E. TEST PLANS

TEST PLAN – FORD 455C, 201 cu.in. (3294 cc) Engine

DPA DISTRIBUTOR TYPE FUEL INJECTION PUMP – TYPE NUMBER 3238 F800 – 809

PUMP SPECIFICATION

Rotation (looking on drive end)	Clockwise
Governor type	Mechanical all-speed
Governor link length	54.0 mm ± 0.3 mm
Governor Arm hole	No: 3
Throttle lever link hole	No: 1
Diameter of Plungers	7.0 mm (4 off)
Drive Arrangement	Unsupported, quill shaft
Advance type	Automatic speed

Special features
Solenoid shut-off device, 12 volts
Transfer pressure adjuster in end plate

ISO TEST CONDITIONS (IMPORTANT: Read explanatory notes)

These figures, for service use only, have been compiled on, and must only be used on, a test machine conforming to International Standard ISO 4008.

Test oil	ISO 4113 at temperature 40 ± 2°C
Inlet feed pressure	1.5 bar
Nozzles	ISO 4010
Nozzle opening pressure	172 + 3 – 0 bar
H.P. outlet connections	Original
H.P. pipes	ISO 4093.2

- Screw transfer pressure adjuster fully out and then 2.5 turns in before commencing test.
- Fit auto-advance gauge and set to zero before commencing test.
- Fit pressure gauge to measure cambox pressure using special bleed-off connection.
- Where marked thus * use 30 seconds glass draining time and allow fuel to settle for 15 seconds before taking readings unless stated otherwise by the test bench manufacturer's instructions.
- A 1.0 mm shim is fitted to the piston spring cap on assembly.
  This must NOT be removed.
  No additional shimming is required.
- Note 1 Critical fuel deliveries are given in mm^3/stroke. Hence the tester must determine the number of strokes applicable in accordance with the test m/c manufacturer's instructions.

TEST PLAN – FORD 455C, 201 cu.in. (3294 cc) Engine continued

TEST PROCEDURE

Test	Operation	RPM	Requirements
1	Priming	100	Obtain delivery from all injectors
2	Transfer pressure	100	0.55 bar (8.0 lbf/in²) minimum
3	Cambox pressure	100	0.35 – 0.7 bar (5 – 10 lbf/in²)
4	Advance setting	500	Adjust transfer pressure screw to obtain advance of 5.5°
5	Full advance	900	6.75° – 7.25°
6	Advance check	100	0°
7	Transfer pressure	1100	5.3 – 6.7 bar (75 – 95 lbf/in²)
8	Back leakage	1100	20 – 60 cm³ per 100 strokes time cycle (Flow rate 220 – 660 cm³/min)
9	Max. delivery setting	*Set to code on n/plate	Delivery tolerance ± 0.5 mm³/stroke. Spread between lines not to exceed 5.0 mm³/stroke. See Note 1
10	Governor setting	1220	Set throttle by max. speed adjustment screw to give max. average delivery of 2.0 cm³. No line to exceed 3.0 cm³. Lock stop screw.
11	Delivery check	1100	With throttle set as at (10), average delivery not to be less than at test (9), minus 2.0 cm³
12	Delivery check	* 100	Minimum delivery to be as at test (9), minus 20 mm³/stroke. See Note 1.
13	Throttle operation	200	Average delivery not to exceed 1.2 cm³. Throttle lever closed
14	Cut-off operation	200	Average delivery not to exceed 0.5 cm³. Shut-off lever closed
15	Cut-off operation Solenoid de-energised Shut-off open	200	Average delivery not to exceed 0.5 cm³
16	Timing		Using outlet 'W' (55 bar pressure) and indexing tool set to 272°, scribe line on pump housing flange

TEST PLAN – FORD 555C, 256 cu.in. (4195 cc) Engine

DPS DISTRIBUTOR TYPE FUEL INJECTION PUMP – TYPE NUMBER DPS 8520A 590A TO 9A

BASIC PUMP SPECIFICATION

Rotation (Looking on drive end)	Clockwise
Governor type	Mechanical all-speed
Throttle lever link hole No.	1
Governor link length	41,5 mm ± 0,5 mm
Diameter of plungers	7 mm × 4 off
Drive arrangement	20 mm dia. taper drive with supported shaft
Advance type	Automatic speed with start retard
Mounting spigot diameter	50 mm

Special features
Scroll plate max. fuel adjustment with hydraulic excess fuel device.
Transfer pressure adjuster in end plate.
Timing mark on flange.
Cambox non-return valve incorporated in backleak connection.
Axial outlet head with pressurising valve incorporated.
Internal venting via flatted metering valve.
Solenoid shut-off device, 12 volts.

ISO TEST CONDITIONS. (IMPORTANT: Read Explanatory Notes)

These figures, for service use only, have been compiled on, and must only be used on, a test machine conforming to International Standard ISO 4008.

Test oil	ISO 4113 at temperature 40 ± 2°C
Inlet feed pressure	0,1 bar
Nozzles	ISO 4010
Nozzle opening pressure	172 + 3 − 0 bar
H.P. pipes	6 × 2 × 845 mm (ISO 4093.2)
H.P. outlet connections	Original

- All deliveries (other than critical deliveries) to be over 200 strokes except for test/s 7 using 100 strokes.
- Note 1:
  Critical fuel deliveries are given in mm^3/stroke. Hence the tester must determine the number of strokes applicable in accordance with the test m/c manufacturer's instructions.
- A 2,5 mm shim is fitted to the piston spring cap on assembly.
  This must NOT be removed.
  No additional shimming is required.

Connect transfer pressure gauge to solenoid hole using adaptor.

- Throttle and shut-off levers to be fully open unless otherwise stated.
- Maximum fuel adjusting screw to be screwed out until it protrudes 15,0 mm above surface of locknut.
- Screw transfer pressure adjuster fully out and then 1,5 turns in before commencing test.
- Latch valve adjuster to be flush with surface of its locknut.
- Fully back off idling screw.
- Fully back off maximum speed screw.
- Fit auto-advance gauge and set to zero before commencing test.
- Where marked thus * use 30 seconds glass draining time and allow fuel to settle for 15 seconds before taking readings unless stated otherwise by the test bench manufacturer's instructions.

TEST PLAN – FORD 555C, 256 cu. in. (4195 cc) Engine continued

Test	Operation	RPM	Requirements
1	Priming	200	Obtain delivery from all injectors and backleak
2	Stabilisation	1000	Run pump for 3 minutes
3	Transfer pressure check	100	0,4 bar (6 lbf/in²) minimum
4	Advance setting	700	Adjust transfer pressure screw to obtain advance of 3,5° (2,76 mm)
5	Transfer pressure check	700	4,0 to 5,2 bar (59 to 75 lbf/in²)
6	Full advance check	900	5,25° to 6,25° (4,14 to 4,93 mm)
7	Back leakage	900	40 to 100 cm³ per 100 strokes time cycle. (Flow rate 360 to 900 cm³/min.)
	Stop test machine. Remove transfer pressure gauge. Fit and energise solenoid. Re-start test machine and prime as in test 1.		
8	Maximum delivery setting. See Note 1	*1100	56,0 ± 0,5 mm³/stroke Spread between lines not to exceed 5,0 mm³/stroke
9	Governor setting	1220	Set throttle by max. speed adjustment screw to give average delivery of between 5,0 and 6,0 cm³. Lock stop screw.
10	Governor cut-off check	1280	Average delivery to be not more than 1,6 cm³
11	Delivery check	1100	Delivery to be as at test 9 ± 0,3 cm³
	Run test machine down to 100 rpm and stop. Screw latch valve adjuster fully in. Re-start test machine.		
12	Latch valve setting	200	Screw latch valve adjuster fully in, then screw out until advance reads 1,25° to 2,0° (0,98 to 1,58 mm). Lock adjuster.
	Run test machine down to 100 rpm and stop. Re-start test machine.		
13	Excess fuel delivery check	150	Average delivery to be 20 cm³ minimum with advance at 0°.
	Move throttle lever to closed position for tests 14, 15 and 16		
14	Idling delivery	280	With throttle lever against idle screw, set delivery to 3,0 to 3,5 cm³ using idle screw. Lock screw.
15	Cut-off operation	280	With shut-off lever closed, average delivery not to exceed 0,5 cm³.
16	Solenoid shut-off check	280	De-energise solenoid and wait for 5 seconds before operating trip gear. Average delivery not to exceed 0,5 cm³.
17	Timing		Using outlet 'X' (55 bar pressure) set indexing tool to 261°. Scribe a line on pump housing flange.

TEST PLAN – FORD 655C, 268 cu. in. (4390 cc) Engine

DPS DISTRIBUTOR TYPE FUEL INJECTION PUMP – TYPE NUMBER DPS 8520A 600A TO 9A

BASIC PUMP SPECIFICATION

Rotation (Looking on drive end)	Clockwise
Governor type	Mechanical all-speed
Throttle lever link hole No.	1
Governor link length	41,5 mm ± 0,5 mm
Diameter of plungers	7 mm × 4 off
Drive arrangement	20 mm dia. taper drive with supported shaft
Advance type	Automatic speed with start retard
Mounting spigot diameter	50 mm

Special features

Scroll plate max. fuel adjustment with hydraulic excess fuel device.
Transfer pressure adjuster in end plate.
Timing mark on flange.
Cambox non-return valve incorporated in backleak connection.
Axial outlet head with pressurising valve incorporated.
Internal venting via flatted metering valve.
Solenoid shut-off device, 12 volts.

ISO TEST CONDITIONS. (IMPORTANT: Read Explanatory Notes)

These figures, for service use only, have been compiled on, and must only be used on, a test machine conforming to International Standard ISO 4008.

Test oil	ISO 4113 at temperature 40 ± 2°C
Inlet feed pressure	0,1 bar
Nozzles	ISO 4010
Nozzle opening pressure	172 + 3 − 0 bar
H.P. pipes	6 × 2 × 845 mm (ISO 4093.2)
H.P. outlet connections	Original

- All deliveries (other than critical deliveries) to be over 200 strokes except for test/s 7 using 100 strokes.
- Note 1:
  Critical fuel deliveries are given in mm^3/stroke. Hence the tester must determine the number of strokes applicable in accordance with the test m/c manufacturer's instructions.
- A 2,5 mm shim is fitted to the piston spring cap on assembly.
  This must NOT be removed.
  No additional shimming is required.

Connect transfer pressure gauge to solenoid hole using adaptor.

- Throttle and shut-off levers to be fully open unless otherwise stated.
- Maximum fuel adjusting screw to be screwed out until it protrudes 10,0 mm above surface of locknut.
- Screw transfer pressure adjuster fully out and then 1,5 turns in before commencing test.
- Latch valve adjuster to be flush with surface of its locknut.
- Fully back off idling screw.
- Fully back of maximum speed screw.
- Fit auto-advance gauge and set to zero before commencing test.
- Where marked thus * use 30 seconds glass draining time and allow fuel to settle for 15 seconds before taking readings unless stated otherwise by the test bench manufacturer's instructions.

TEST PLAN – FORD 655C, 268 cu. in. (4390 cc) Engine continued

Test	Operation	RPM	Requirements
1	Priming	200	Obtain delivery from all injectors and backleak
2	Stabilisation	1000	run pump for 3 minutes
3	Transfer pressure check	100	0,4 bar (6 lbf/in²) minimum
4	Advance setting	700	Adjust transfer pressure screw to obtain advance of 3,5° (2,76 mm)
5	Transfer pressure check	700	4,0 to 5,2 bar (59 to 75 lbf/in²)
6	Full advance check	900	5,25° to 6,25° (4,14 to 4,93 mm)
7	Back leakage	900	40 to 100 cm³ per 100 strokes time cycle. (Flow rate 360 to 900 cm³/min.)
	Stop test machine. Remove transfer pressure gauge. Fit and energise solenoid. Re-start test machine and prime as in test 1.		
8	Maximum delivery setting. See Note 1	*1100	61,0 ± 0,5 mm³/stroke Spread between lines not to exceed 5,0 mm³/stroke
9	Governor setting	1220	Set throttle by max. speed adjustment screw to give average delivery of between 5,0 and 6,0 cm³. Lock stop screw.
10	Governor cut-off check	1280	Average delivery to be not more than 1,6 cm³
11	Delivery check	1100	Delivery to be as at test 9 ± 0,3 cm³
	Run test machine down to 100 rpm and stop. Screw latch valve adjuster fully in. Re-start test machine.		
12	Latch valve setting	200	Screw latch valve adjuster fully in, then screw out until advance reads 1,25° to 2,0° (0,98 to 1,58 mm). Lock adjuster.
	Run test machine down to 100 rpm and stop. Re-start test machine.		
13	Excess fuel delivery check	150	Average delivery to be 20 cm³ minimum with advance at 0°.
	Move throttle lever to closed position for tests 14, 15 and 16		
14	Idling delivery	280	With throttle lever against idle screw, set delivery to 3,0 to 3,5 cm³ using idle screw. Lock screw.
15	Cut-off operation	280	With shut-off lever closed, average delivery not to exceed 0,5 cm³
16	Solenoid shut-off check	280	De-energise solenoid and wait for 5 seconds before operating trip gear. Average delivery not to exceed 0,5 cm³
17	Timing		Using outlet 'X' (55 bar pressure) set indexing tool to 263°. Scribe a line on pump housing flange.

DELIVERY MEASUREMENT SYSTEM CONVERSION CHART

mm³ per Stroke per Cyl	cm³ in 50 Shots	cm³ in 100 Shots	cm³ in 200 Shots	cm³ in 300 Shots	cm³ in 400 Shots	cm³ in 500 Shots	cm³ in 600 Shots	cm³ in 700 Shots	cm³ in 800 Shots	cm³ in 900 Shots	cm³ in 1000 Shots
0,1	0,005	0,01	0,02	0, 03	0,04	0,05	0,06	0,07	0,08	0,09	0,10
0,2	0,010	0,02	0,04	0,06	0,08	0,10	0,12	0,14	0,16	0,18	0,20
0,3	0,015	0,03	0,06	0,09	0,12	0,15	0,18	0,21	0,24	0,27	0,30
0,4	0,020	0,04	0,08	0,12	0,16	0,20	0,24	0,28	0,32	0,36	0,40
0,5	0,025	0,05	0,10	0,15	0,20	0,25	0,30	0,35	0,40	0,45	0,50
0,6	0,030	0,06	0,12	0,18	0,24	0,30	0,36	0,42	0,48	0,54	0,60
0,7	0,035	0,07	0,14	0,21	0,28	0,35	0,42	0,49	0,56	0,63	0,70
0,8	0,040	0,08	0,16	0,24	0,32	0,40	0,48	0,56	0,64	0,72	0,80
0,9	0,045	0,09	0,18	0,27	0,36	0,45	0,54	0,63	0,72	0,81	0,90
1	0,05	0,10	0,20	0,30	0,40	0,50	0,60	0,70	0,80	0,90	1,00
2	0,10	0,20	0,40	0,60	0,80	1,00	1,20	1,40	1,60	1,80	2,00
3	0,15	0,30	0,60	0,90	1,20	1,50	1,80	2,10	2,40	2,70	3,00
4	0,20	0,40	0,80	1,20	1,60	2,00	2,40	2,80	3,20	3,60	4,00
5	0,25	0,50	1,00	1,50	2,00	2,50	3,00	3,50	4,00	4,50	5,00
6	0,30	0,60	1,20	1,80	2,40	3,00	3,60	4,20	4,80	5,40	6,00
7	0,35	0,70	1,40	2,10	2,80	3,50	4,20	4,90	5,60	6,30	7,00
8	0,40	0,80	1,60	2,40	3,20	4,00	4,80	5,60	6,40	7,20	8,00
9	0,45	0,90	1,80	2,70	3,60	4,50	5,40	6,30	7,20	8,10	9,00
10	0,50	1,00	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00	10,00
11	0,55	1,10	2,20	3,30	4,40	5,50	6,60	7,70	8,80	9,90	11,00
12	0,60	1,20	2,40	3,60	4,80	6,00	7,20	8,40	9,60	10,80	12,00
13	0,65	1,30	2,60	3,90	5,20	6,50	7,80	9,10	10,40	11,70	13,00
14	0,70	1,40	2,80	4,20	5,60	7,00	8,40	9,80	11,20	12,60	14,00
15	0,75	1,50	3,00	4,50	6,00	7,50	9,00	10,50	12,00	13,50	15,00
16	0,80	1,60	3,20	4,80	6,40	8,00	9,60	11,20	12,80	14,40	16,00
17	0,85	1,70	3,40	5,10	6,80	8,50	10,20	11,90	13,60	15,30	17,00
18	0,90	1,80	3,60	5,40	7,20	9,00	10,80	12,60	14,40	16,20	18,00
19	0,95	1,90	3,80	5,70	7,60	9,50	11,40	13,30	15,20	17,10	19,00
20	1,00	2,00	4,00	6,00	8,00	10,00	12,00	14,00	16,00	18,00	20,00
21	1,05	2,10	4,20	6,30	8,40	10,50	12,60	14,70	16,80	18,90	21,00
22	1,10	2,20	4,40	6,60	8,80	11,00	13,20	15,40	17,60	19,80	22,00
23	1,15	2,30	4,60	6,90	9,20	11,50	13,80	16,10	18,40	20,70	23,00
24	1,20	2,40	4,80	7,20	9,60	12,00	14,40	16,80	19,20	21,60	24,00
25	1,25	2,50	5,00	7,50	10,00	12,50	15,00	17,50	20,00	22,50	25,00
26	1,30	2,60	5,20	7,80	10,40	13,00	15,60	18,20	20,80	23,40	26,00
27	1,35	2,70	5,40	8,10	10,80	13,50	16,20	18,90	21,60	24,30	27,00
28	1,40	2,80	5,60	8,40	11,20	14,00	16,80	19,60	22,40	25,20	28,00
29	1,45	2,90	5,80	8,70	11,60	14,50	17,40	20,30	23,20	26,10	29,00
30	1,50	3,00	6,00	9,00	12,00	15,00	18,00	21,00	24,00	27,00	30,00
31	1,55	3,10	6,20	9,30	12,40	15,50	18,60	21,70	24,80	27,90	31,00
32	1,60	3,20	6,40	9,60	12,80	16,00	19,20	22,40	25,60	28,80	32,00
33	1,65	3,30	6,60	9,90	13,20	16,50	19,80	23,10	26,40	29,70	33,00
34	1,70	3,40	6,80	10,20	13,60	17,00	20,40	23,80	27,20	30,60	34,00
35	1,75	3,50	7,00	10,50	14,00	17,50	21,00	24,50	28,00	31,50	35,00
36	1,80	3,60	7,20	10,80	14,40	18,00	21,60	25,20	28,80	32,40	36,00
37	1,85	3,70	7,40	11,10	14,80	18,50	22,20	25,90	29,60	33,30	37,00
38	1,90	3,80	7,60	11,40	15,20	19,00	22,80	26,60	30,40	34,20	38,00
39	1,95	3,90	7,80	11,70	15,60	19,50	23,40	27,30	31,20	35,10	39,00
40	2,00	4,00	8,00	12,00	16,00	20,00	24,00	28,00	32,00	36,00	40,00

mm³ per Stroke per Cyl	cm³ in 50 Shots	cm³ in 100 Shots	cm³ in 200 Shots	cm³ in 300 Shots	cm³ in 400 Shots	cm³ in 500 Shots	cm³ in 600 Shots	cm³ in 700 Shots	cm³ in 800 Shots	cm³ in 900 Shots	cm³ in 1000 Shots
41	2,05	4,10	8,20	12,30	16,40	20,50	24,60	28,70	32,80	36,90	41,00
42	2,10	4,20	8,40	12,60	16,80	21,00	25,20	29,40	33,60	37,80	42,00
43	2,15	4,30	8,60	12,90	17,20	21,50	25,80	30,10	34,40	38,70	43,00
44	2,20	4,40	8,80	13,20	17,60	22,00	26,40	30,80	35,20	39,60	44,00
45	2,25	4,50	9,00	13,50	18,00	22,50	27,00	31,50	36,00	40,50	45,00
46	2,30	4,60	9,20	13,80	18,40	23,00	27,60	32,20	36,80	41,40	46,00
47	2,35	4,70	9,40	14,10	18,80	23,50	28,20	32,90	37,60	42,30	47,00
48	2,40	4,80	9,60	14,40	19,20	24,00	28,80	33,60	38,40	43,20	48,00
49	2,45	4,90	9,80	14,70	19,60	24,50	29,40	34,30	39,20	44,10	49,00
50	2,50	5,00	10,00	15,00	20,00	25,00	30,00	35,00	40,00	45,00	50,00
51	2,55	5,10	10,20	15,30	20,40	25,50	30,60	35,70	40,80	45,90	51,00
52	2,60	5,20	10,40	15,60	20,80	26,00	31,20	36,40	41,60	46,80	52,00
53	2,65	5,30	10,60	15,90	21,20	26,50	31,80	37,10	42,40	47,70	53,00
54	2,70	5,40	10,80	16,20	21,60	27,00	32,40	37,80	43,20	48,60	54,00
55	2,75	5,50	11,00	16,50	22,00	27,50	33,00	38,50	44,00	49,50	55,00
56	2,80	5,60	11,20	16,80	22,40	28,00	33,60	39,20	44,80	50,40	56,00
57	2,85	5,70	11,40	17,10	22,80	28,50	34,20	39,90	45,60	51,30	57,00
58	2,90	5,80	11,60	17,40	23,20	29,00	34,80	40,60	46,40	52,20	58,00
59	2,95	5,90	11,80	17,70	23,60	29,50	35,40	41,30	47,20	53,10	59,00
60	3,00	6,00	12,00	18,00	24,00	30,00	36,00	42,00	48,00	54,00	60,00
61	3,05	6,10	12,20	18,30	24,40	30,50	36,60	42,70	48,80	54,90	61,00
62	3,10	6,20	12,40	18,60	24,80	31,00	37,20	43,40	49,60	55,80	62,00
63	3,15	6,30	12,60	18,90	25,20	31,50	37,80	44,10	50,40	56,70	63,00
64	3,20	6,40	12,80	19,20	25,60	32,00	38,40	44,80	51,20	57,60	64,00
65	3,25	6,50	13,00	19,50	26,00	32,50	39,00	45,50	52,00	58,50	65,00
66	3,30	6,60	13,20	19,80	26,40	33,00	39,60	46,20	52,80	59,40	66,00
67	3,35	6,70	13,40	20,10	26,80	33,50	40,20	46,90	53,60	60,30	67,00
68	3,40	6,80	13,60	20,40	27,20	34,00	40,80	47,60	54,40	61,20	68,00
69	6,45	6,90	13,80	20,70	27,60	34,50	41,40	48,30	55,20	62,10	69,00
70	3,50	7,00	14,00	21,00	28,00	35,00	42,00	49,00	56,00	63,00	70,00
71	3,55	7,10	14,20	21,30	28,40	35,50	42,60	49,70	56,80	63,90	71,00
72	3,60	7,20	14,40	21,60	28,80	36,00	43,20	50,40	57,60	64,80	72,00
73	3,65	7,30	14,60	21,90	29,20	36,50	43,80	51,10	58,40	65,70	73,00
74	3,70	7,40	14,80	22,20	29,60	37,00	44,40	51,80	59,20	66,60	74,00
75	3,75	7,50	15,00	22,50	30,00	37,50	45,00	52,50	60,00	67,50	75,00
76	3,80	7,60	15,20	22,80	30,40	38,00	45,60	53,20	60,80	68,40	76,00
77	3,85	7,70	15,40	23,10	30,80	38,50	46,20	53,90	61,60	69,30	77,00
78	3,90	7,80	15,60	23,40	31,20	39,00	46,80	54,60	62,40	70,20	78,00
79	3,95	7,90	15,80	23,70	31,60	39,50	47,40	55,30	63,20	71,10	79,00
80	4,00	8,00	16,00	24,00	32,00	40,00	48,00	56,00	64,00	72,00	80,00
81	4,05	8,10	16,20	24,30	32,40	40,50	48,60	56,70	64,80	72,90	8100
82	4,10	8,20	16,40	24,60	32,80	41,00	49,20	57,40	65,60	73,80	82,00
83	4,15	8,30	16,60	24,90	33,20	41,50	49,80	58,10	66,40	74,70	83,00
84	4,20	8,40	16,80	25,20	33,60	42,00	50,40	58,80	67,20	75,60	84,00
85	4,25	8,50	17,00	25,50	34,00	42,50	51,00	59,50	68,00	76,50	85,00
86	4,30	8,60	17,20	25,80	34,40	43,00	51,60	60,20	68,80	77,40	86,00
87	4,35	8,70	17,40	26,10	34,80	43,50	52,20	60,90	69,60	78,30	87,00
88	4,40	8,80	17,60	26,40	35,20	44,00	52,80	61,60	70,40	79,20	88,00
89	4,45	8,90	17,80	26,70	35,60	44,50	53,40	62,30	71,20	80,10	89,00
90	4,50	9,00	18,00	27,00	36,00	45,00	54,00	63,00	72,00	81,00	90,00

