Testing Dynamo and Regulator

WARNING – When testing a dynamo take great care with the drive belt, pulley and fan to ensure that body parts or clothing are not caught or dragged in.

Ground Rules

Tractor dynamos convert external power via a belt to electrical power. They are relatively efficient, possibly between 80 and 90%. A dynamo outputting 14 volts and 30 amps is producing 420 watts. At 90% efficiency this would require 420/.9 or 467 watts from the engine… a little over 0.6 hp.

When a belt squeals it is slipping because it cannot transmit this power. A cold engine just started has discharged the battery and the dynamo at this point is asked to provide its maximum output, often with a damp belt and pulleys.

Types of Dynamo

The dynamos fitted to UK built tractors in the 50's and 60's were often supplied by Lucas and were very similar or identical to those on cars in the same period. Operation of all dynamos and their regulators is essentially the same so these notes apply equally to other makes.

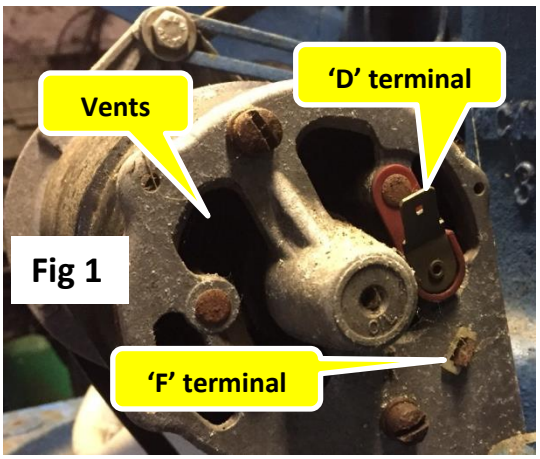
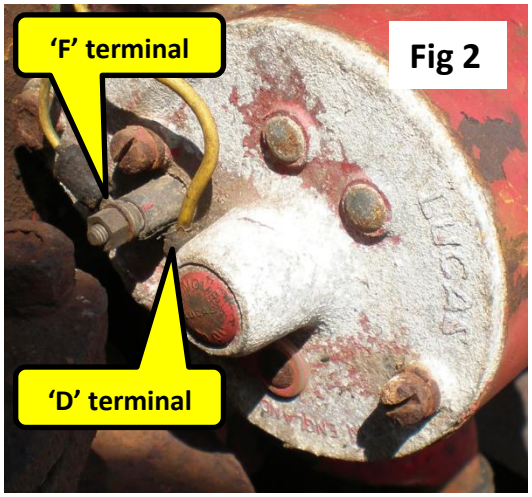


Fig 1 shows a common Lucas car version (also fitted to some tractors) which was ventilated with non-solid end plates that allowed additional cooling as shown here. These units often had an oil hole in the end as seen in the photograph.

Some tractors were fitted with non-ventilated types as shown in Fig 2. The reduced cooling resulted in these tractor units typically being rated at 11 Amps while the vented were mostly



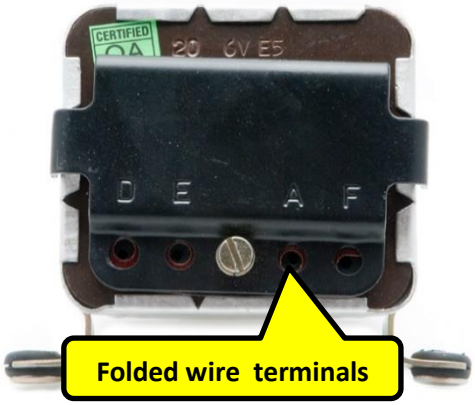
rated at around 22 Amps or more. Electrically the two types would appear to be identical so the differences in practice come down to the type of regulator fitted – more on this later.

Some dynamos even have a tachometer gearbox fitted to the end as shown in Fig 3 but otherwise operate as the other types.

Connections can be by push-on spade as in the first example or bolted-on ring terminals as in the second. Often faults can be as simple as loose connections on the dynamo.

Regulators

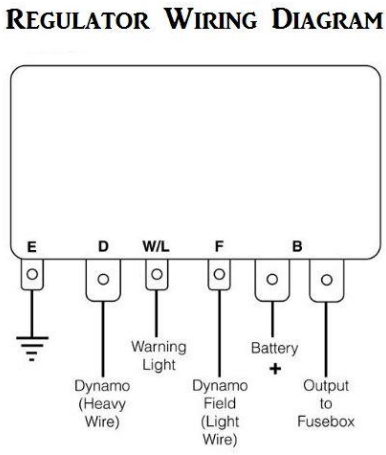
There are many different types of regulator, some in sealed metal cans, some in plastic and some with removable covers. Connections can be by spade, screw or a folded wire bullet as shown in this four terminal version.



