-wave rectification and as experiments progressed we found that the high in pedance relay attached to the contr motor didn't either. One could get a rela which worked satisfactorily on the tw high tappings, but not on the lower, an every relay tried behaved erraticall The root of the difficulty was the hal wave rectification, especially at low tappings. It was, therefore, finall decided to substitute full-wave rectifica tion at 25 volts, no matter what tran former tapping was used. The R.A.I motors are wound for 24 volts and th scheme is 100 per cent. successful.

It was also decided to incorpora remote control of the push buttons b the use of electrical contactors; this outlined in the diagram. The reaso for this was that the testing ground wa Arthur Bridge's Gauge 1 outdoor (ol layout which was some 80 yards lon with extremities not in sight of eac other, and by using a three-core wand lead we could "control" from a point.

One would now think that we ha achieved our first success, but this wa not yet to be.

To be continued

Fig. 9. Locomotive Plan

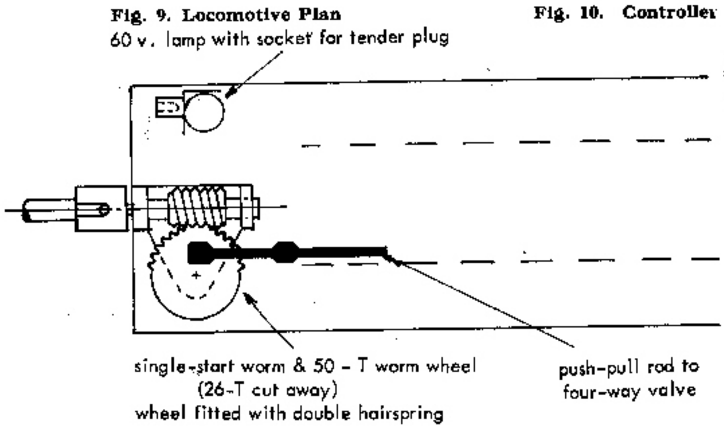


Fig. 10. Controller