mm³ per Stroke per Cyl	cm³ in 50 Shots	cm³ in 100 Shots	cm³ in 200 Shots	cm³ in 300 Shots	cm³ in 400 Shots	cm³ in 500 Shots	cm³ in 600 Shots	cm³ in 700 Shots	cm³ in 800 Shots	cm³ in 900 Shots	cm³ in 1000 Shots
91	4,55	9,10	18,20	27,30	36,40	45,50	54,60	63,70	72,80	81,90	91,00
92	4,60	9,20	18,40	27,60	36,80	46,00	55,20	64,40	73,60	82,80	92,00
93	4,65	9,30	18,60	27,90	37,20	46,50	55,80	65,10	74,40	83,70	93,00
94	4,70	9,40	18,80	28,20	37,60	47,00	56,40	65,80	75,20	84,60	94,00
95	4,75	9,50	19,00	28,50	38,00	47,50	57,00	66,50	76,00	85,50	95,00
96	4,80	9,60	19,20	28,80	38,40	48,00	57,60	67,20	76,80	86,40	96,00
97	4,85	9,70	19,40	29,10	38,80	48,50	58,20	67,90	77,60	87,30	97,00
98	4,90	9,80	19,60	29,40	39,20	49,00	58,80	68,60	78,40	88,20	98,00
99	4,95	9,90	19,80	29,70	39,60	49,50	59,40	69,30	79,20	89,10	99,00
100	5,00	10,00	20,00	30,00	40,00	50,00	60,00	70,00	80,00	90,00	100,00
200	10,00	20,00	40,00	60,00	80,00	100,00	120,00	140,00	160,00	180,00	200,00
300	15,00	30,00	60,00	90,00	120,00	150,00	180,00	210,00	240,00	270,00	300,00
400	20,00	40,00	80,00	120,00	160,00	200,00	240,00	280,00	320,00	360,00	400,00
500	25,00	50,00	100,00	150,00	200,00	250,00	300,00	350,00	400,00	450,00	500,00

EVERY EFFORT HAS BEEN MADE TO ENSURE THAT THE DATA GIVEN ON TEST PLANS IS ACCURATE BUT LUCAS CAV LIMITED CANNOT GUARANTEE THAT PUMPS SET TO THESE FIGURES WILL REPEAT ORIGINAL ENGINE PERFORMANCE AS THIS IS DEPENDENT ON MANY FACTORS IN ADDITION TO THE FUEL INJECTION EQUIPMENT.

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PART 3
ELECTRICAL SYSTEM

Chapter 1
WIRING, LIGHTS AND CONTROLS

Chapter 2
BATTERY

Chapter 3
STARTING SYSTEM

Chapter 4
CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR

Chapter 5
TROUBLE SHOOTING, SPECIFICATIONS AND SPECIAL TOOLS

PART 3
ELECTRICAL SYSTEM

Chapter 1
WIRING, LIGHTS AND CONTROLS

A. WIRING, LIGHTS AND CONTROLS – DESCRIPTION AND OPERATION

The Ford 455C, 555C and 655C Industrial tractors utilise a conventional type electrical system featuring a 12 volt lead acid wet battery, an alternator and a pre-engaged starting motor.

To reduce wiring harness complexity all main harnesses with exception of the cab roof harness and roll over protection system are common irrespective of vehicle build.

The lighting specifications for the various models differ according to local government regulations and to accommodate these variations separate fender harnesses connect directly into the main instrument and lighting harness to complete the lighting circuits.

The main wiring harnesses can be divided into four categories, as follows:-

1. Engine and transmission harness.
2. Steering console harness.
3. Instrument and lighting harness.
4. Roof harness.

The approximate locations of these harnesses are shown in Figure 1.

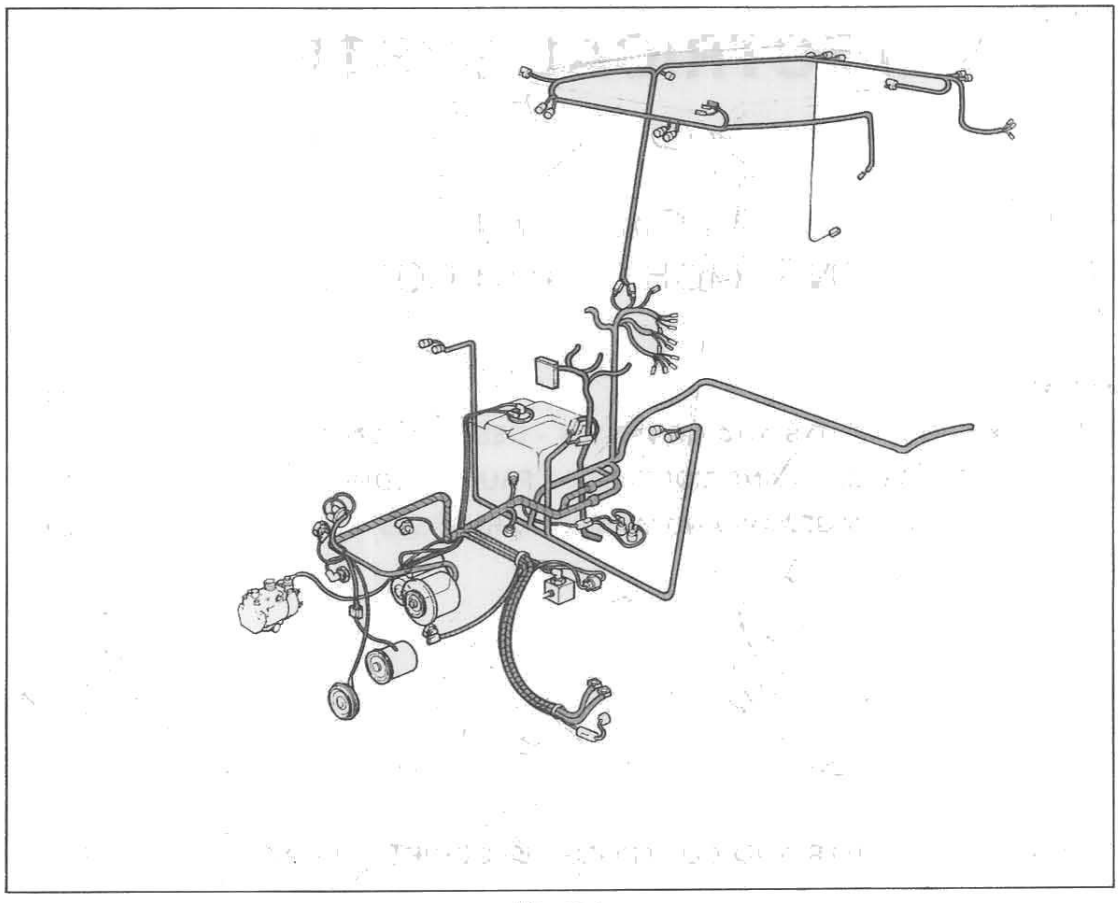


Figure 1
Ford 455C, 555C and 655C with Cab Industrial Tractors
Electrical System Wiring Harness Locations

- Engine and Transmission Harness
- Steering and Console Harness
- Instrument and Lighting Harness
- Roof Harness

The main wiring harnesses are interconnected by either screw type or snap type multipin connectors.

The connectors are conveniently located and provide ideal wiring break points for performing continuity tests of the vehicle wiring.

The pins on the screw type connectors are individually numbered and correspond to the connector pin numbers on the wiring diagrams.

On the snap type connectors pin numbers are not always identified on the connector moulding and in these instances reference should be made to the colour codes on the wiring diagrams.

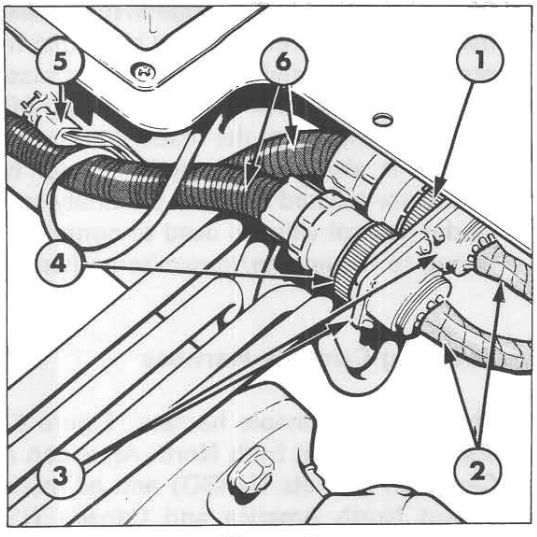


Figure 2
Engine and Transmission to Instrument and Lighting Harness Connectors

1. Plastic Locking Ring
2. Instrument Lighting Harness
3. Connectors (Screw Type)
4. Plastic Locking Ring
5. Transmission Disconnect Harness
6. Engine and Transmission Harness

Location of the main wiring harnesses connectors are as follows:-

The engine and transmission harness is connected to the instrument and lighting harness using two large screw type connectors located beneath the cab floor, Figure 2.

The steering console harness is located beneath the front console and connects to the instrument and lighting harness using a screw type and snap type connector as shown in Figure 3.

Two snap type connectors, Figure 4, located in the right hand control console at the base of the "B" pillar connect the roof harness for both with cab and roll over protection system

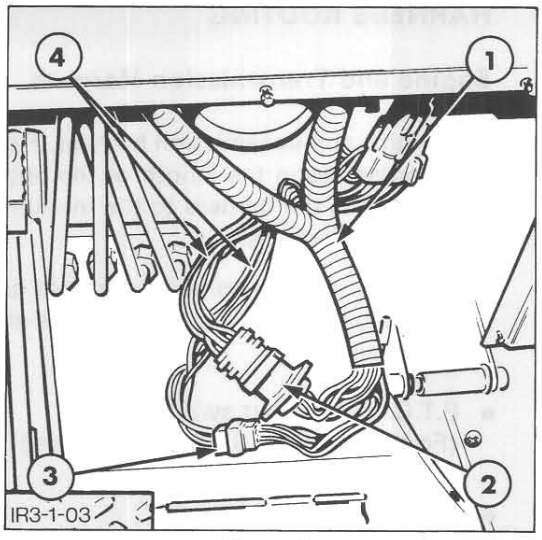


Figure 3
Steering Console to Instrument and Lighting Harness Connectors

1. Steering Console Harness
2. Screw Type Connector
3. Snap Type Connector
4. Instrument and Lighting Harness

frame models to the instrument and lighting harness.

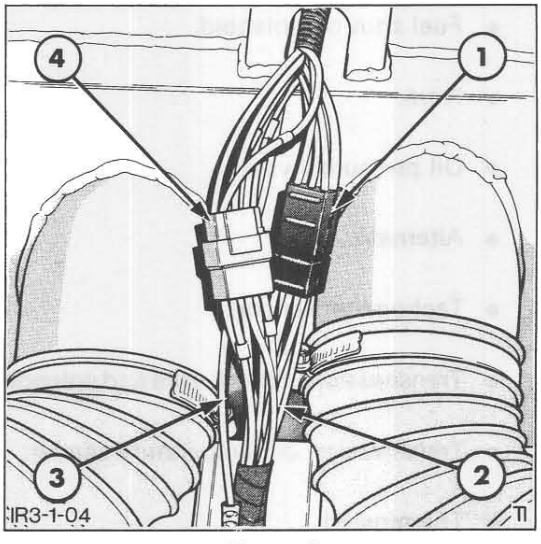


Figure 4
Roof Harness to Instrument and Lighting Harness Connectors

1. Connector (6 Pin)
2. Instrument and Lighting Harness
3. Radio Feed
4. Connector (8 Pin)

HARNESS ROUTING

Engine and Transmission Harness

The engine and transmission harness, Figure 5, is routed along the length of the engine and connects the harness to the instrument and lighting harness.

The engine and transmission harness connects the following components to the electrical system:

- P.T.O. Safety start switch (Ford 455C with 8 × 8 transmission)
- Fuel tank level sender.
- Air cleaner restrictor switch.
- Water temperature warning switch.
- Water temperature switch.
- Starter motor solenoid.
- Starter motor.
- Fuel shut off solenoid.
- Horn.
- Oil pressure switch.
- Alternator.
- Tachometer sensor.
- Transmission control valve and solenoids.
- Transmission oil temperature sender.
- Thermostart.
- Air conditioning compressor clutch.
- Battery temperature sender.
- Battery.

Also connected to the engine/transmission harness is the wiring for the hydraulic filter pressure differential switch and transmission disconnect buttons. On 555C and 655C Units the wiring for the loader return to dig system is also incorporated. A snap type connector located in close proximity to the loader control valve is used to connect this wiring to the engine/transmission harness.

Steering Console Harness

The steering console harness, Figure 6, is adaptable to suit both North American and Canadian markets (NASO) and all markets except North America and Canada (ISO) lighting requirements. In order to achieve this adaptability two turn indicator connectors are provided in the harness, one for NASO and a second for ISO requirements. When the harness is connected only the appropriate connector for the vehicle build is used and the remaining connector left disconnected. Similarly, where an electrical component is not fitted the connector or wiring is also left free beneath the console after ensuring any bare wires are fully insulated to prevent a short circuit from occurring.

The steering console harness connects the following components to the electrical system.

- Brake light switch.
- Transmission control lever.
- Transmission modulator.
- Indicator light panel.
- Stop light switch.
- Washer motor.
- Turn indicator switch.
- Accessory socket.

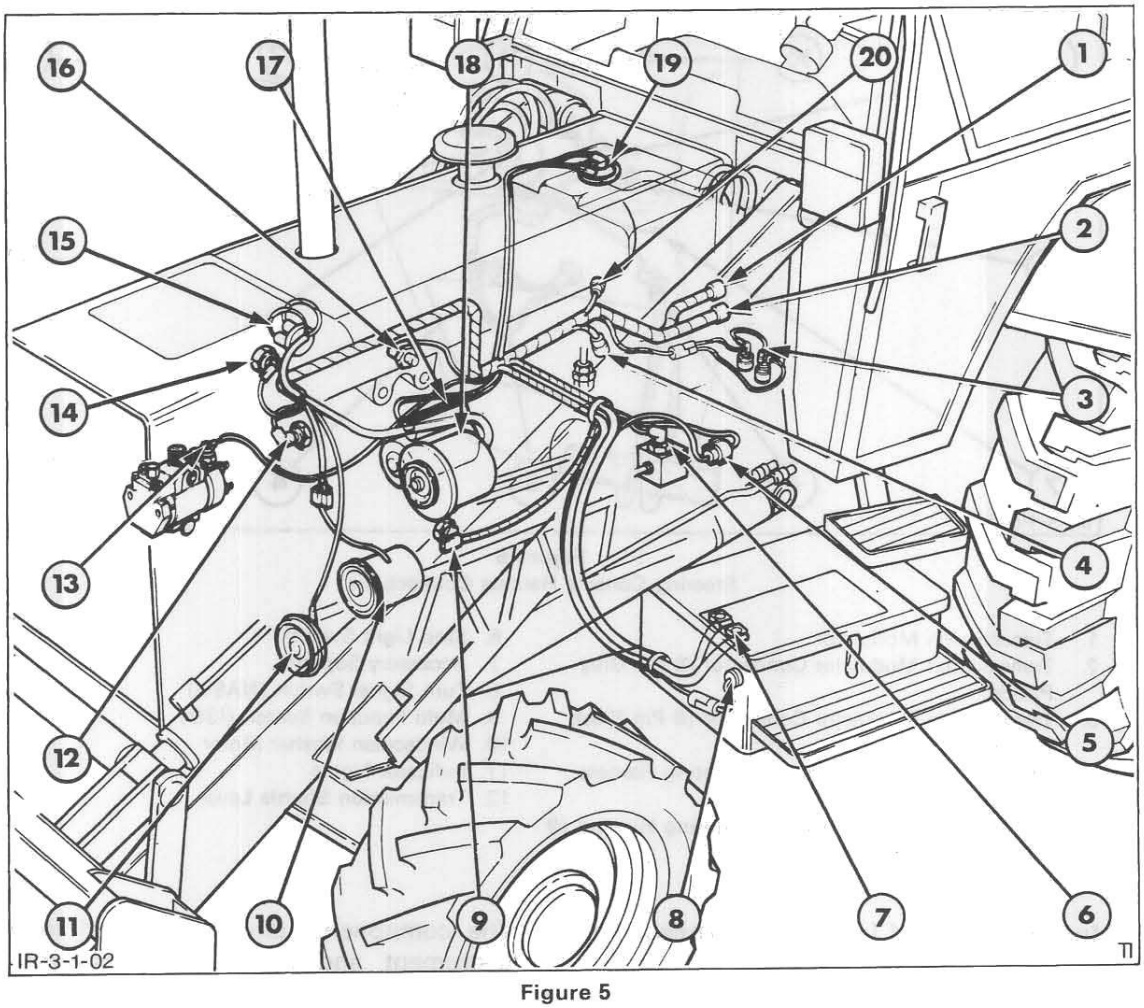


Figure 5
Engine and Transmission Harness

1. Screw Type Connector (7 Pin)
2. Screw Type Connector (24 Pin)
3. Safety Start Switch
4. P.T.O. Safety Start Switch (with PTO)
5. Transmission Control Connector (with 4 × 4 Transmission)
6. Transmission Oil Temperature Sender
7. Battery
8. Battery Temperature Sensor
9. Engine Oil Pressure Switch
10. Air Conditioning Compressor
11. Horn
12. Engine Temperature Sender
13. Fuel Shut Off Solenoid
14. Thermostart
15. Air Cleaner Restriction Switch
16. Engine Temperature Warning Switch
17. Starter Motor and Solenoid
18. Alternator
19. Fuel Tank Level Sender
20. Return to Dig, Hydraulic Filter and Transmission Disconnect Button Harness Connector.

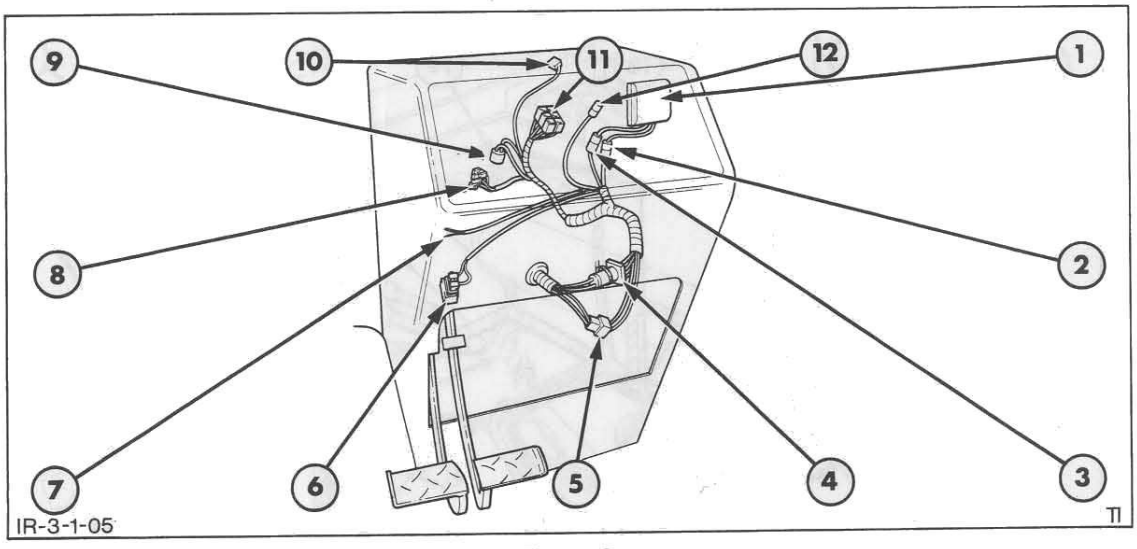


Figure 6
Steering Console Harness Connections

1. Transmission Modulator
2. Transmission Modulator Connector (8 Pin Grey Plastic)
3. Transmission Modulator Connector (8 Pin Black Plastic)
4. Connection to Instrument and Lighting Harness (22 Pin Screw Type)
5. Connection to Instrument and Lighting Harness (9 Pin Snap Type)
6. Stop Light Switch
7. Accessory Supply
8. Turn Signal Switch (NASO)
9. Multi Function Switch (ISO)
10. Windscreen Washer Motor
11. Indicator Lights
12. Transmission Shuttle Lever

Instrument and Lighting Harness

The instrument and lighting harness is the main harness on the vehicle and is adaptable to suit both NASO and ISO build standards. The harness is situated beneath the cab floor, Figure 7, and inter connects the engine and transmission, steering console and roof harnesses into the electrical system.

Where lighting regulations between NASO and ISO markets are different two sets of connectors are provided in the harness and only the appropriate connectors for the lighting specification required is connected. Similarly, where a build option or dealer installed accessory is not fitted, appropriate connectors are also not connected.