While many regulators have only four terminals, several have six. To add slightly to the complexity, connections having the same function may have a different name, - and that is without the possibility that it is in a different language for a foreign tractor.

This table gives the most common usage.

E or G	Earth or ground – connect to the chassis
D	Dynamo output- connect to heavy dynamo terminal
F	Dynamo field – connect to the smaller dynamo terminal
A or B	Heavy connection from regulator to ammeter or battery. If an ammeter isn't fitted then this just connects to the battery non-earth terminal
A1, B1 or second A or B	Second connection to A or B above. This is sometimes used to connect to a fuse block or for a second cable to share the current with the one above.
W/L	Used to drive a dashboard warning light to indicate that the dynamo is not charging.



This diagram is for the six terminal type of regulator where the connections here marked as 'B' could alternatively be marked 'A' and 'A1'. On a four terminal regulator the 'W/L' and second 'B' (or 'A') terminal is unused – the single 'A' (or 'B') terminal does both jobs.

Not all voltage regulators sold as suitable replacements are directly equivalent. One bought via the internet was quoted as the correct part for the tractor, a description which was only partially correct. The regulator would work with the dynamo but was actually for a vented version in that its nominal current was 22, not 11 Amps, pushing out a good 30 Amps when the engine was first started. The regulators are intended to allow higher charging currents when everything is cold to help recharge the battery after cold starting demands then, as the regulator heats up, the maximum current is reduced to the standard rating (11 or 22 Amps here.)

In UK temperatures there doesn't initially seem to be immediately obvious overheating problem when running the non-vented dynamo at these higher currents. The dynamo pictured here had been run in this configuration for a couple of years without apparent problems until it was examined internally. On dismantling the dynamo, a ring of fine solder splashes was found indicating that the commutator solder became hot enough to soften if not fully melt, not ideal for long term reliability. So, if the dynamo is non-vented and charges at over 15 Amps, the regulator is either broken or the wrong model.

On-tractor Testing

If smoke or flames are coming out of the dynamo, this is a clear indication that it is faulty! Discontinue immediately and either replace or investigate… but the dynamo is probably beyond economic repair.

Assuming everything externally looks ok, simple checks with a multi-meter (DVM) should enable the problem to be isolated. The multi-meter doesn't need to be expensive – this one was available via the internet for under £6 at the time of writing. It is also worth getting or making leads with crocodile clips to leave hands free.

There are two different ways to test a dynamo – a quick and rough test of the dynamo only and a detailed test (based on the original Lucas procedure.) Both are described below.

Quick Test

- **Ensure the engine is stopped**
- Check that the dynamo belt is serviceable and correctly adjusted – ½" to 1" movement when moved up and down… and that the fixing bolts are secure . Too tight a belt leads to belt wear and overloads bearings. Too slack a belt leads to slip, belt wear and reduced dynamo output.
- Disconnect both field (the thinner wire with smaller spade or ring connector) and power connections (thicker wire with larger ring or spade connector) ensuring that they don't short to surrounding metalwork in case there is also a regulator fault.
- Start the tractor and run at low speed (about 600 RPM).
- Measure the voltage between the power terminal and earth – this is typically 2 or 3 volts but may initially be lower.
- Link the field and power terminals with a piece of wire, taking care not to short either terminal to earth. The voltage should rise (possibly to around 8 or 9 volts.) Raise the engine speed slowly and the voltage should rise – take care not to exceed 20 volts or there is a risk of damage to the dynamo's insulation.
- Listen to the dynamo for noisy bearings – even if working electrically then a mechanical repair may be needed.

If the above works then the dynamo is capable of providing power although this test doesn't confirm that it can deliver its full rated output current.

If this doesn't work, the dynamo may need re-polarising… resetting its residual magnetism. This is also sometimes necessary if the tractor's battery polarity is changed for any reason, e.g. changing from positive to negative earth. To do this, connect a wire to the non-earth side of the battery then quickly touch the other end to the field terminal – a fraction of a second is all that is necessary then repeat the simple dynamo check above.

Detailed Test

The following test procedure is that advised by Lucas in the 1960s.

Again, ensure the engine is stopped.

Check the belt tension (approximately ½" to 1" movement) and ensure the fixing bolts are secure.

The DVM should normally be used on a 20V range.