The components directly attached to the instrument and lighting harness are as follows:-

- Fuses and relays.
- Front and rear side/indicator lights and switches.
- Hazard light switch.
- Work light switches.
- Fog light switch.
- Rotating beacon switch.
- Fuel gauge.
- Temperature gauge.
- Hourmeter.
- Tachometer.

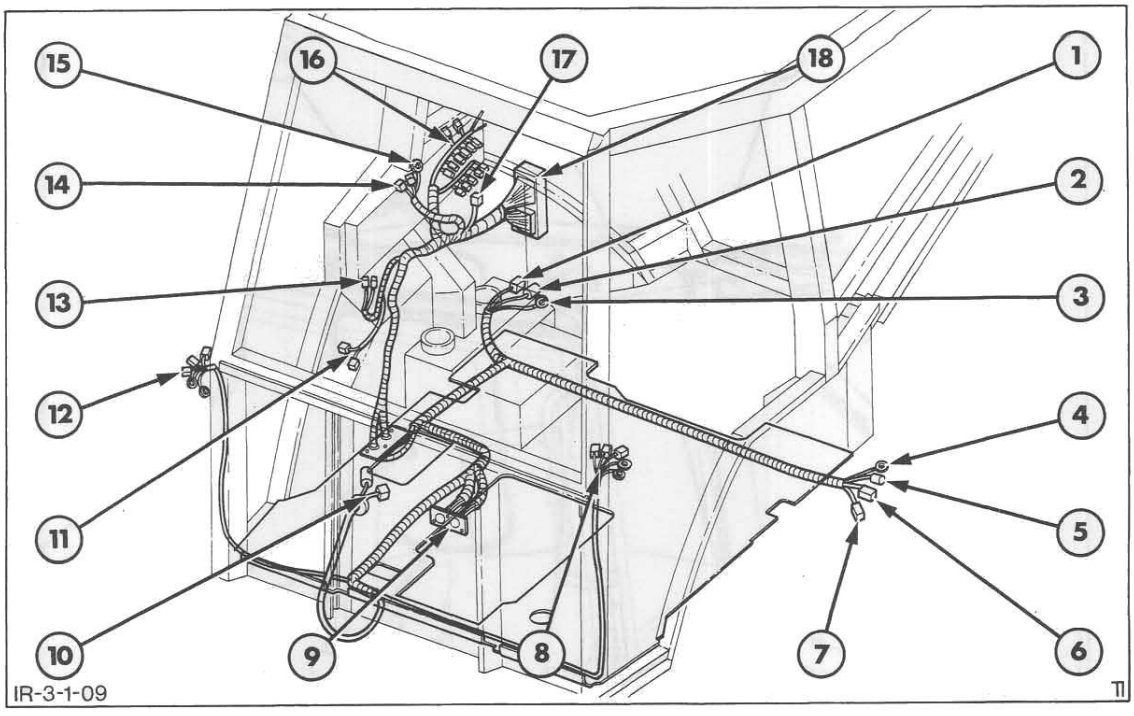


Figure 7
Instrument and Lighting Harness Connections

1. Right Hand Fender Lights
2. Rear Horn
3. Reversing Alarm
4. Rear Fog Light
5. Ploughlamp
6. Trailer Socket
7. Left Hand Fender Lights
8. Left Hand Front Light Cluster
9. Connection to Engine and Transmission Harness
10. Connection to Steering Console Harness
11. Right Hand Front Light Cluster
12. Handbrake Warning Buzzer and Light Switch (Where Fitted)
13. Blower Motor Switch
14. Connection to Roof Harness
15. Radio Feed
16. Instrument Console
17. Hazard Flasher Unit (ISO)
18. Fuses, Relays and Warning Buzzers

- Key start switch.
- Handbrake switch (where fitted).
- Instrument warning buzzer (where fitted).
- Front and rear windscreen wipers.
- Horn button.
- Reversing audible alarm.
- Headlights and switch.
- Radio feed.

Roof Harness

Two types of roof harness are available, one for with cab models and a similar but simpler version for Units built with the roll over protection frame.

Figure 8 illustrates the routing of the roof harness for with cab models and Figure 9, the routing for roll over protection frame models. As with the other harnesses any connectors supplied with the harness for options not fitted to the Unit are left disconnected.

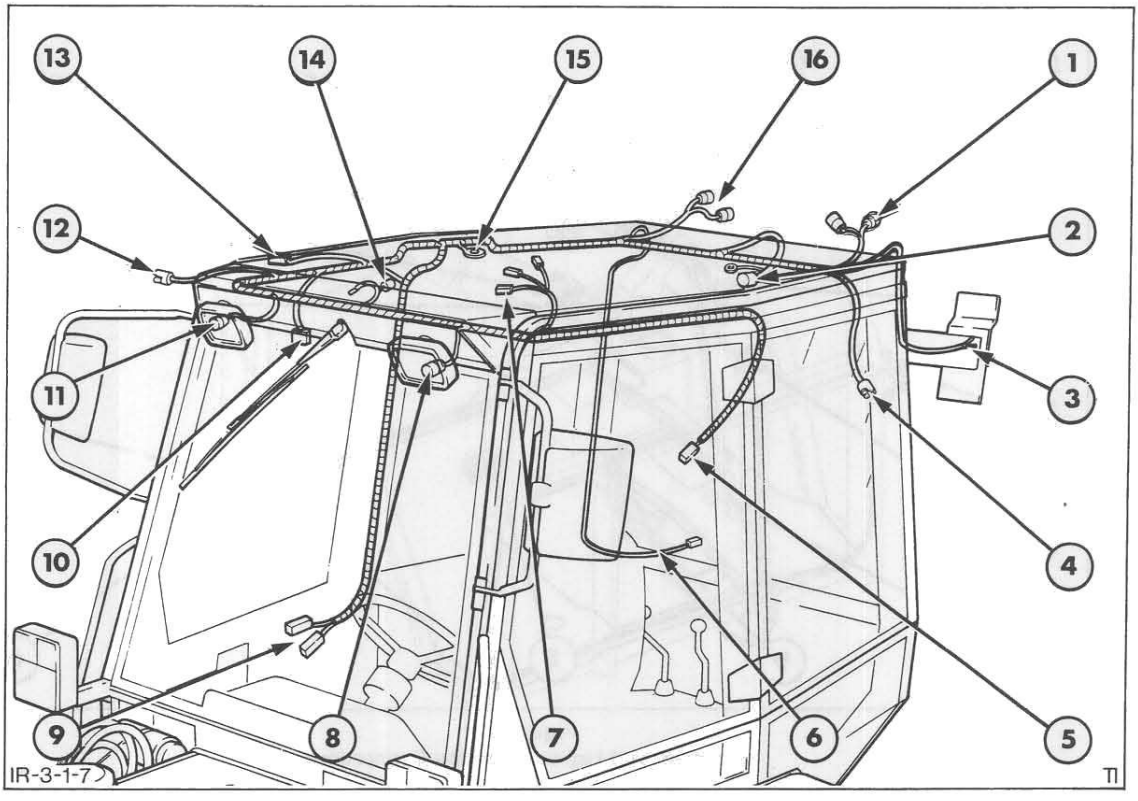


Figure 8
Roof Harness Connections With Cab

1. Rear Work Light
2. Rear Windscreen Motor
2. License Plate Light
4. Rear Rotating Beacon
5. Door Switch
6. Rear Window Fan
7. Courtesy Light
8. Front Work Light
9. Connection to Instrument and Lighting Harness
10. Air Conditioning
11. Front Work Light
12. Front Rotating Beacon
13. Door Switch
14. Front Windscreen Motor
15. Earth

The electrical components connected by the roof harness are as follows:-

With Cab Models

- Front and rear work lights.
- Headlights and side lights.
- Front and rear windscreen motors.
- License plate light.
- Front and rear rotating beacons.
- Door switches.
- Courtesy light.
- Air conditioning unit.
- Rear window ran.

With Roll Over Protection Frame Models

- Front and rear work lights.
- License plate light.
- Front and rear rotating beacons.

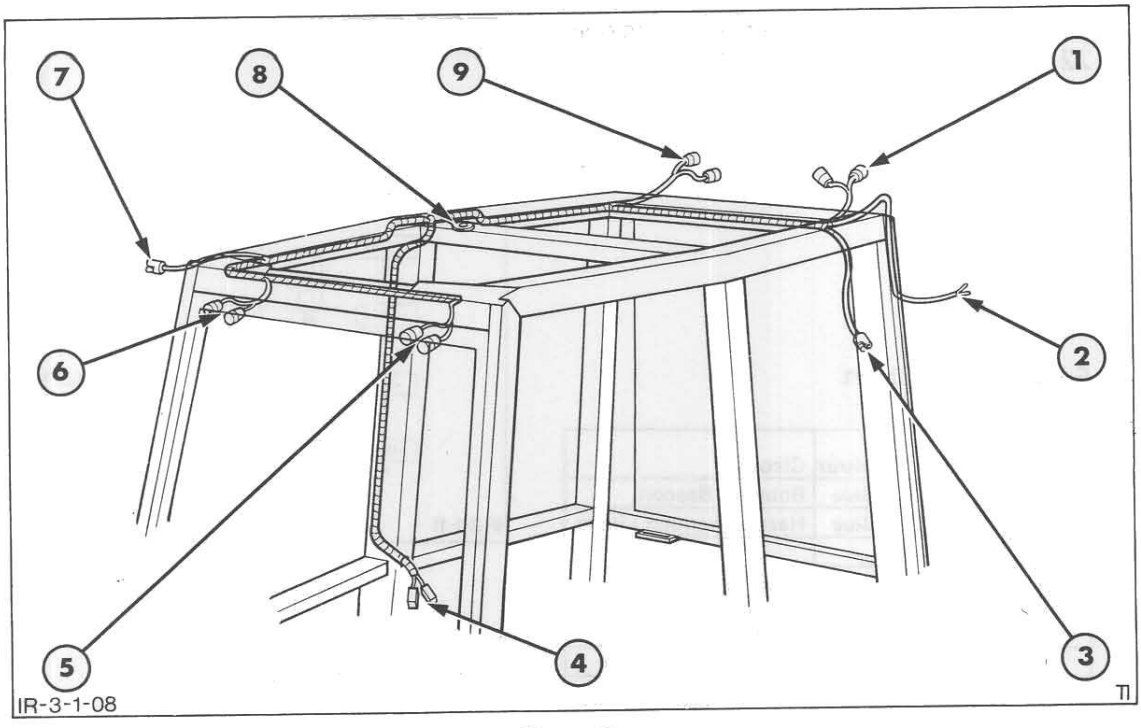


Figure 9
Roof Harness Connections With Roll Over Protection Frame

1. Rear Work Light
2. License Plate Light
3. Rear Rotating Beacon
4. Connection to Instrument and Lighting Harness
5. Front Work Light
6. Front Working Light
7. Front Rotating Beacon
8. Earth
9. Rear Work Light

FUSES AND RELAYS

The fusebox, Figure 10, is located at the rear of the instrument console on the right-hand side of the unit. To gain access to the fuses, withdraw the retaining screws and remove the fuse cover.

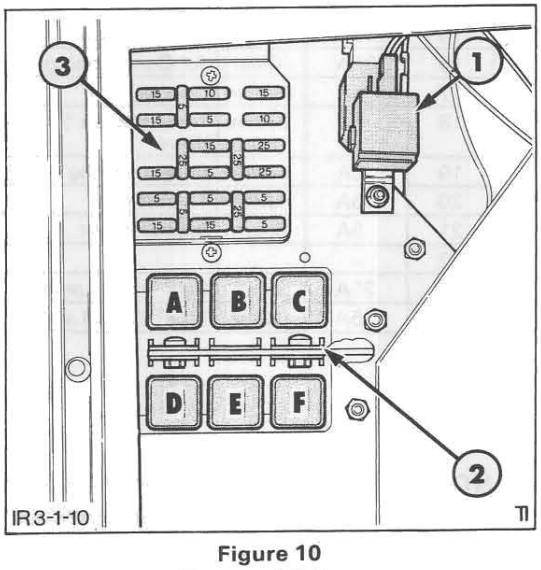


Figure 10
Fuses and Relays

1. Warning Buzzer
2. Relays
3. Fuses

A Starter Relay
B Warning Light Earthing Relay
C Air Conditioning Relay
D Front Work Lamp Relay
E Rear Work Lamp Relay
F Warning Buzzer Relay

The six relays used in the engine starting, worklamp, air conditioning and warning buzzer circuits are positioned below the fuse box assembly. Reference should be made to Figure 10 for relay identification.

There is provision for 24 fuses, although only 22 are fitted. The fuses are numbered and the table and Figure 11 will permit rapid identification of the circuits they protect.

Fuse Rating Chart

Fuse No.	Rating	Colour	Circuit
1	15A	Blue	Rotating Beacon
2	15A	Blue	Hazard Warning Lights
3	–	–	
4	15A	Blue	Headlight Switch
5	5A	Brown	R.H. Side/Rear Lights and Fog Lamp
6	15A	Blue	Headlight Dip Beam
7	10A	Red	Turn Signals
8	5A	Brown	Fuel Shut-Off
9	15A	Blue	Wipe/Wash
10	5A	Brown	Radio
11	5A	Brown	L.H. Side/Rear Lights and Instrument Lights
12	15A	Blue	Headlight Main Beam
13	15A	Blue	Stop Lights
14	10A	Red	Horn
15	25A	Clear	Heater Blower
16	25A	Clear	Air Conditioning
17	5A	Brown	Gauges
18	5A	Brown	Transmission Shuttle Valve
19	5A	Brown	Return-to-Dig
20	25A	Clear	Thermostart
21	5A	Brown	Interior Light
22	–	–	
23	25A	Clear	Rear Work Lamps
24	25A	Clear	Front Work Lamps

NOTE: *Certain optional items of equipment may not be installed on the Unit however, the fuses are still installed and may be used as spares.*

Do not replace a blown fuse with another of a different rating.

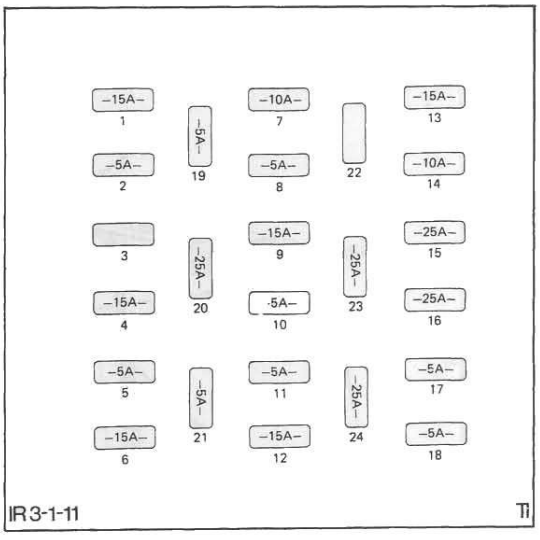


Figure 11
Fuse Identification

INSTRUMENT CONSOLE

The instrument console is illustrated in Figure 12. The upper section of the console contains two panels. The left-hand panel contains two gauges and seven indicator lights which give warnings of a system malfunction or provide operating information.

The right-hand panel contains

EITHER:

A proofmeter indicating engine speed in revolutions per minute, on an analogue type display, sensed from the tractor alternator. Also incorporated within the proofmeter is an electro-mechanical digital hourmeter which records true time when the key-start/stop switch is turned "ON".

OR

An electro-mechanical digital hourmeter without the proofmeter (tachometer) installed.

Where necessary, the proofmeter may be fitted to all units as a dealer installed accessory without any modifications to the wiring harness.

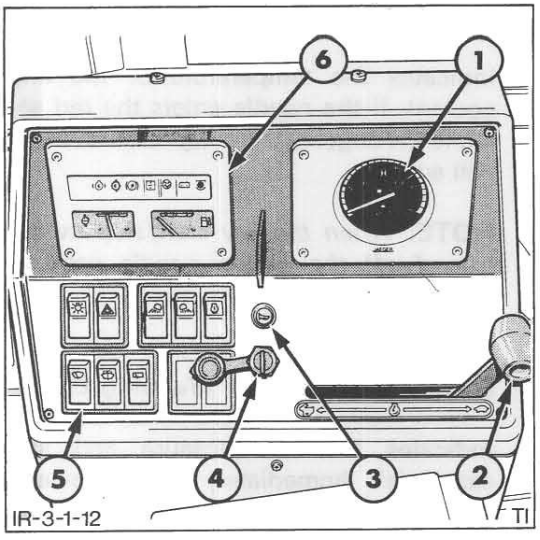


Figure 12
Instrument Console

1. Proofmeter
2. Hand throttle
3. Horn push
4. Key-start/stop switch
5. Rocker switches
6. Gauges and indicator warning light panel

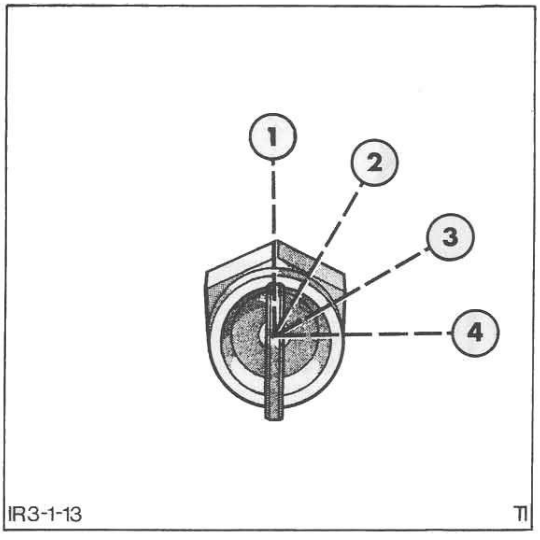


Figure 13
Key-Start/Stop Switch

1. Electrical equipment "OFF"
2. Accessories "ON"
3. Warning lights and instruments "ON"
4. Starting motor operates

Rocker switches in the bottom left-hand panel control the headlights, worklamps, hazard warning lights, windscreen wipers and windscreen wash.

Certain tractor functions have been classed as critical. They are:

- Engine coolant temperature.
- Engine oil pressure.
- Transmission oil temperature.

In the event of a fault occurring in one of the above functions an audible alarm will sound until the malfunction is corrected or the key-start/stop switch is turned off.

NOTE: *On Units where the parking brake engagement audible alarm has been disconnected no attempt should be made to reconnect the circuit even though the wiring is still incorporated within the wiring harness.*

In order to test the operation of the audible alarm system the warning buzzer will also sound when the key start/stop switch is turned to the warning lights and instruments "ON" position shown in Figure 13.

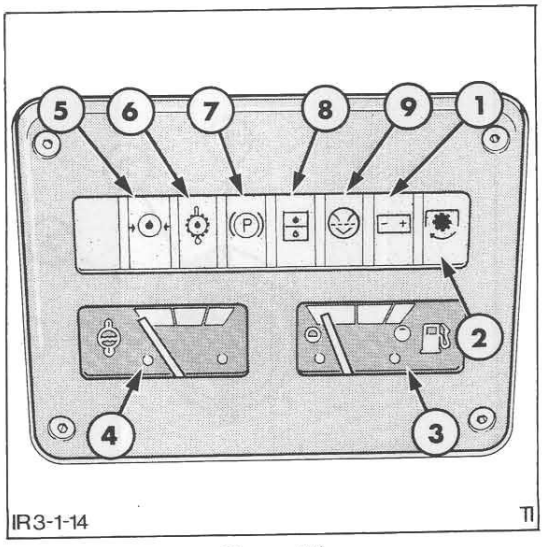


Figure 14
Indicator Warning Light Panel

1. Alternator Charge Warning Light
2. P.T.O. Engaged Warning Light (where fitted)
3. Fuel Level Gauge
4. Engine Coolant Temperature Gauge
5. Engine Oil Pressure Warning Light
6. Transmission Oil Temperature Warning Light
7. Parking Brake Warning Light (where fitted)
8. Hydraulic System Filter By-Pass Warning Light
9. Air Cleaner Restriction Warning Light

The function and operation of the instrument console switches and warning lights as shown in Figures 13 & 14 are as follows.

Alternator Charge Warning Light

Indicates the battery is not being charged and should extinguish when the engine speed is increased above idle.

P.T.O. Engaged Warning Light (Ford 455C with 8 × 8 Transmission only)

Indicates the P.T.O. lever is in the disengaged position. The lever must be disengaged before starting the motor.

Fuel Level Gauge

Indicates the level of fuel in the tank and is only operative with the key-start/stop switch in the "ON" position.

NOTE: *When the key-start/stop switch is turned off the gauge needle assumes a random position.*

Engine Coolant Temperature Gauge

Indicates the temperature of the engine coolant. If the needle enters the red sector while the engine is running the audible alarm will sound.

NOTE: *When the key-start/stop switch is turned off the gauge needle assumes a random position.*

Engine Oil Pressure Warning Light

Indicates low oil pressure and should extinguish immediately after the engine starts. Should the oil pressure drop below a predetermined level the warning light will illuminate and the audible alarm will sound.

Transmission Oil Temperature Warning Light

Should the transmission oil temperature exceed a predetermined level the warning light will illuminate and the audible alarm will sound. If the warning light illuminates, place the transmission in neutral, check that the oil level is correct and run the engine at 1000 – 1200 rev/min. until the warning light goes out and the audible alarm no longer sounds.

Hydraulic System Filter By-Pass Warning Light

Should the hydraulic system oil filter become blocked the warning light will illuminate to indicate the filter requires servicing.

NOTE: *The warning light may stay illuminated for a few minutes after engine start up in cold ambient temperatures. Run the engine until the light is extinguished before operating the tractor hydraulic system.*

Air Cleaner Restriction Warning Light

Will illuminate when the air cleaner requires servicing.

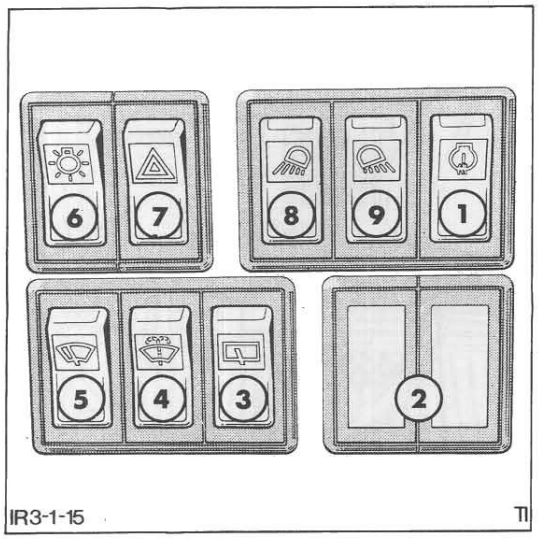


Figure 15
Rocker Switches

1. Thermostart switch
2. Blanks for dealer installed accessories
3. Rear windscreen wiper switch
4. Front windscreen washer switch
5. Front windscreen wiper switch
6. Tractor lights switch
7. Hazard warning lights switch
8. Front work lamp switch (where fitted)
9. Rear work lamp switch

Thermostart Switch

The rocker switch is of the spring loaded type, depress and hold the front of the switch to activate the thermostart. The thermostart switch should be used in conjunction with the key-start/stop switch and reference should be made to the Operator's Manual for thermostart operating instructions.

Rear Windscreen Wiper Switch (with cab)

The single speed self-parking rear windscreen wiper is actuated when the front of the switch is depressed.

Front Windscreen Washer Switch (with cab)

The rocker switch is of the spring loaded return type. Depress and hold the front of the switch to activate the electric windscreen washer.

Front Windscreen Wiper Switch (with cab)

The two speed front windscreen wiper is operated by a 3-way rocker type switch, the rear position being off, the centre position actuates the slow wiper speed and the foremost position actuating the fast speed. The wiper arm is self-parking.

Tractor Lights Switch

The rocker switch is of the 3-way type and operation of the switch differs between NASO and ISO markets as follows:-

NASO markets: The bottom switch position is off, the centre position actuates the rear tail and instrument panel lights and the top position, the rear tail lights, front tractor lights and instrument panel lights.

ISO markets: The bottom switch is off, the centre position actuates the side lights and instrument panel lights. The top position actuates the side lights, headlights and instrument panel lights. Selection of main or dip beam is by means of the stalk-type switch mounted on the steering column, refer to Figure 17. When the headlight main beam is selected the warning light will be illuminated.

Hazard Warning Lights Switch

The switch is internally illuminated and when actuated will flash in unison with all the tractor turn signals, and the green warning lights on the steering console.

The hazard warning lights on NASO tractors will only operate with the key-start/stop switch turned "ON".

Front Worklamp Switch (ISO markets)

The front worklamps will only operate with the tractor light rocker switch actuated for headlight dip or main beam operation. When the worklamp switch is depressed the headlight dip beam will extinguish leaving the tractor side lights and worklamps illuminated.

Rear Worklamp Switch

The switch is internally illuminated and when actuated the rear worklamps will operate independently of the side or headlights.

Key-Start/Stop Switch

Actuates the starting motor and stops the engine.

Horn Push

Press to actuate the horn. The horn will only operate when the key-start/stop switch is turned "ON".

Accessories

The blanking caps fitted in the panel may be removed, and rocker switches installed to operate dealer installed accessories such as a rotating beacon, rear fog lamp etc. The power feed for these accessories is fed directly to the rocker switches through the connectors provided in the instrument and lighting harness into which the switches should be fitted.

STEERING CONSOLE

The steering console instrument controls differ between NASO and ISO market requirements as illustrated in Figures 15 & 16. The function and operation of the lights and switches are as follows.

Turn Signal Indicator Lights

The turn signal indicator lights will flash in unison with the turn signal lights.

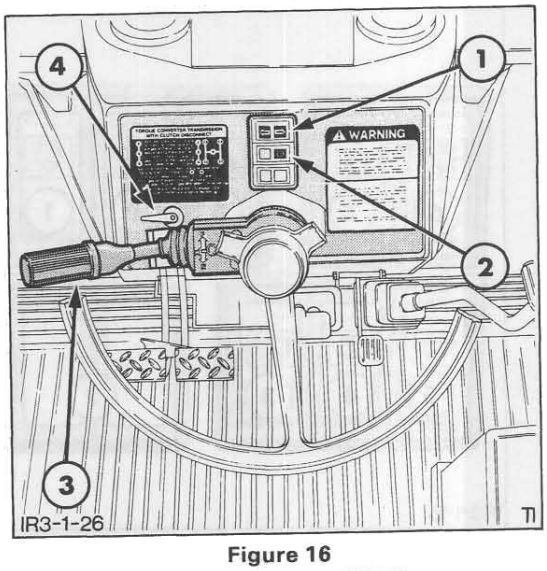


Figure 16
Steering Console – NASO

1. Turn signal indicator lights
2. Torque converter lock-up warning light – 8 × 8 transmission only
3. Power-reversing lever
4. Turn signal switch

Turn Signal Switch (NASO markets only)

The turn signal indicator lights are operated by the switch mounted on the steering console, Figure 16. When the switch is operated, the turn signal light towards the turn will flash while the opposite light burns continuously.

Multi-Function Switch (Ford 555C and 655C ISO markets)

The stalk-type switch is mounted on the steering column, Figure 17 . The switch operates the horn, turn signals and headlight flash and is also used to select main or dipped beam.

Pressing in the end of the stalk actuates the horn. The stalk will operate the right-hand turn signal if moved clockwise and the left-hand turn signal if moved anti-clockwise. The turn signal warning light (and trailer lights, if connected), will also flash when the turn signals are operated.

With the headlights switched on, push the stalk downwards to select main beam. The blue warning light on the instrument panel will also illuminate. Pull the stalk back to the central position to select dip beam.

Pull the stalk further back, against the spring pressure, to flash the headlight main beam. The stalk will automatically return to the central, dip beam position when released.

NOTE: *The horn, headlight flash and turn signals will only operate when the key-start/stop switch is turned "ON".*

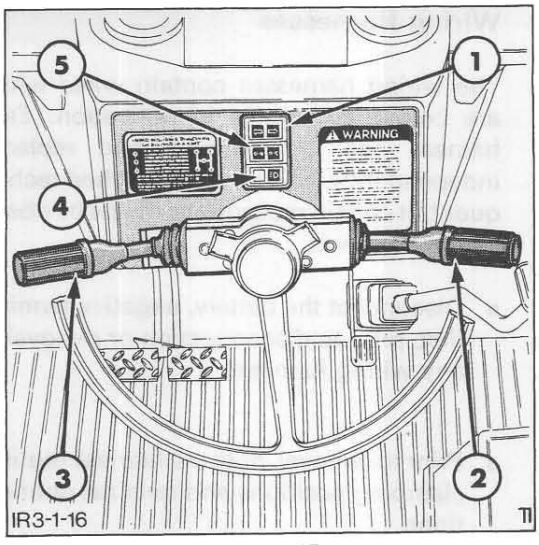


Figure 17
Steering Console
Ford 555C and 655C-ISO

1. Turn signal indicator lights
2. Multi-function switch
3. Power-reversing lever
4. Headlight main beam warning light
5. Trailer turn signal indicator lights

B. WIRING LIGHTS AND CONTROLS – FAULT FINDING AND REPAIR

General:

No special tools are required to remove or replace electrical components. Refer to the appropriate section of this Repair Manual for overhaul procedures to cover the starter motor and alternator.

If an electrical fault is identified, check fuses for capacity and rating before commencing with stripdown and continuity testing of the wiring harnesses.

Fault finding of electrical systems should be carried out in a logical and methodical fashion. A few minutes spent understanding the system and analysing the concern can save considerable time.

An essential piece of equipment for checking electrical systems is a good quality multimeter with a high impedence which can measure voltage, current and resistance.

IMPORTANT: *Care should be exercised when using the instrument. In particular, resistance measurements MUST NOT be made on the transmission control module. When measuring the continuity of wiring, it is necessary to isolate the transmission control module. When working with a multimeter it is good practice to work from a higher range downwards to avoid damaging the instrument.*

Where it is necessary to clean the multipin connectors a contact spray should be used. DO NOT USE ANY OTHER METHOD FOR CLEANING THE TERMINALS.

DO NOT use a cleaner that contains trichlorethylene which will dissolve the plastic connectors. It is preferable to use a cleaner with a Freon TF base.

Wiring Harnesses

The wiring harnesses contain wires which are colour coded for identification. Each harness can be removed and replaced independently following established techniques but certain precautions musts be observed as follows:

- Disconnect the battery, negative terminal first, prior to disconnection or removal of any wiring harness.
- Prior to removal, note the harness routing, clamping positions and terminal connections.
- On replacement, ensure the harness routing and clamping is as specified and not in contact with sharp edges, the exhaust system or moving parts.
- Check connections for wire colour matching (where applicable).
- Ensure all connectors are fully engaged and no conductor is exposed.
- Tape back unused connectors.
- Ensure ground connections are clean with metal-to-metal contact. Use toothed lock washers where specified.
- Ensure fuses are of the specified rating.
- Check the circuit current draw before connecting power to the harness.
- Check polarity of the battery before connecting power to the harness.

CONNECT POSITIVE TO POSITIVE AND NEGATIVE TO NEGATIVE.

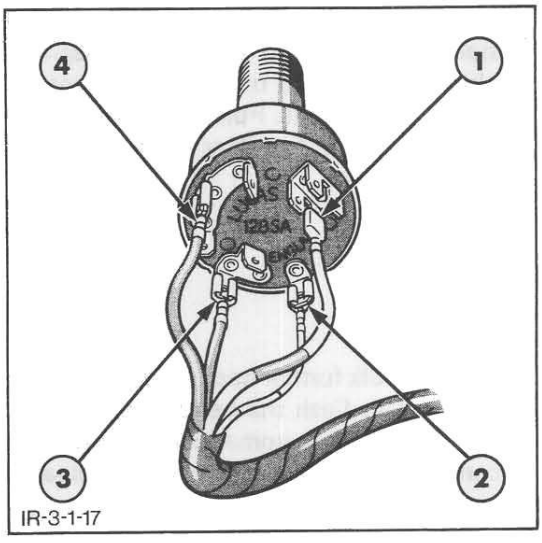


Figure 18
Ignition Switch Wiring

1. Run Terminal – Yellow/White Wire
2. Start Terminal – Thin White/Yellow Wire
3. Instrument and Alternator – Brown/Yellow Wire
4. Feed from Battery – Brown Wire

When it is necessary to remove or partially disconnect a wiring harness, label each connector before removal from its mating instrument. Labelling of connectors prior to disassembly will greatly assist in reconnecting the harness.

Should the harness be inadvertently disconnected at either the instrument console or ignition switch reference should be made to Figures 18 and 19 to ensure that the wires are reconnected to the correct terminals.

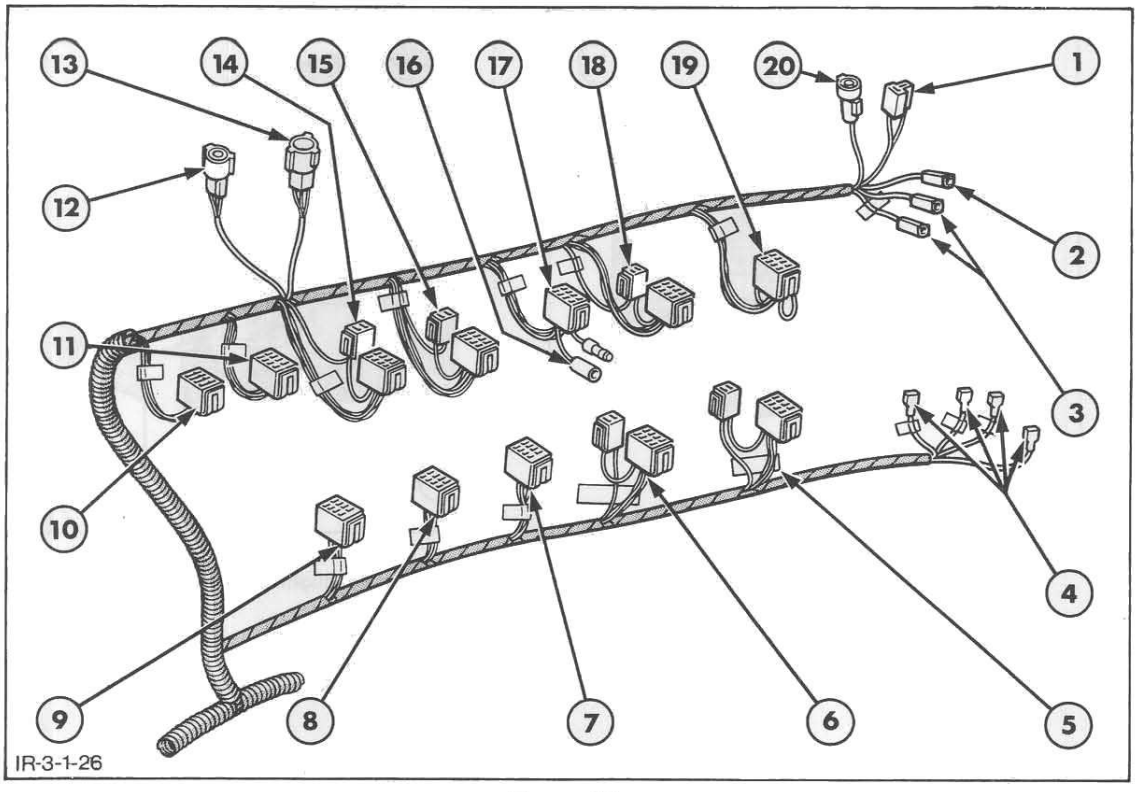


Figure 19
Instrument Console Wiring Connectors

1. Hourmeter
2. Rear Horn (Where Fitted)
3. Horn Button
4. Ignition Switch
5. Fog Light Switch
6. Rotating Beacon Switch
7. Rear Windscreen Wiper Switch
8. Windscreen Washer Switch
9. Front Windscreen Wiper Switch
10. Headlamp Switch (NASO)
11. Headlamp Switch (ISO)
12. Instrument Cluster
13. Instrument Cluster
14. Hazard Warning Switch (NASO)
15. Hazard Warning Switch (ISO)
16. Worklamp Bridging Connectors (Less Cab ISO Units)
17. Front Worklamp Switch (NASO)
18. Rear Worklamp Switch
19. Thermostart Switch
20. Tachometer

In section C of this Chapter are a series of circuit diagrams which detail the individual harnesses and circuits used in the 455C, 555C and 655C vehicles. Reference to the appropriate circuit diagram is essential in tracing electrical concerns in the system.

Reference should also be made to Figures 2, 3 and 4 at the front of this Chapter which identifies the location of the main multipin connectors at which the harnesses can be disconnected to perform continuity tests.

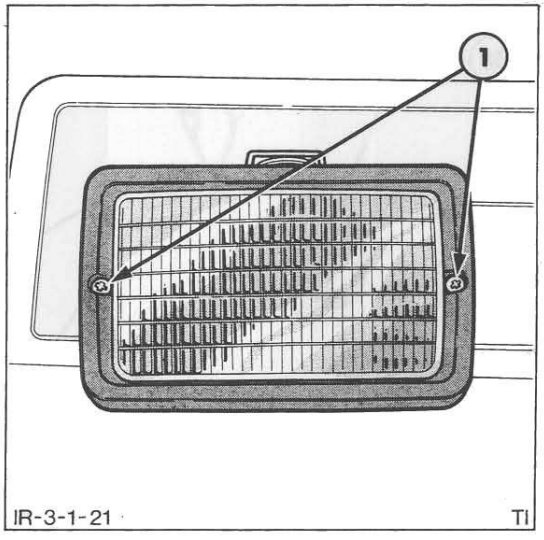


Figure 20
Worklamp Bulb Replacement

1. Bezel Retaining Screws

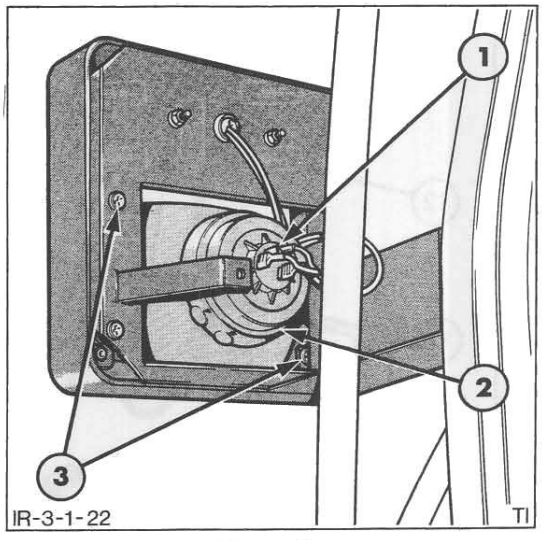


Figure 21
Headlight Bulb Replacement

1. Wiring Connectors
2. Spring Clip
3. Rear Cover Retaining Screws

BULB REPLACEMENT

Worklamp

To gain access to the bulb, extract the two securing screws and remove the lamp bezel and lens/reflector assembly, Figure 20. Release the spring clip and extract the bulb from the back of the reflector assembly. Detach the connector from the bulb.

Replacement of the bulb follows the removal procedure in reverse.

NOTE: *All headlights and worklamps have halogen bulbs. Never touch a halogen bulb with the fingers. Natural moisture in the skin will cause the bulb to burn out when the lamp is switched on. Always use a clean cloth or tissue when handling halogen bulbs.*

Headlight – ISO Markets

To gain access to the bulb, extract the three securing screws and remove the rear cover assembly.

Detach the connectors, remove the rubber cover and release the spring clip, Figure 21. Extract the bulb from the lamp assembly. Replacement of the bulb follows the removal procedure in reverse.

To gain access to the headlight beam adjustment screws remove the headlight rear cover as previously described.

The headlights are retained by three spring-loaded screws. The beam may be adjusted vertically or laterally by turning one or more of the screws in or out, as required.

Rear, Stop and Indicator Lights

All bulbs are accessible after the moulded plastic lens assembly has been removed. Insert a suitable screwdriver between the lens and the lamp casing and pry the tangs at either end of the lamp casing away from the lens, refer to Figure 22. Remove the lens assembly.

The bulbs have a bayonet cap fitting and may be removed by depressing slightly and rotating approximately 20° anti-clockwise.

Replacement of the bulb follows the removal procedure in reverse. The lens is replaced by positioning within the casing and depressing until the tangs in the casing lock onto the lens.

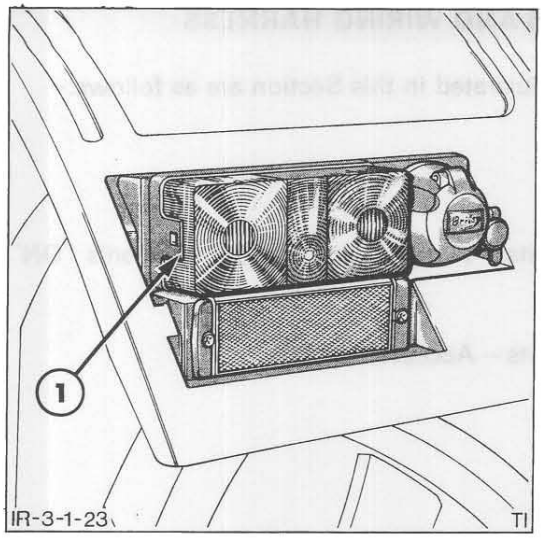


Figure 22
Rear, Stop and Indicator Lights

1. Tang

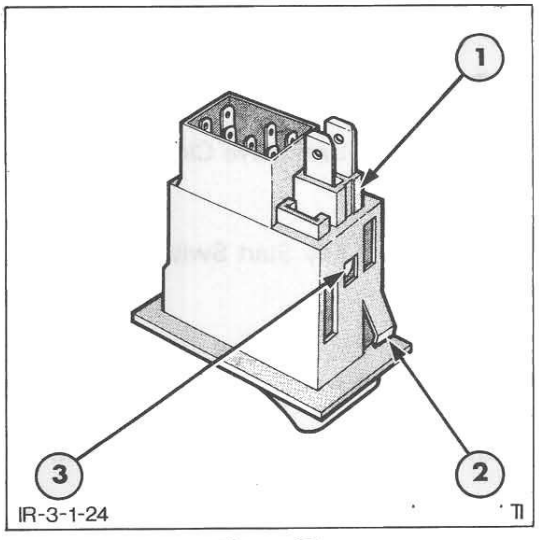


Figure 23
Rocker Switch Bulb Replacement

1. Bulb Retainer
2. Sprung Tang
3. Tang

Interior Lamp

The interior lamp bulbs are accessible after removal of the moulded plastic lens cover. Depress the cover and rotate approximately 5° clockwise to remove. The bulb may be removed by exerting outward pressure on one of the retaining tangs and sliding the opposite end of the bulb from its retaining tang. Installation of the bulb and lens cover follow the removal procedure in reverse.

Rocker Switch Bulb

Certain of the rocker switches are internally illuminated, the bulb being removable from the rear of the switch assembly. To gain access, remove the instrument panel.

The switch assembly is retained by a sprung tang at either end. Press in the tangs and remove the switch assembly from the console.

To change a bulb, press in the tang using a small screwdriver and pull the bulb retainer from the back of the switch, refer to Figure 23. The bulb is of the capless type, rated at 1.2W and is a push fit in the retainer. After changing the bulb, push the retainer into the back of switch until the tang locates in the aperture.

Instrument Panel Bulb

The warning and panel light bulbs are removable from the front of the instrument panel. To gain access, remove the panel lens. The bulb is of the capless type, rated at 1.2W and is a push fit in the retainer, Figure 24.

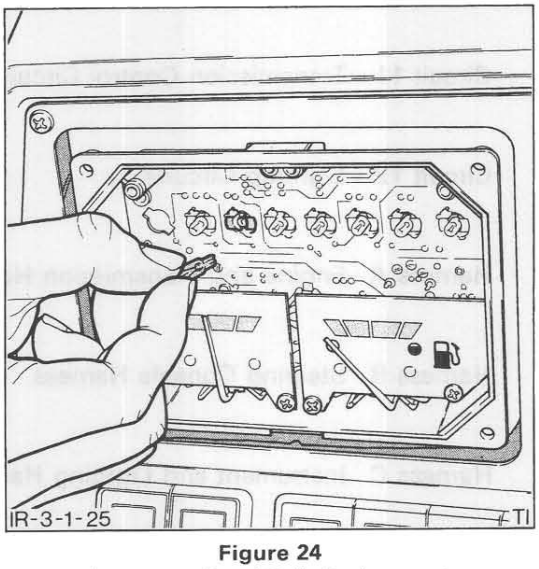


Figure 24
Instrument Panel Bulb Replacement

C CIRCUIT DIAGRAMS AND WIRING HARNESS

The circuit diagrams and wiring harnesses illustrated in this Section are as follows:-

Circuit 1 Basic Live Circuits.

Circuit 2 Key Start Switch Operated Circuits – Warning Lights and Instruments "ON".

Circuit 3 Key Start Switch Operated Circuits – Accessories "ON".

Circuit 4 Engine Cranking Circuit.

Circuit 5 Thermostart Circuit.

Circuit 6 Instrumentation Circuits.

Circuit 7 Alarm Protected Circuits.

Circuit 8 Turn Indicator and Hazard Warning Circuits (NASO).

Circuit 9 Turn Indicator and Hazard Warning Circuits (ISO).

Circuit 10 Loader Return To Dig Circuit.

Circuit 11 Transmission Control Circuits.