If the tractor has a positive ground, the positive lead of the meter is connected to ground and the negative used for measurements to get positive readings. The DVM will however work safely either way round, just the values will be shown as negative.

DVM CONNECTION	READING	ACTION
TEST 1. Disconnect leads from dynamo. Connect one lead of the DVM to D terminal and the other to a good ground. Start engine and raise speed until dynamo is running at about 2/3 full engine speed.	**A.** 2-4 volts with engine at normal charging speed.	Dynamo armature and brush connections ok. Go to Test 2.
	B. Zero volts.	Examine dynamo brushes and make sure they are free in their boxes and making good contact with the commutator. If there is still no reading, try re-polarising the dynamo (described later) and retry. If still no reading, the armature is faulty.
	C. Voltage rising with increase in engine speed when well above tick-over	This indicates an internal short between the D and F terminals.
TEST 2. Stop the engine for safety. Reconnect the dynamo leads. Remove the D and F leads from the regulator. Start engine speed at tick-over. Connect the DVM between ground and the regulator D lead.	**A.** Rising volts with rising engine speed.	Dynamo is working. Go to Test 3.
	B. Maximum of 2-4 volts as engine speed is increased.	Open circuit in field coils. Repair fault or replace dynamo.
	C. Zero volts.	Grounded field coils or 'F' connection. Repair fault or replace dynamo.
TEST 3. Stop the engine for safety. With the dynamo leads still disconnected, link dynamo D & F terminals. Remove the D and F leads from the regulator. Start engine speed at tick-over. Connect the DVM between ground and the regulator D lead.	**A.** 2-4 volts.	D lead from dynamo isn't broken (although it could still have poor connections.) Go to Test 4.
	B. Zero volts.	Rewire D lead and repeat test.
	C. Rising volts with rising engine speed.	Locate short between D and F wires.
TEST 4. Leave DVM connected as in Test 3. Reduce engine speed to tick-over. Join the regulator D and F leads together. Gradually speed up the engine to at least a fast tick-over	**A.** Rising voltage with rising speed.	Wiring from dynamo to regulator is working. Go to Test 5.
	B. Zero volts.	Short between F wire and ground. Correct and retest.
	C. 2-4 volts.	Open circuit/broken F wire between dynamo and regulator. Correct and retest.
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TEST 5. Measure the voltage across the battery terminals [1] and also from dynamo D to ground [2].	**A.** [2] is slightly higher than [1] (approximately 0.5 volt maximum.)	Battery charging. Go to Test 10.
	B. [2] is significantly higher than [1] (more than about 0.5V.)	There is an abnormal voltage drop along the wiring. Go to Test 6.
	C. [2] is lower than [1].	Still not charging. Something has been missed in the previous tests. Go to Test 1.
TEST 6. Measure the voltage from battery ground post to dynamo case.	**A.** Voltage less than 0.1 volt.	Ground connection between battery and dynamo ok. Go to Test 7.
	B. Voltage above 0.1 volts.	High resistance ground. Check voltage drop across each ground connection to find problem, rectify and repeat test.
TEST 7. Measure the voltage between battery non-ground terminal and regulator A.	**A.** Voltage less than 0.1 volt (0.2V if ammeter fitted.)	Connection between battery and regulator A terminal ok. Go to Test 8.
	B. Voltage above 0.1 volts (0.2V if ammeter fitted.)	Bad connection between battery and regulator A terminal. This will be via an ammeter if fitted. Find problem, rectify and repeat test.
TEST 8. Measure the voltage between regulator and dynamo D terminals.	**A.** Voltage less than 0.1 volt.	Good connection between regulator and dynamo when carrying charging current. Go to Test 9.
	B. Voltage above 0.1 volts.	Bad connection between regulator and dynamo D terminals. Find problem, rectify and repeat test.
TEST 9. Measure the voltage between regulator A and D terminals.	**A.** Voltage less than 0.1 volt.	No unexpected high resistance inside regulator charging path. Go to Test 10.
	B. Voltage above 0.1 volts.	Regulator high contact resistance. If not sealed, clean contacts and retest. IF sealed, replace regulator.
TEST 10. Measure the voltage across the battery terminals over time with the engine at about half speed.	**A.** Battery voltage rises to between 13.8 and 14.4 volts	Battery charging to correct level. Both dynamo and regulator are working normally.
	B. Battery voltage higher than 14.5 volts.	Regulator faulty.
	C. Battery voltage lower than 13.7 volts.	If battery will charge externally with a higher voltage then the regulator is faulty. If not, the problem is with the battery.

ARTICLE CONTRIBUTED BY ANDREW CHAPMAN