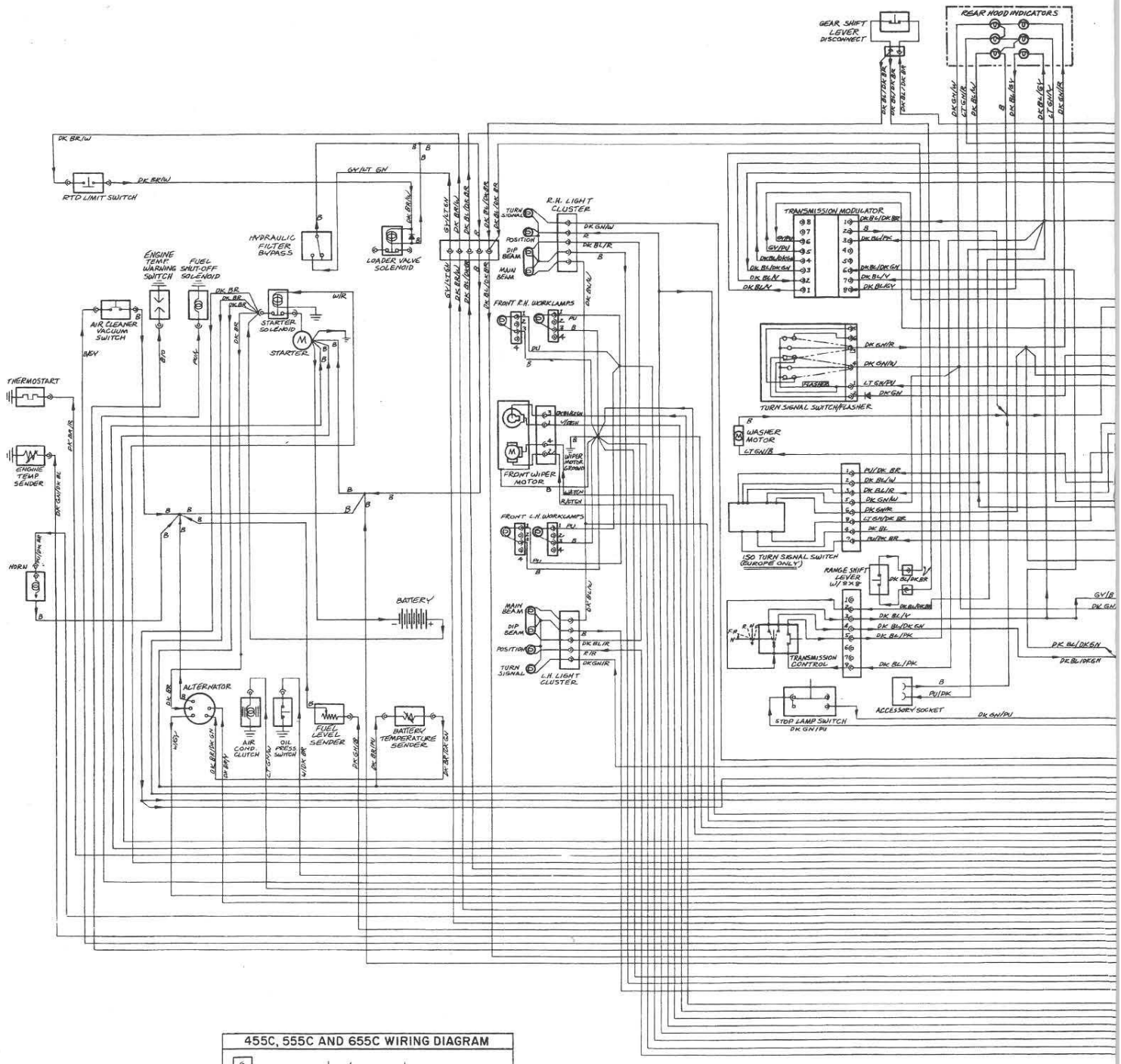
Circuit 12 Lighting Circuits.

Harness A Engine and Transmission Harness.

Harness B Steering Console Harness.

Harness C Instrument and Lighting Harness.

Harness D Roof Harness.

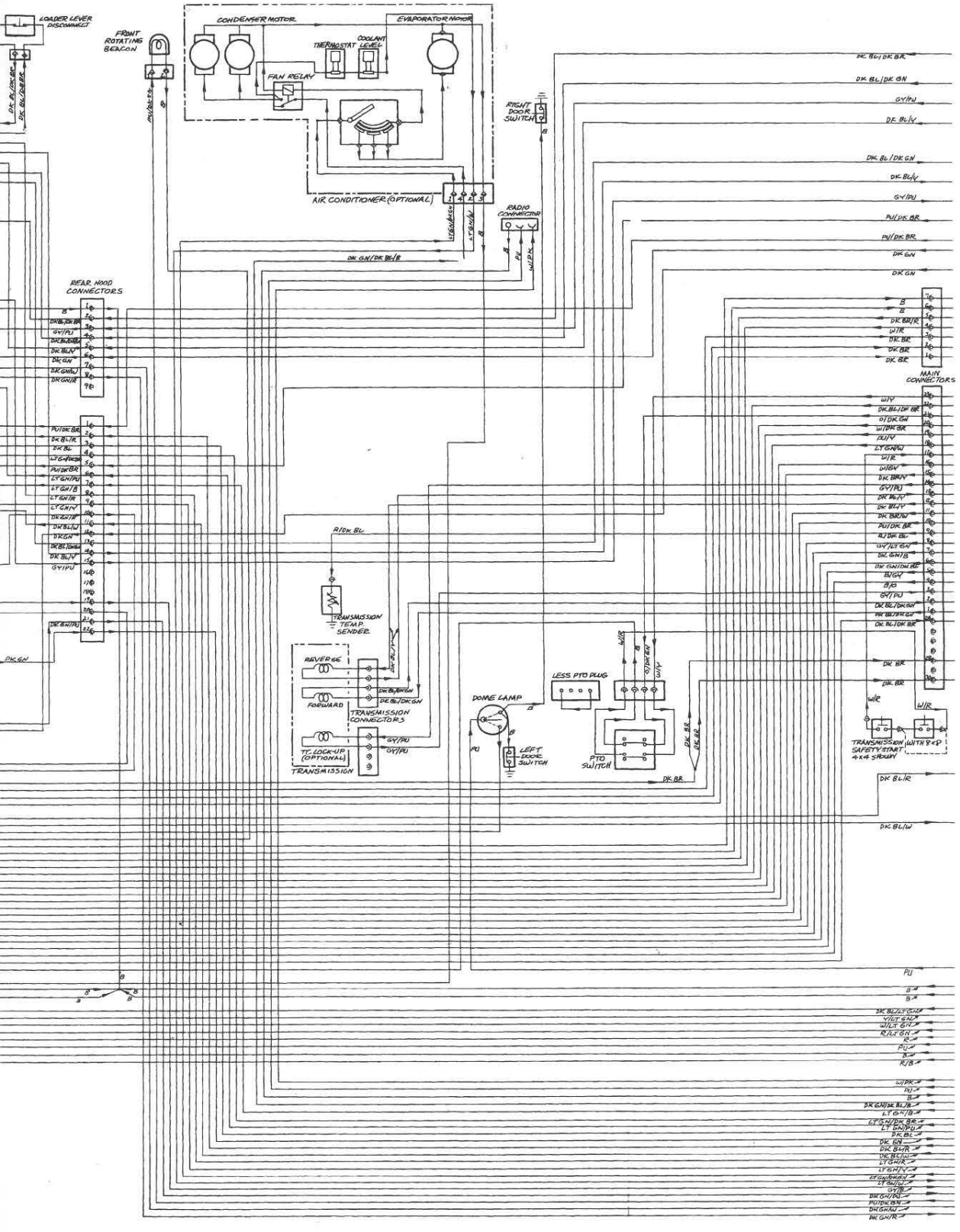


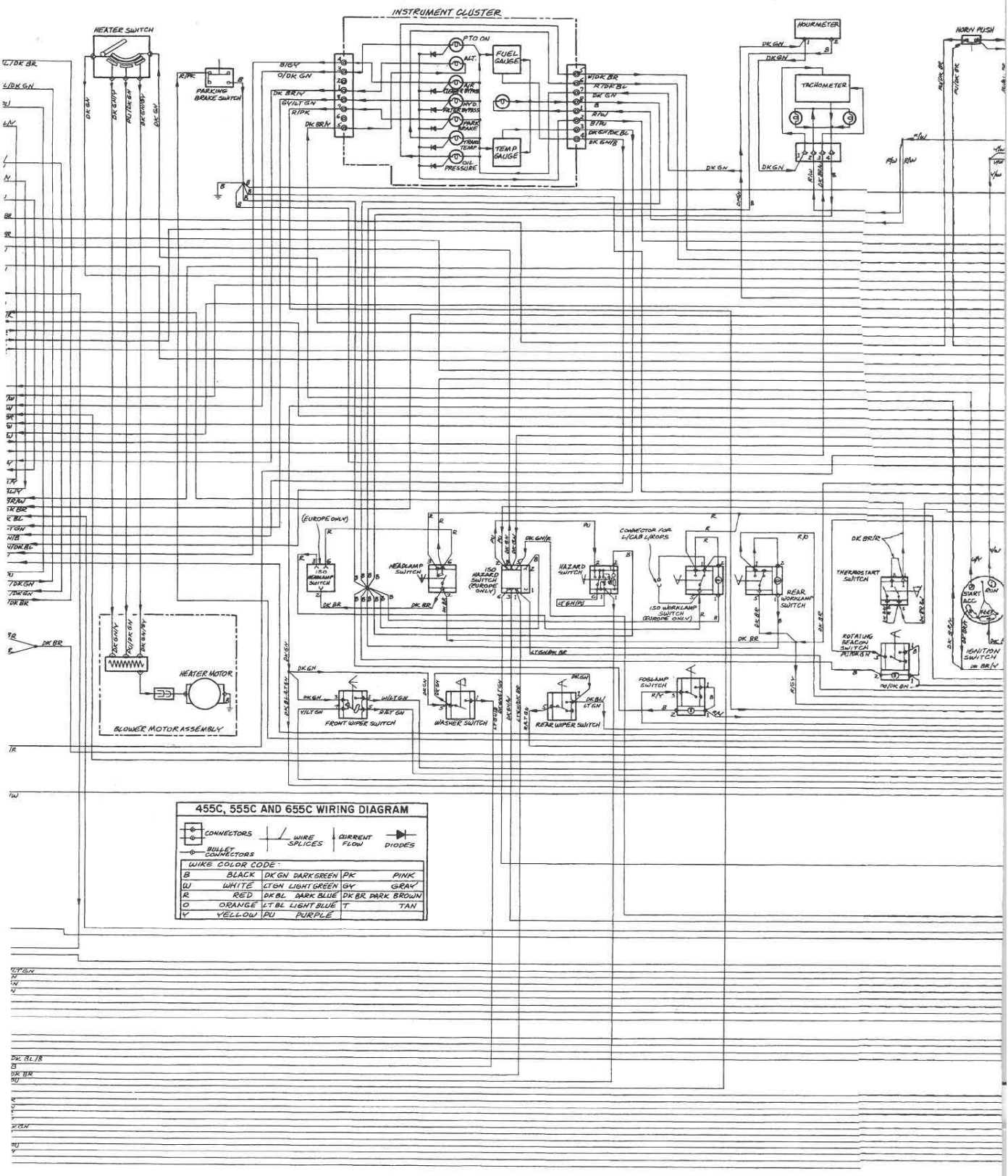
455C, 555C AND 655C WIRING DIAGRAM

CONNECTORS — BULLET CONNECTORS | WIRE SPLICES | CURRENT FLOW | DIODES

WIRE COLOR CODE:

B	BLACK	DK GN	DARK GREEN	PK	PINK
W	WHITE	LT GN	LIGHT GREEN	GY	GRAY
R	RED	DK BL	DARK BLUE	DK BR	DARK BROWN
O	ORANGE	LT BL	LIGHT BLUE	T	TAN
Y	YELLOW	PU	PURPLE		

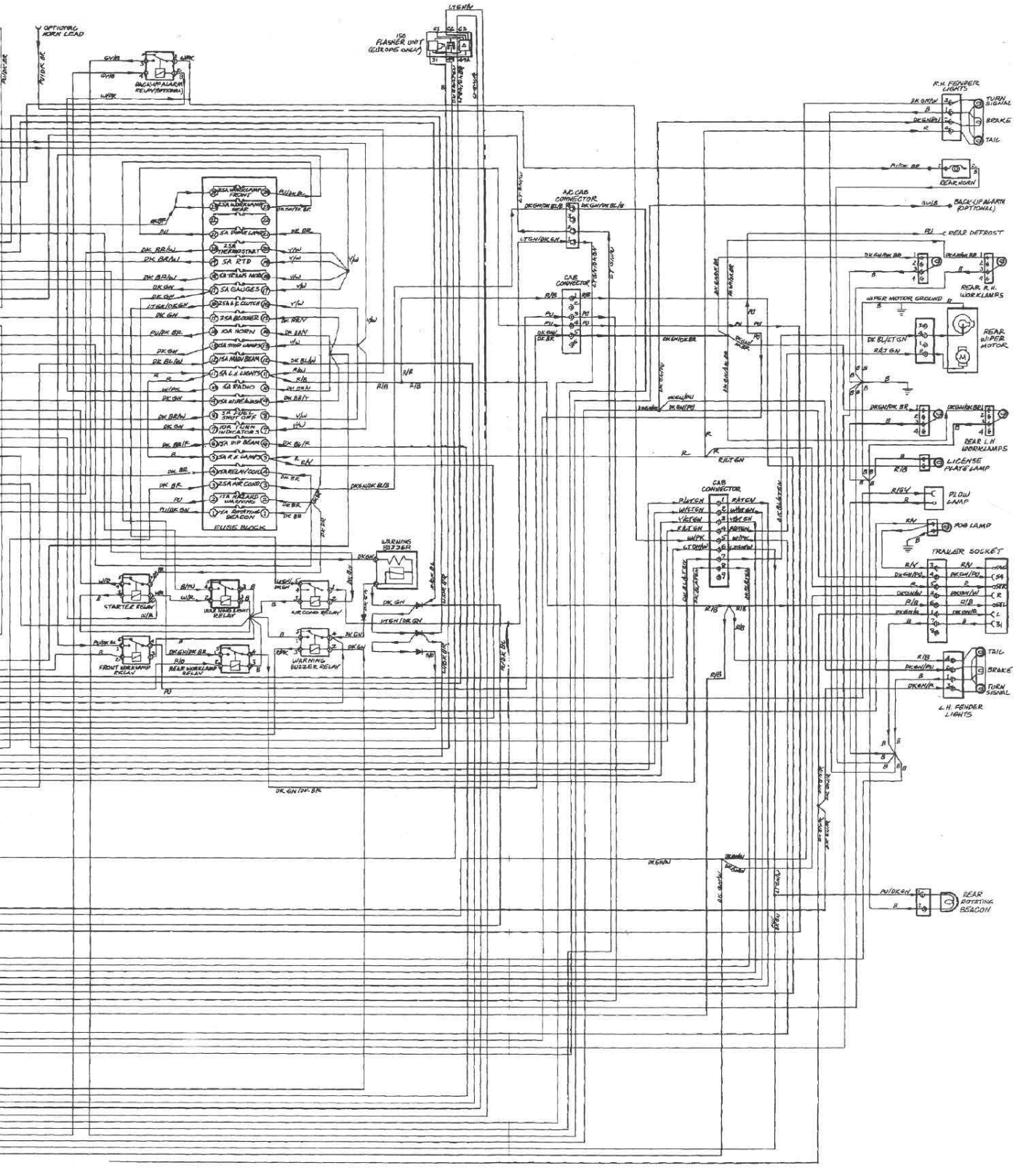


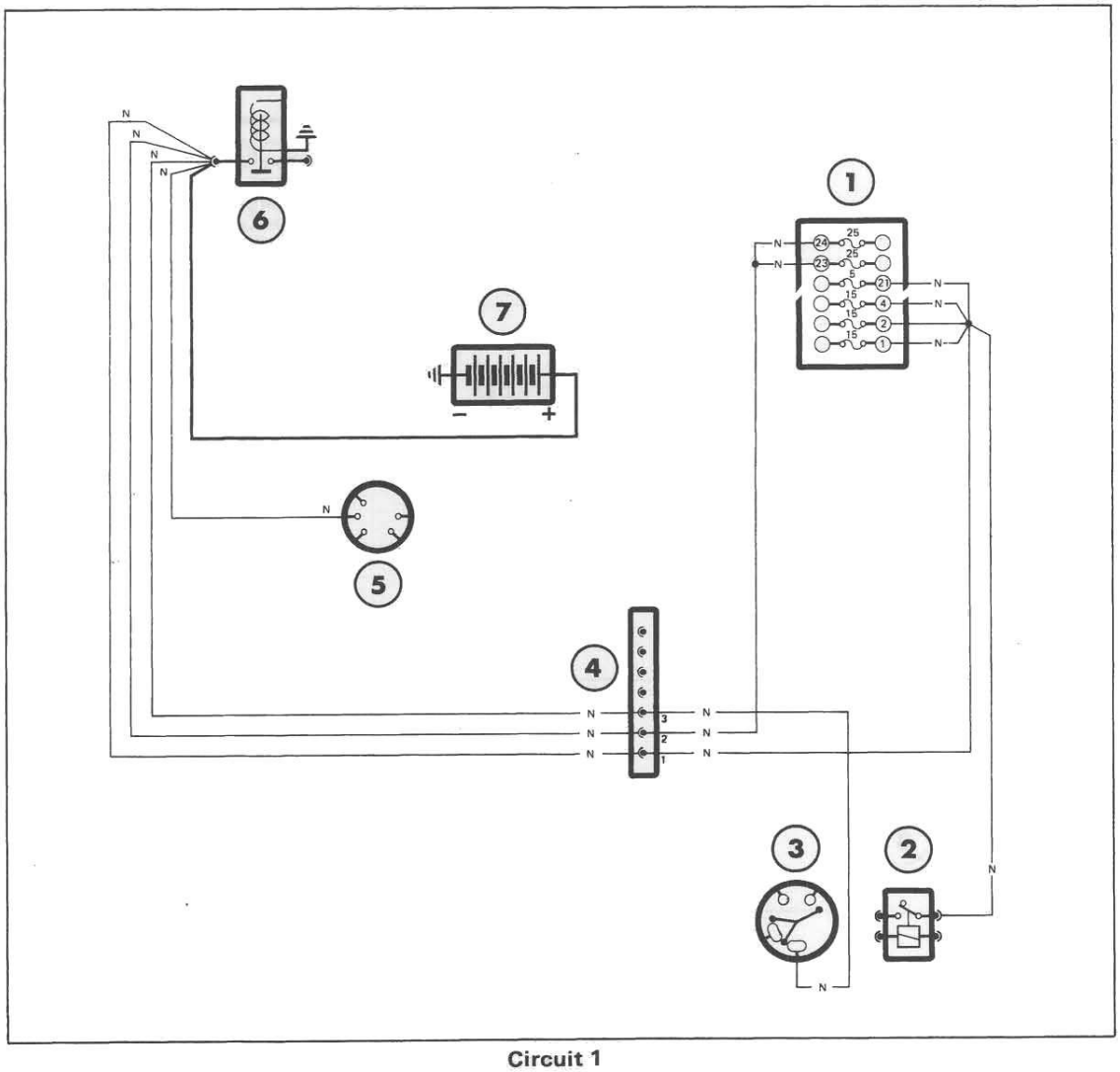


455C, 555C AND 655C WIRING DIAGRAM

CONNECTORS — BULLET CONNECTORS — WIRE SPLICES — CURRENT FLOW — DIODES

WIRE COLOR CODE:					
B	BLACK	DK GN	DARK GREEN	PK	PINK
W	WHITE	LT GN	LIGHT GREEN	GY	GRAY
R	RED	DK BL	DARK BLUE	DK BR	DARK BROWN
O	ORANGE	LT BL	LIGHT BLUE	T	TAN
Y	YELLOW	PU	PURPLE		

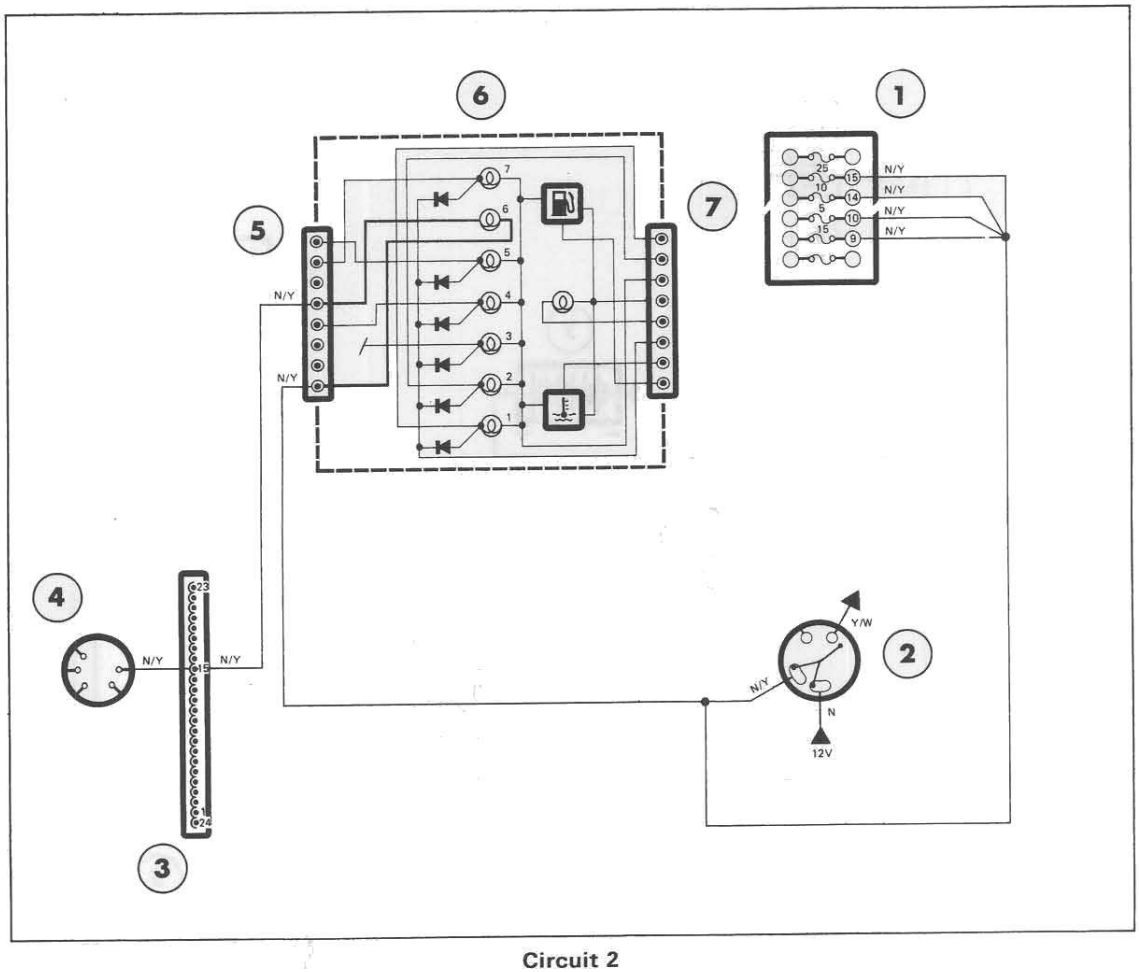




Circuit 1
Basic Live Circuits

1. Fuse Box
2. Starter Relay
3. Keystart Switch
4. Main Under Floor Connector (7 Pin)
5. Alternator
6. Starter Motor Solenoid
7. Battery

WIRING COLOUR CODES			
B	Black	P	Purple
G	Green	R	Red
K	Pink	S	Grey
LG	Light Green	U	Blue
N	Brown	W	White
O	Orange	Y	Yellow

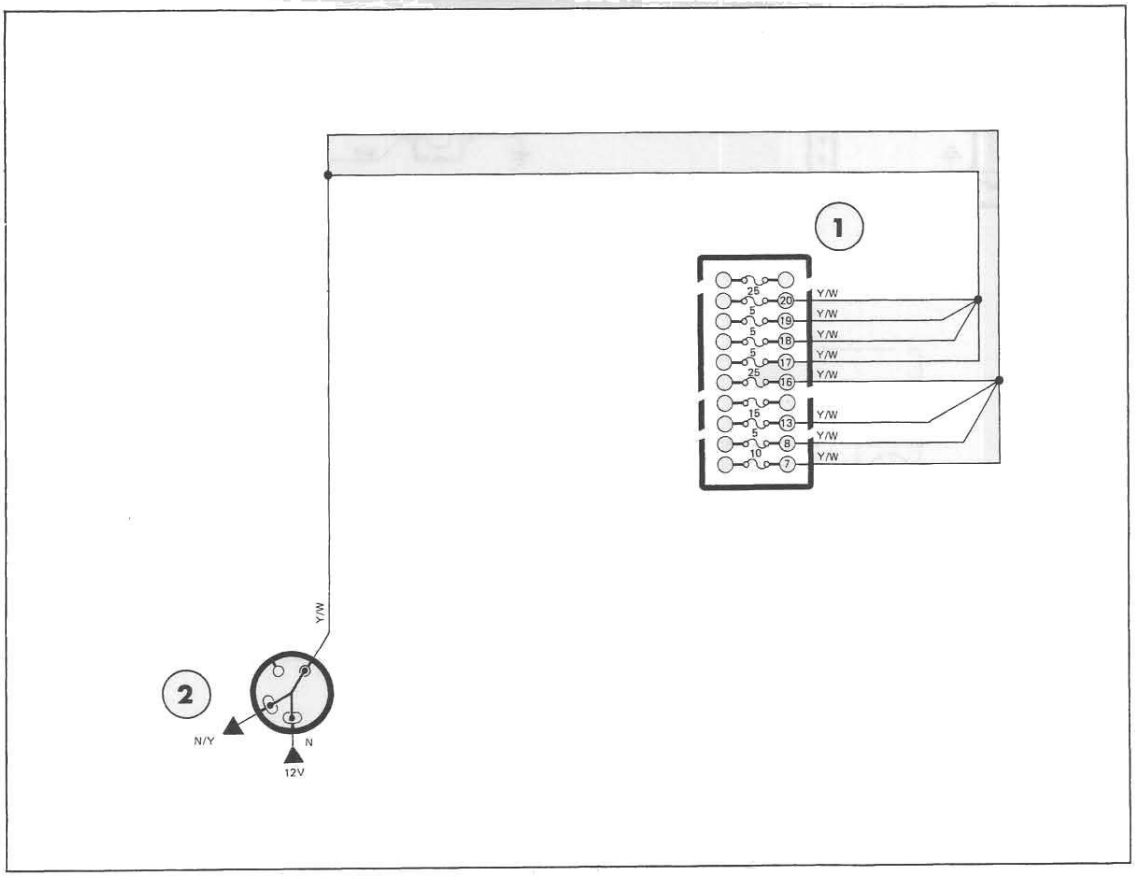


Circuit 2
Key Start Operated Circuits – Accessories "On"

1. Fuse Box
2. Keystart Switch
3. Main Under Floor Connector (24 Pin)
4. Alternator
5. Instrument Panel Connector
6. Instrument Cluster
7. Instrument Panel Connector

Fuses Supplied by Keystart Switch

Fuse No.	Circuit
9.	Wipers and Washer
10.	Radio
14.	Horn
15.	Heater Blower

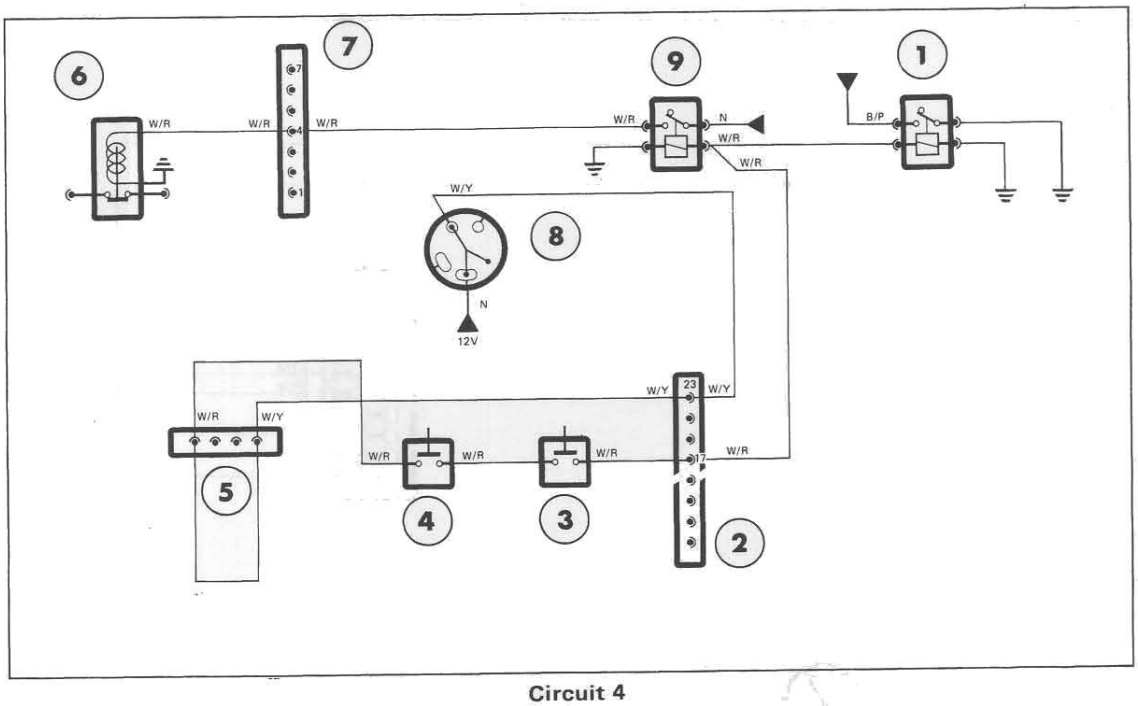


Circuit 3
Key Start Operated Circuits – Warning Lights and Instruments "On"

1. Fuse Box
2. Keystart Switch

Fuses Supplied by Keystart Switch

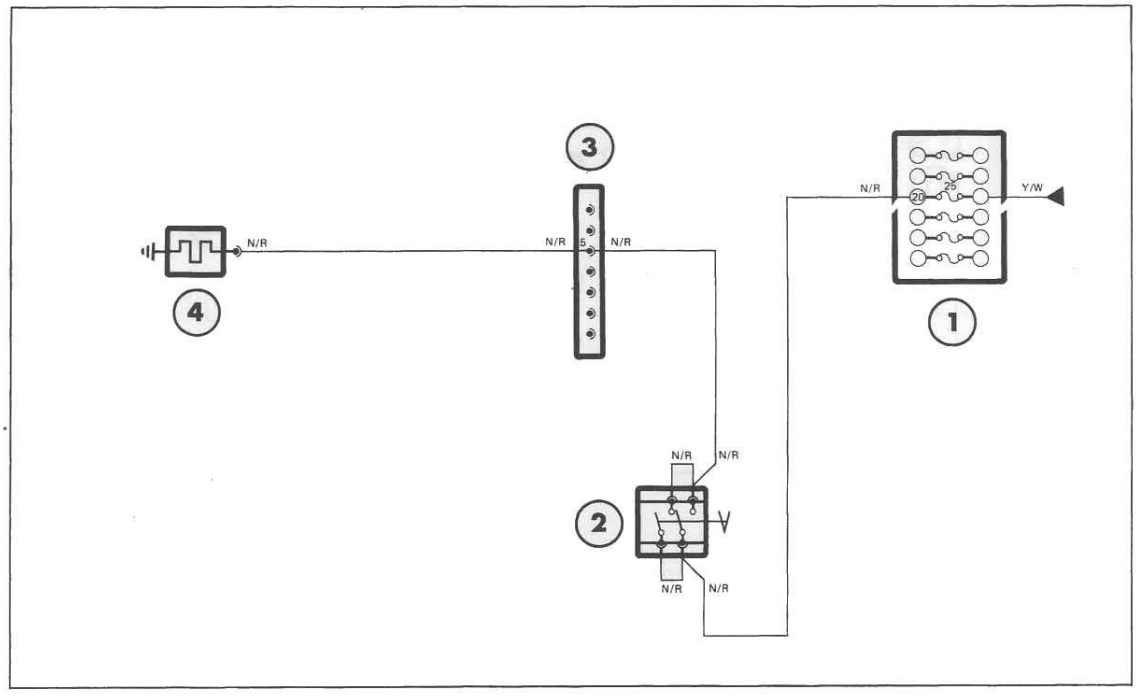
Fuse No.	Circuit
7.	Turn indicators
8.	Fuel Shut Off Solenoid
13.	Stop Lights
16.	Air Conditioning
17.	Gauges and Warning Lights
18.	Transmission Control
19	Return to Dig
20	Thermostart



Circuit 4
Engine Cranking Circuit

1. Instrumentation Earthing Relay
2. Main Under Floor Connector (24 Pin)
3. Safety Start Switch
4. Safety Start Switch
5. Connecting Loop
6. Starter Motor Solenoid
7. Main Under Floor Connector (7 Pin)
8. Key Start Switch
9. Starter Relay

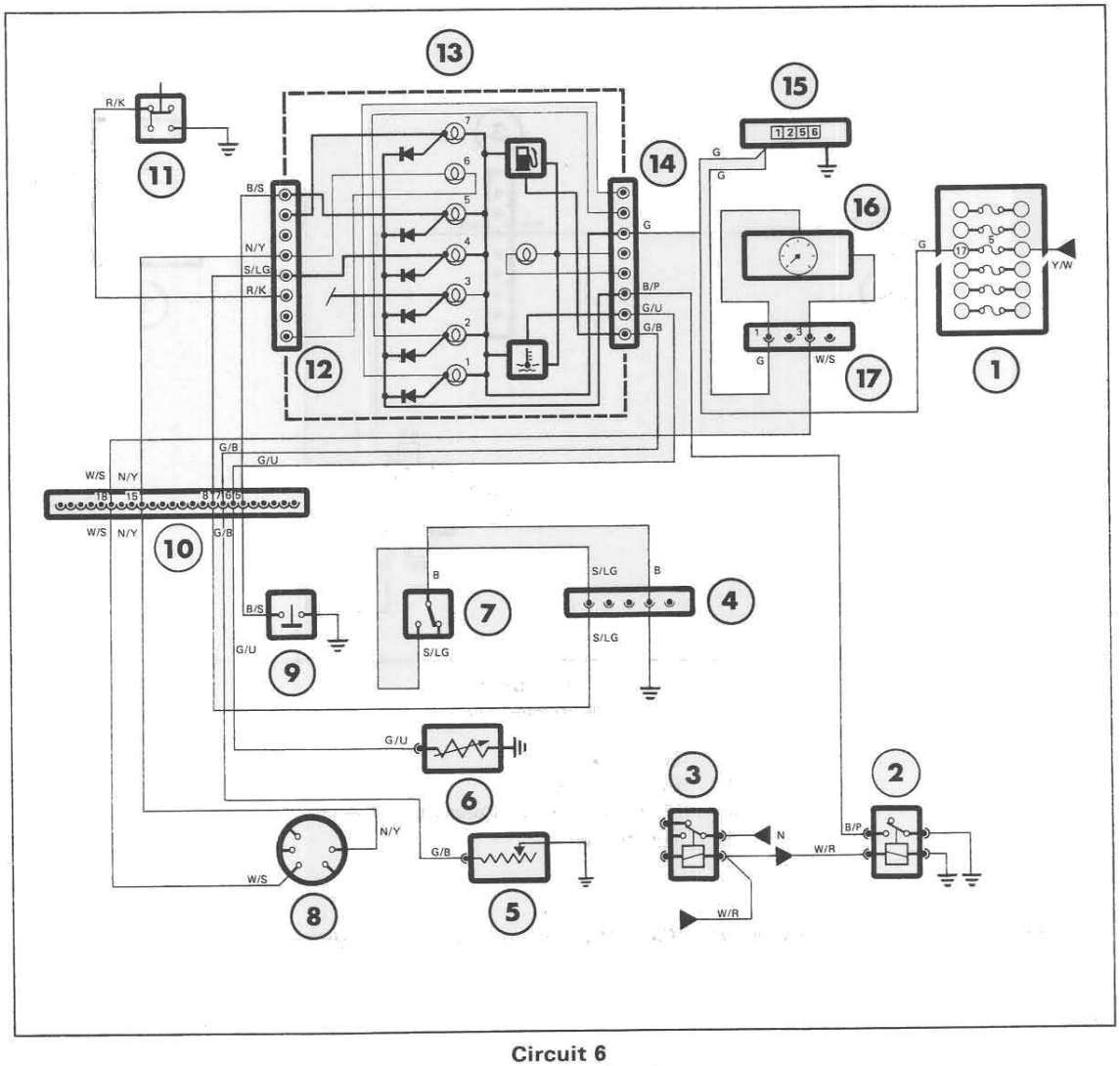
NOTE: *455C models with 8 × 8 transmission have a PTO safety start switch incorporated in the engine cranking circuit and not the connecting loop (item 5) as shown.*



Circuit 5
Thermostart Circuit

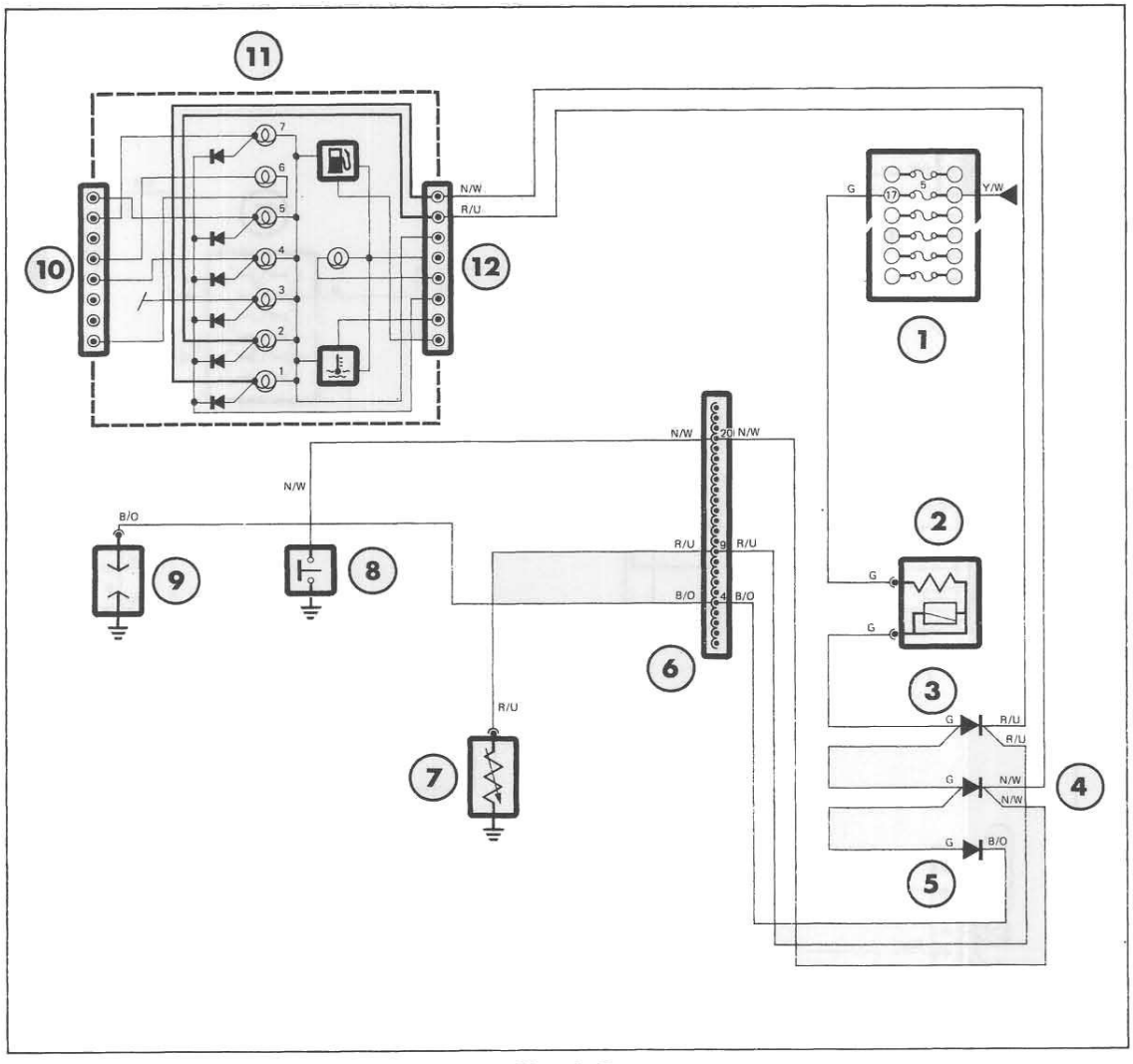
1. Fuse Box
2. Rocker Switch
3. Main Under Floor Connector (7 Pin)
4. Thermostart

NOTE: *Key Start Switch MUST be ON when operating the thermostart cold start.*



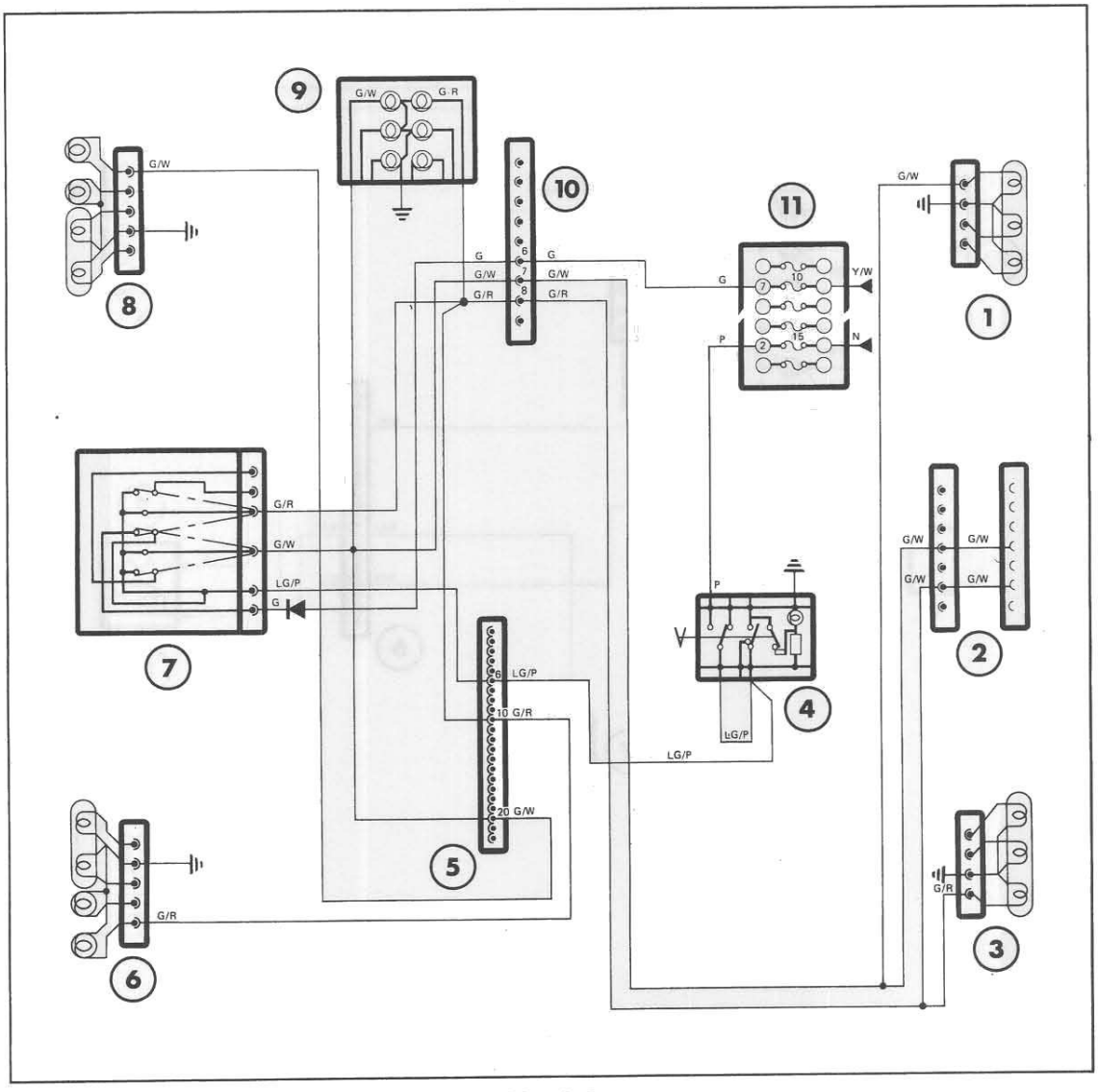
Circuit 6
Instrumentation Circuits

1. Fuse Box
2. Instrumentation Earthing Relay
3. Starter Relay
4. Transmission Dump Switch/Return to Dig Connector
5. Fuel Tank Sender
6. Engine Temperature Sender
7. Hydraulic Filter Bypass Switch
8. Alternator
9. Engine Oil Pressure Switch
10. Main Under Floor Connector (24 Pin)
11. Handbrake Switch
12. Instrument Panel Connector
13. Instrument Cluster
14. Instrument Panel Connector
15. Hourmeter
16. Engine Tachometer
17. Connector



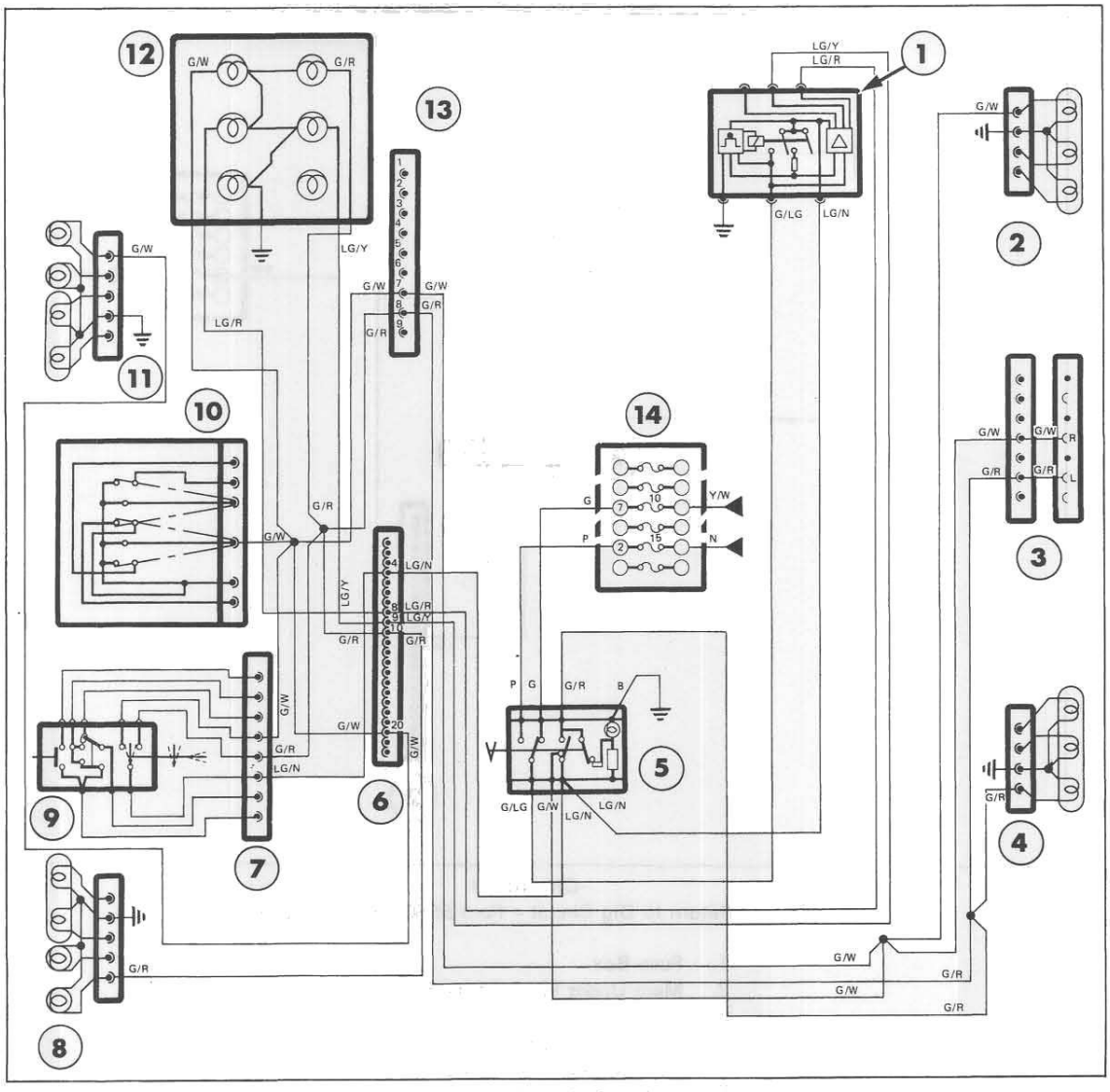
Circuit 7
Alarm Protected Circuits

1. Fuse Box
2. Buzzer
3. Diode – Transmission Temperature
4. Diode – Engien Oil Pressure
5. Diode – Engine Temperature
6. Main Under Floor Temperature Sender
7. Transmission Oil Temperature Sender
8. Engine Oil Pressure Switch
9. Engine Temperature Switch
10. Instrument Panel Connector
11. Instrument Cluster
12. Instrument Panel Connector



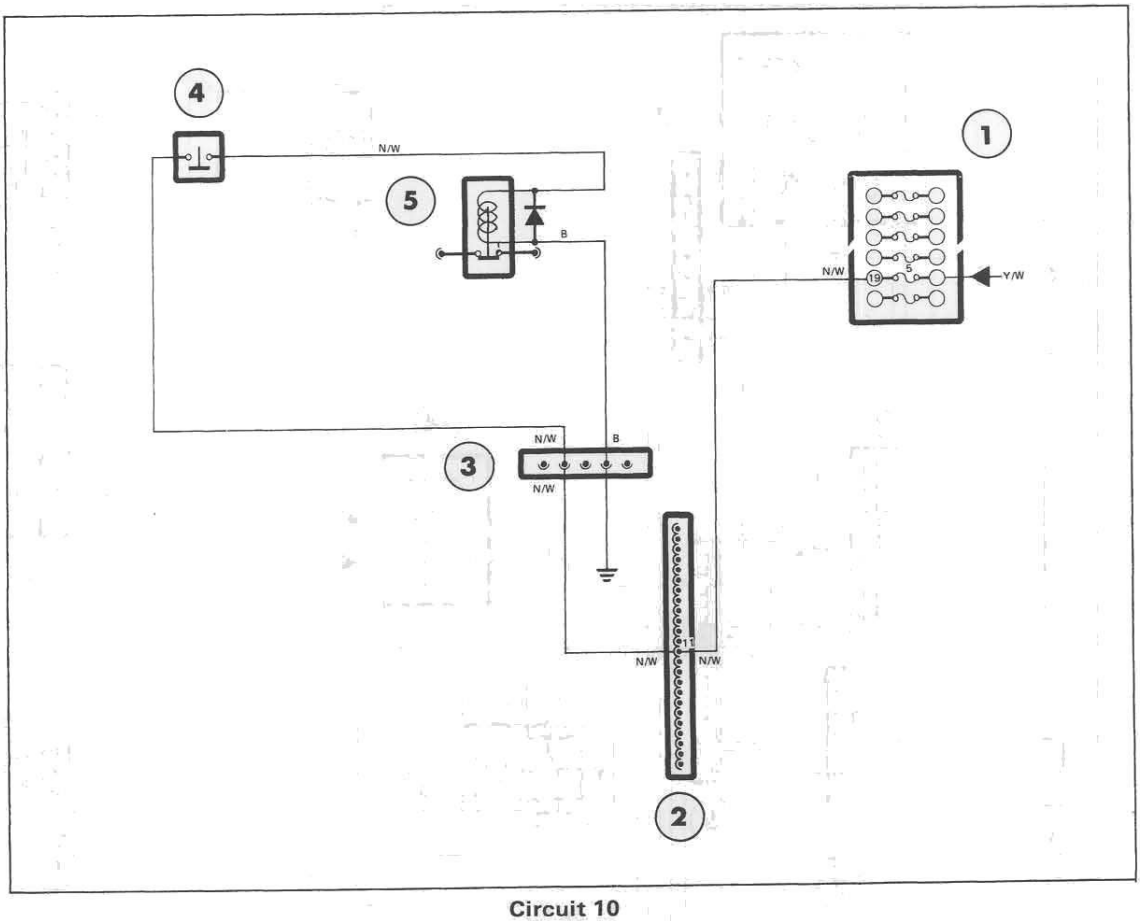
Circuit 8
Turn Indicator and Hazard Warning Circuits – NASO

1. Right Hand Rear Light Cluster
2. Trailer Socket and Connector
3. Left Hand Rear Light Cluster
4. Hazard Switch (NASO)
5. Main Underfloor Connector (24 Pin)
6. Left Hand Front Light Cluster
7. Hazard Flasher and Turn Indicator Switch (NASO)
8. Right Hand Front Light Cluster
9. Indicator Lights
10. Steering Console Connector (9 Pin)
11. Fuse Box



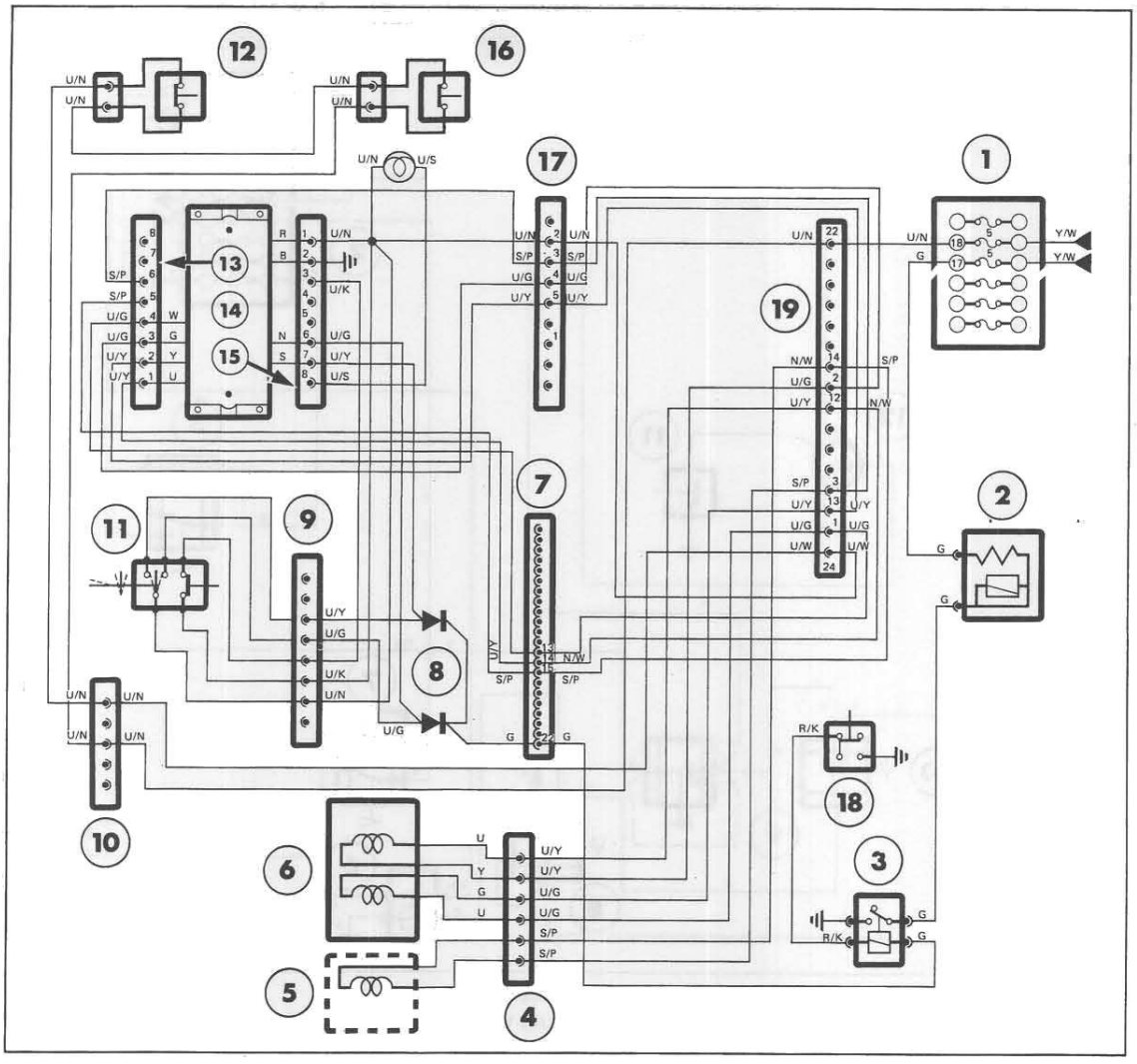
Circuit 9
Turn Indicator and Hazard Warning Circuits – ISO

1. Flasher Unit (ISO)
2. Right Hand Rear Light Cluster
3. Trailer Socket and Connector
4. Left Hand Rear Light Cluster
5. Hazard Switch (ISO)
6. Main Under Floor Connector (24 Pin)
7. Connector
8. Left Hand Front Light Cluster
9. Indicator Turn/Main Beam/Horn Switch
10. Hazard Flasher (NASO)
11. Right Hand Front Light Cluster
12. Indicator Lights
13. Steering Console Connector (9 Pin)



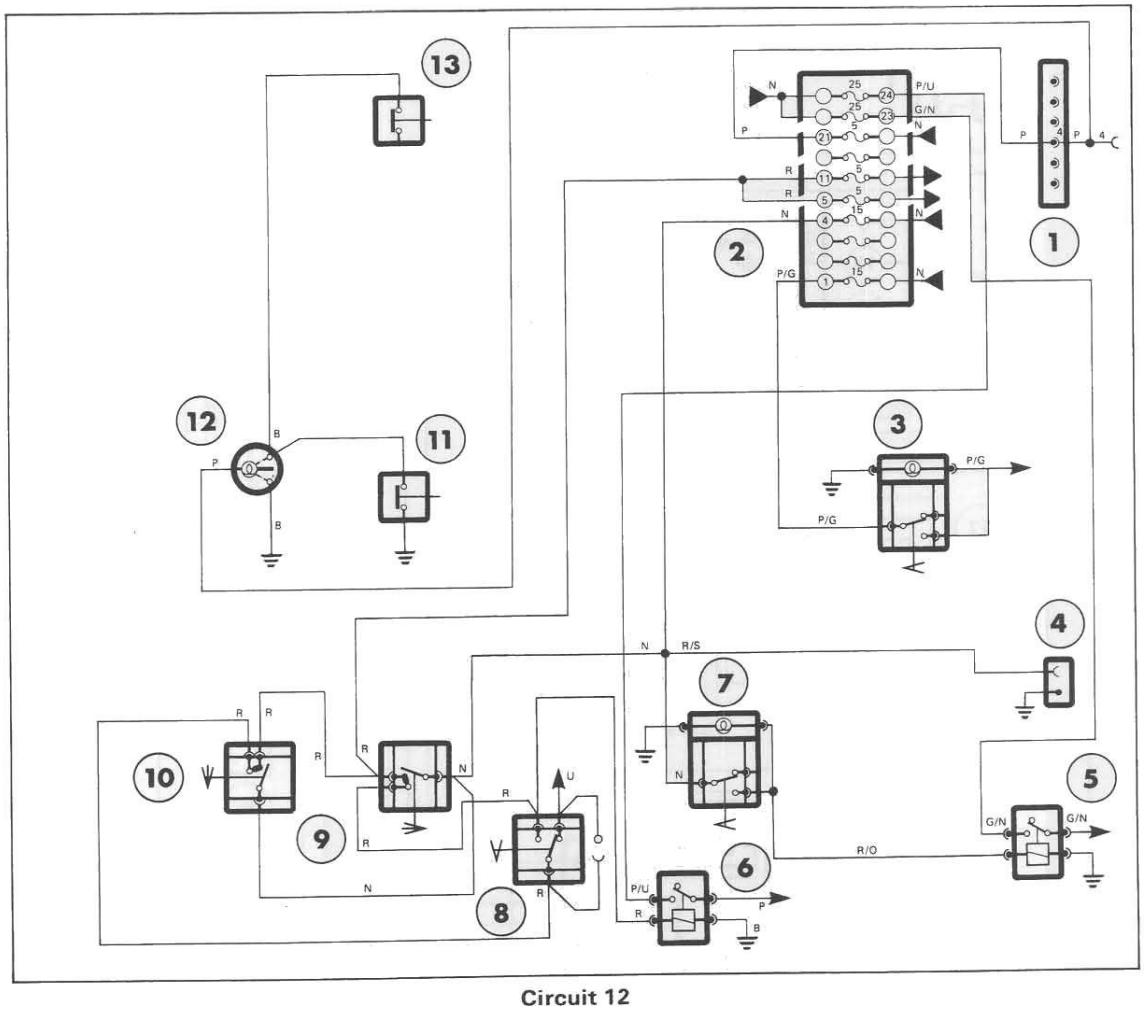
Circuit 10
Loader Return to Dig Circuit – Ford 555C and 655C Only

1. Fuse Box
2. Main Under Floor Connector (24 Pin)
3. Transmission Control Switch and Return to Dig Connector
4. Cylinder Mounted Switch
5. Bucket Spool Solenoid



Circuit 11
Transmission Control Circuits

1. Fuse Box
2. Buzzer
3. Buzzer Relay
4. Transmission Control Connector
5. Torque Convertor Lock Up Solenoid (8 × 8 only)
6. Transmission Control Solenoids
7. Steering Console Connector (22 Pin)
8. Handbrake Warning Circuit Diodes
9. Connector
10. Transmission Dump Switch/ Return to Dig Connector
11. Transmission Control Lever and Switch Assembly
12. Gear Lever Switch
13. Connector
14. Transmission Control Module
15. Connector
16. Loader Lever Switch
17. Steering Console Connector (9 Pin)
18. Handbrake Switch (where fitted)
19. Main Under Floor Connector (24 Pin)



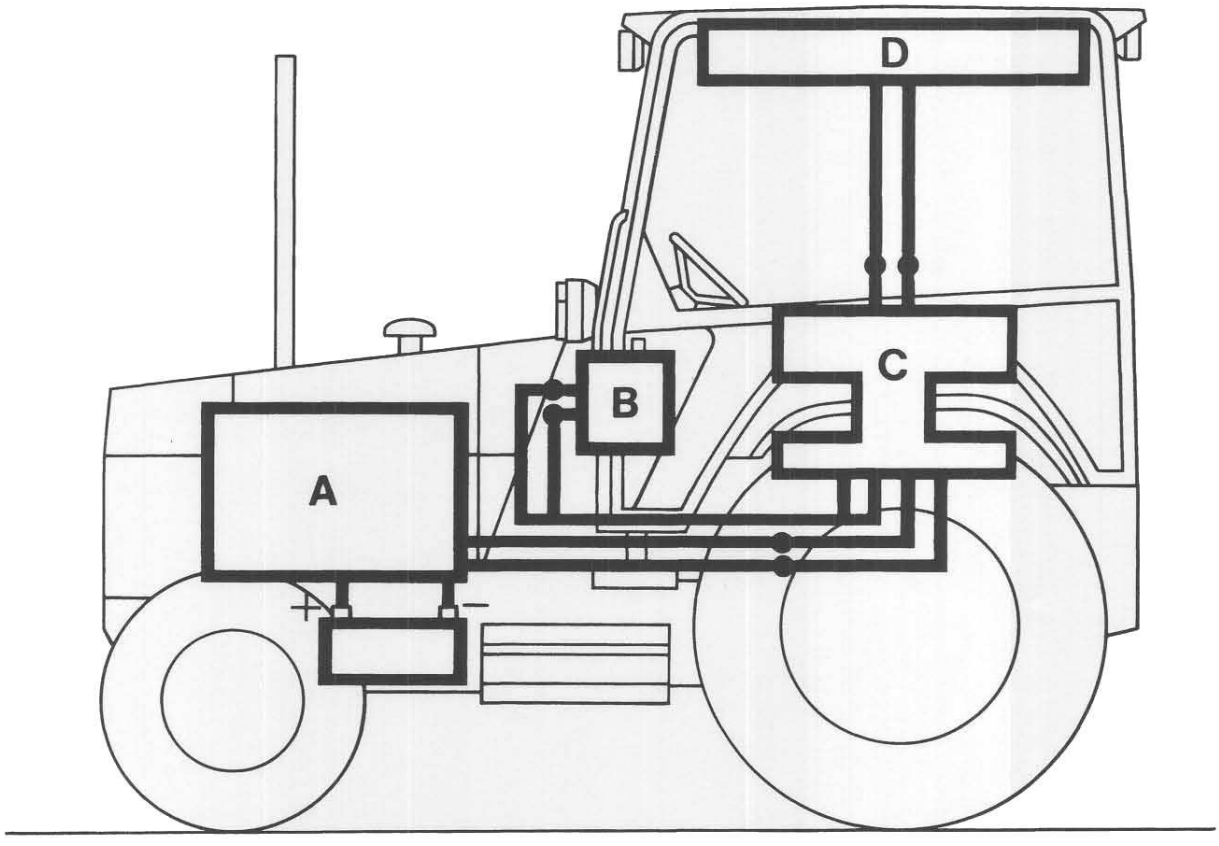
Circuit 12
Lighting Circuits

1. Roof Connector
2. Fuse Box
3. Rotating Beacon Switch
4. Plough Lamp Connection
5. Rear Work Light Relay
6. Front Work Light Relay
7. Rear Work Light Switch
8. Front Work Light/Headlight Selector Switch (ISO)
9. Headlight Switch (NASO)
10. Headlight Switch (ISO)
11. Left Hand Door Switch
12. Cab Interior Light
13. Right Hand Door Switch

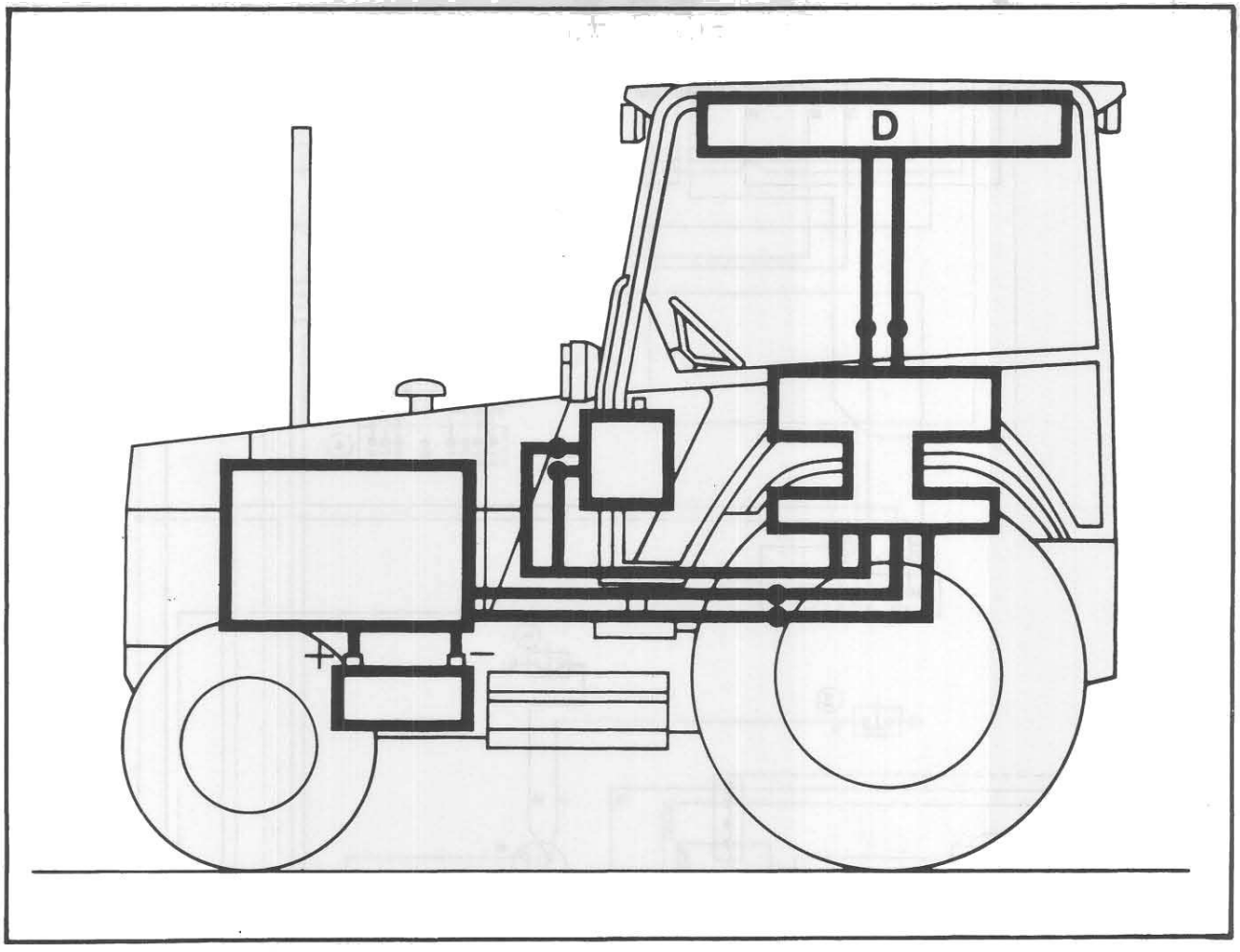
NOTE: *Fuse 5 supplies right hand side lights.*

Fuse 11 supplies left hand side lights and instrumentation lights.

Blue coded wire from 'switch 8' feeds to steering column mounted headlight dip switch; fuse 6 (15A) protects dip beam; fuse 12 (15A) protects main beam.

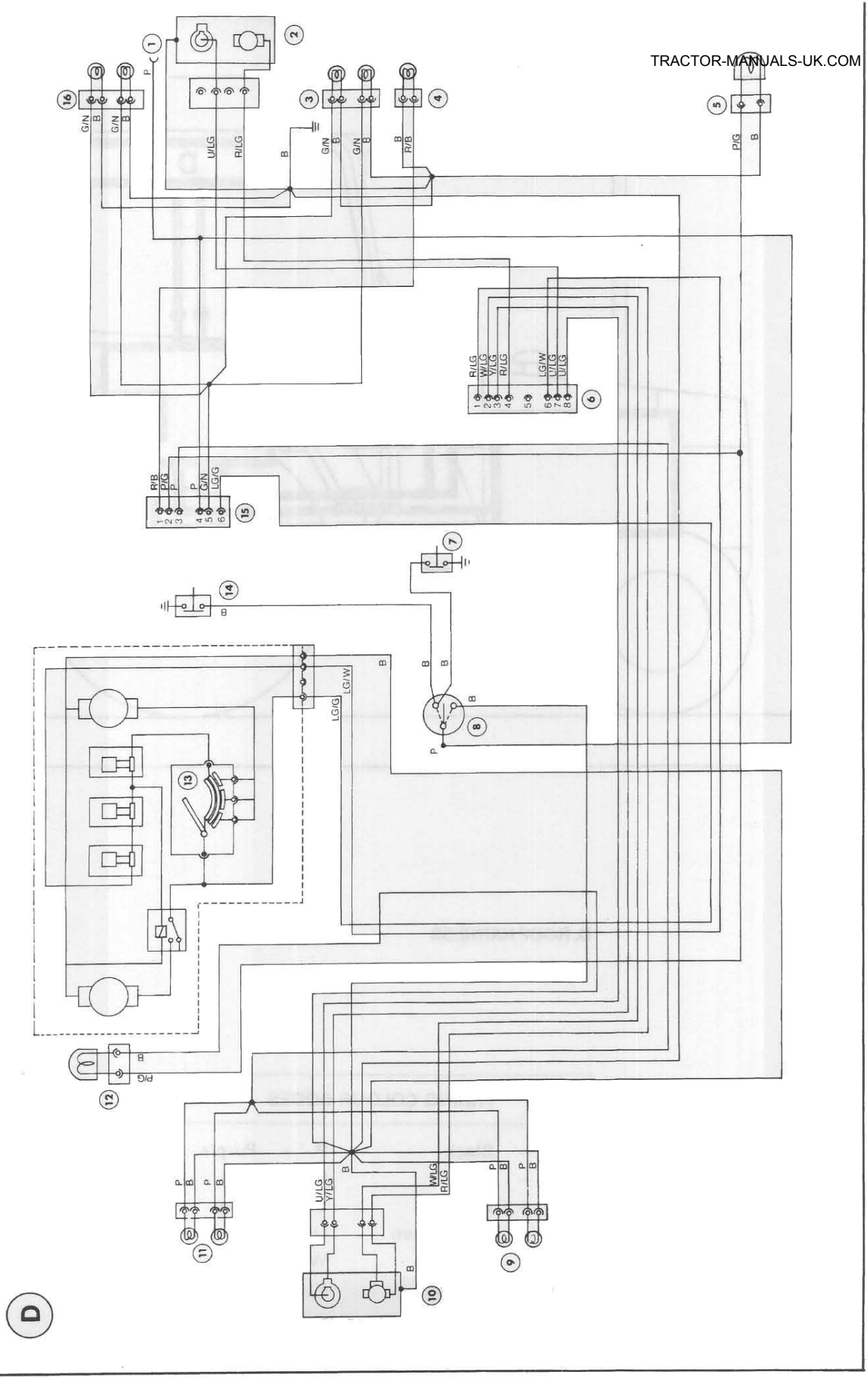


A. ENGINE AND TRANSMISSION HARNESS
B. STEERING CONSOLE HARNESS
C. INSTRUMENT AND LIGHTING HARNESS
D. ROOF HARNESS



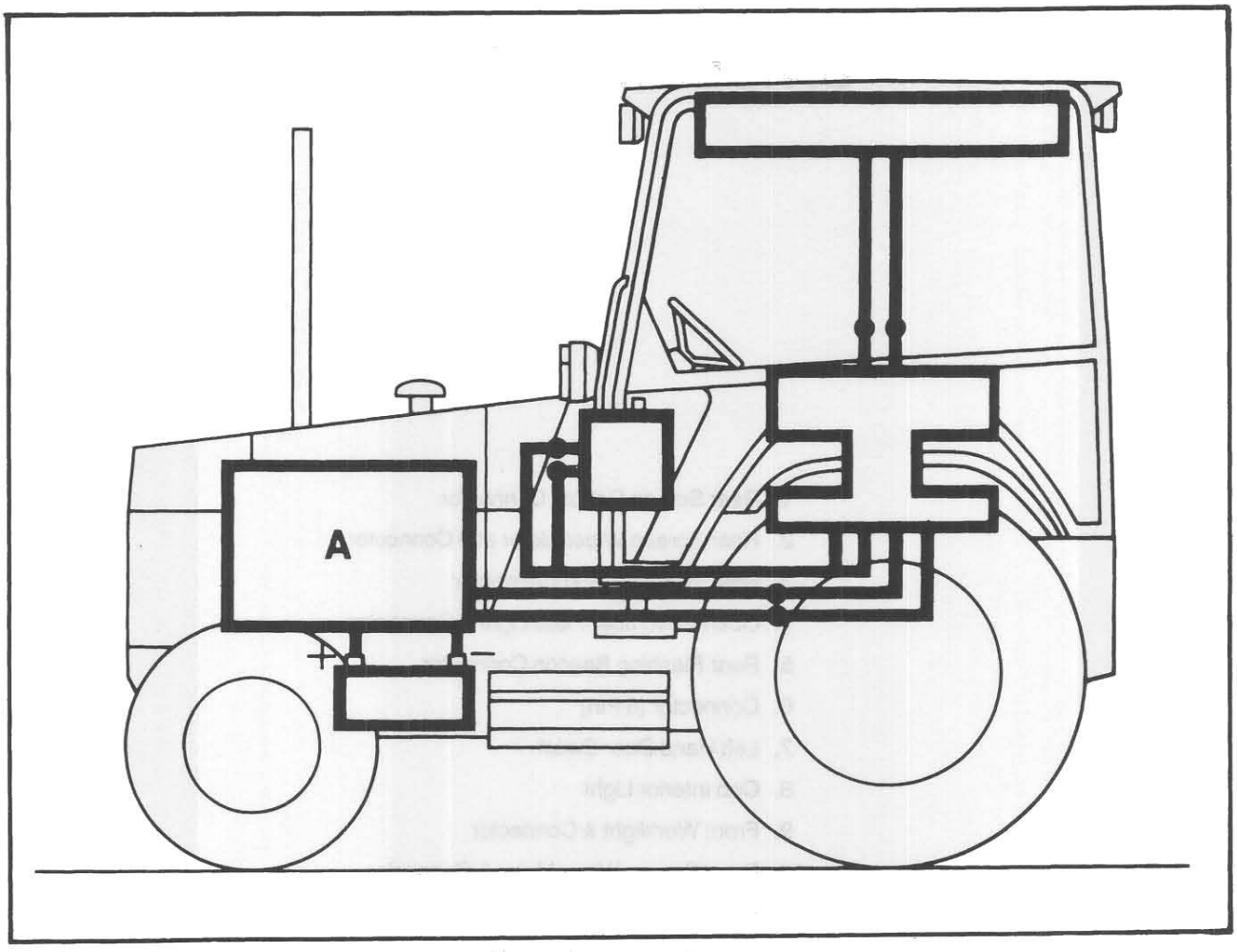
D. ROOF HARNESS

WIRING COLOUR CODES			
B – Black		P – Purple	
G – Green		R – Red	
K – Pink		S – Grey	
LG – Light Green		U – Blue	
N – Brown		W – White	
O – Orange		Y – Yellow	



D. ROOF HARNESS

1. Rear Screen Defrost Connector
2. Rear Screen Wiper Motor and Connector
3. Rear Worklight and Connector
4. Licence Number Plate Light & Connector
5. Rear Flashing Beacon Connector
6. Connector (8 Pin)
7. Left Hand Door Switch
8. Cab Interior Light
9. Front Worklight & Connector
10. Front Screen Wiper Motor & Connector
11. Front Worklight & Connector
12. Front Flashing Beacon Connector
13. Optional Air Conditioning Unit
14. Right Hand Door Switch
15. Connector (6 Pin)
16. Rear Worklight & Connector

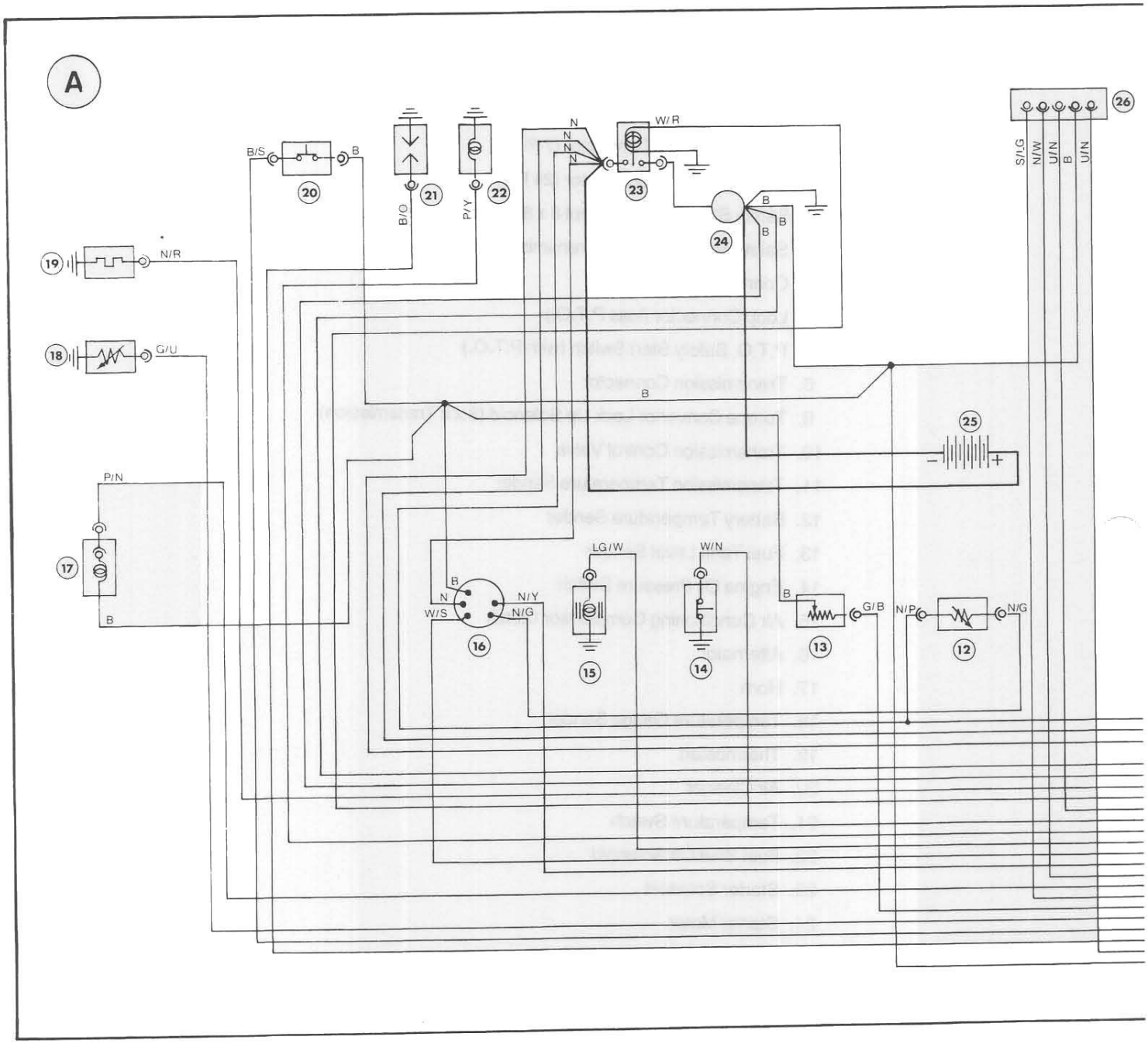


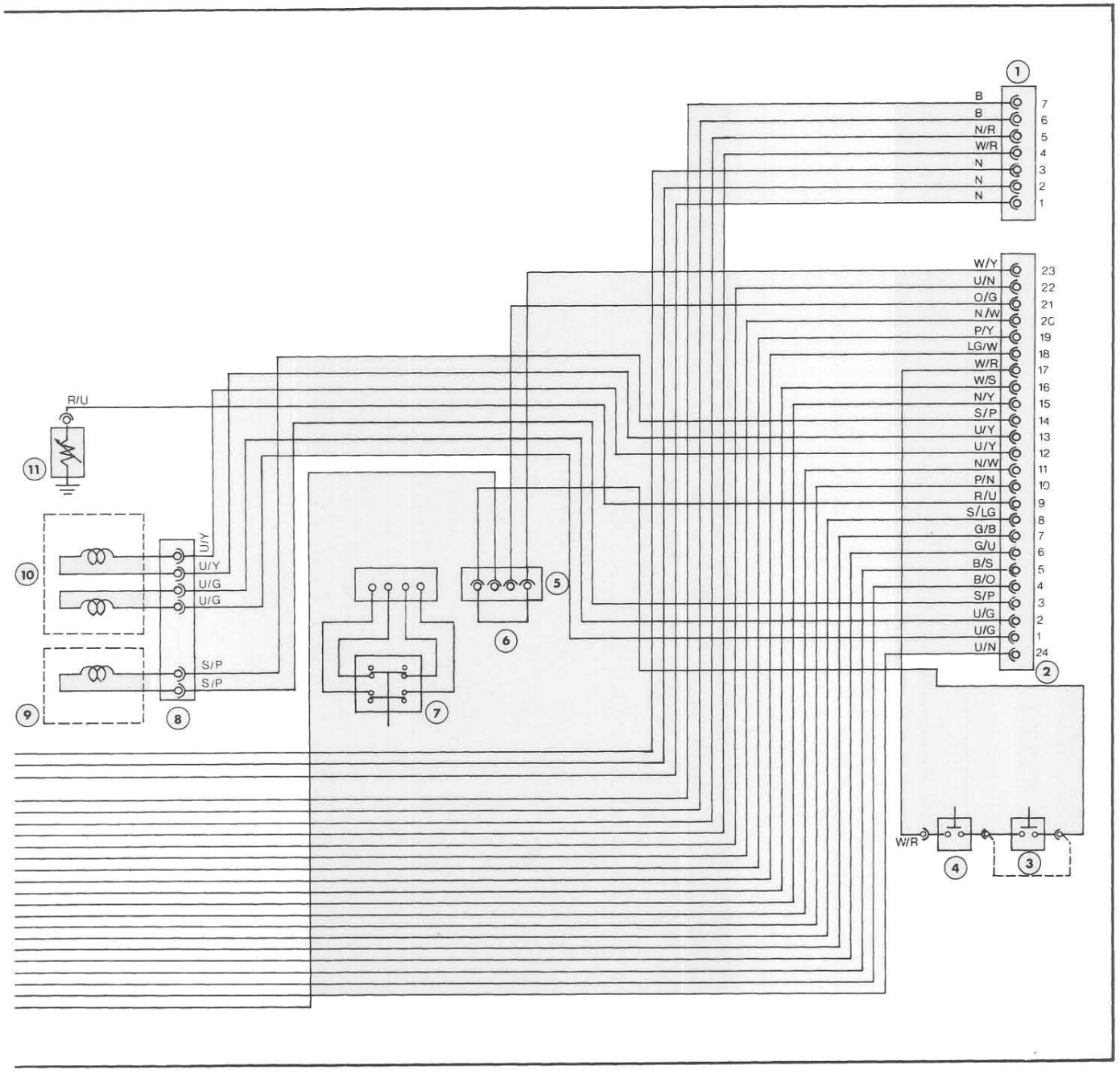
A. ENGINE AND TRANSMISSION HARNESS

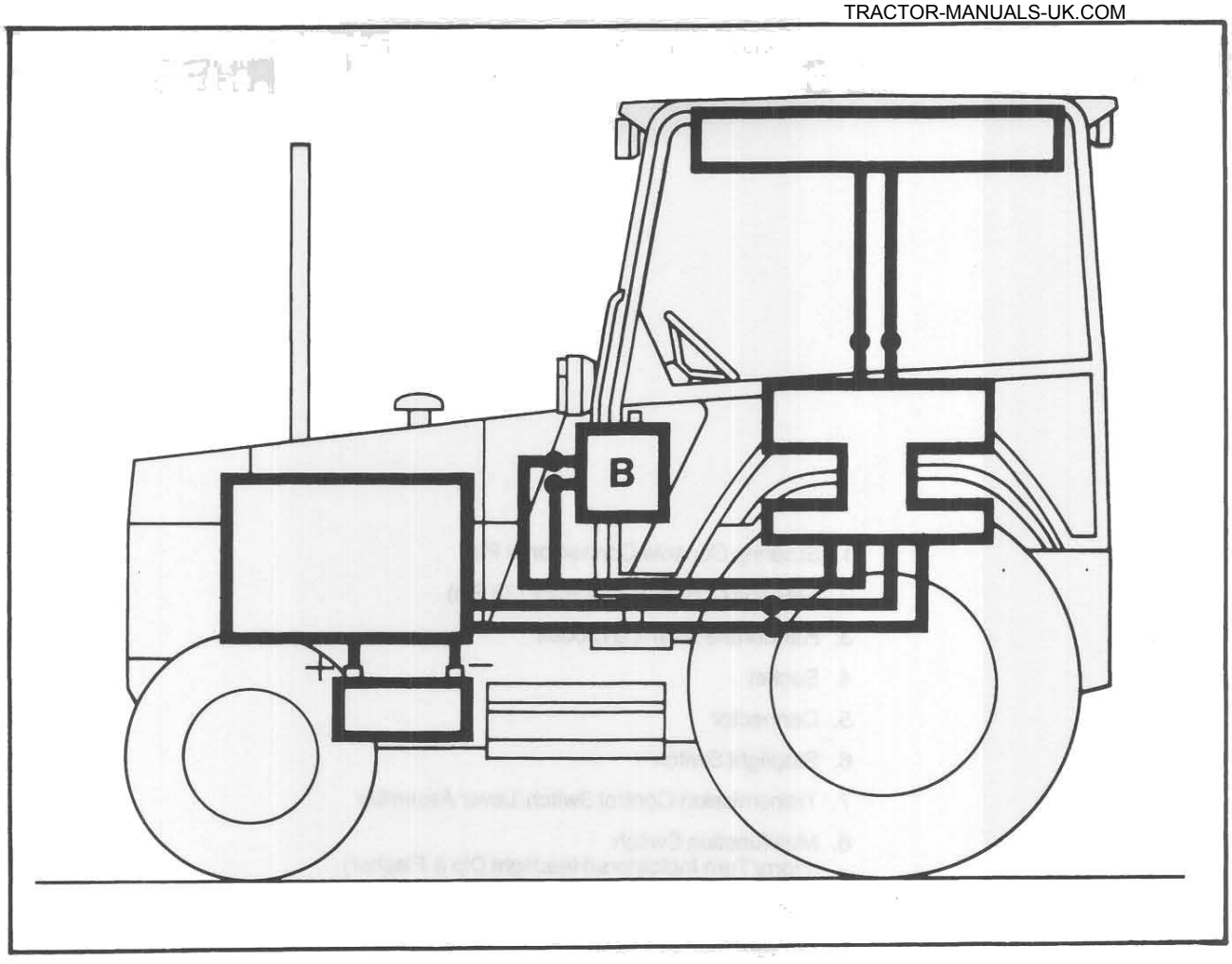
WIRING COLOUR CODES					
B	–	Black	P	–	Purple
G	–	Green	R	–	Red
K	–	Pink	S	–	Grey
LG	–	Light Green	U	–	Blue
N	–	Brown	W	–	White
O	–	Orange	Y	–	Yellow

A. ENGINE AND TRANSMISSION HARNESS

1. Main Underfloor Connector (7 Pin)
2. Main Underfloor Connector (24 Pin)
3. Safety Start Switch (except 8 x 8 Transmission)
4. Safety Start Switch (all Transmission)
5. Connector
6. Loop Connector (less P.T.O.)
7. P.T.O. Safety Start Switch (with P.T.O.)
8. Transmission Connector
9. Torque Convertor Lock Up Solenoid (8 x 8 Transmission)
10. Transmission Control Valve
11. Transmission Temperature Sender
12. Battery Temperature Sender
13. Fuel Tank Level Sender
14. Engine Oil Pressure Switch
15. Air Conditioning Compressor Clutch
16. Alternator
17. Horn
18. Temperature Gauge Sender
19. Thermostart
20. Air Cleaner
21. Temperature Switch
22. Fuel Shut Off Solenoid
23. Starter Solenoid
24. Starter Motor
25. Battery
26. Connector (5 Pin) – Tranmission Control Switches/Return to Dig





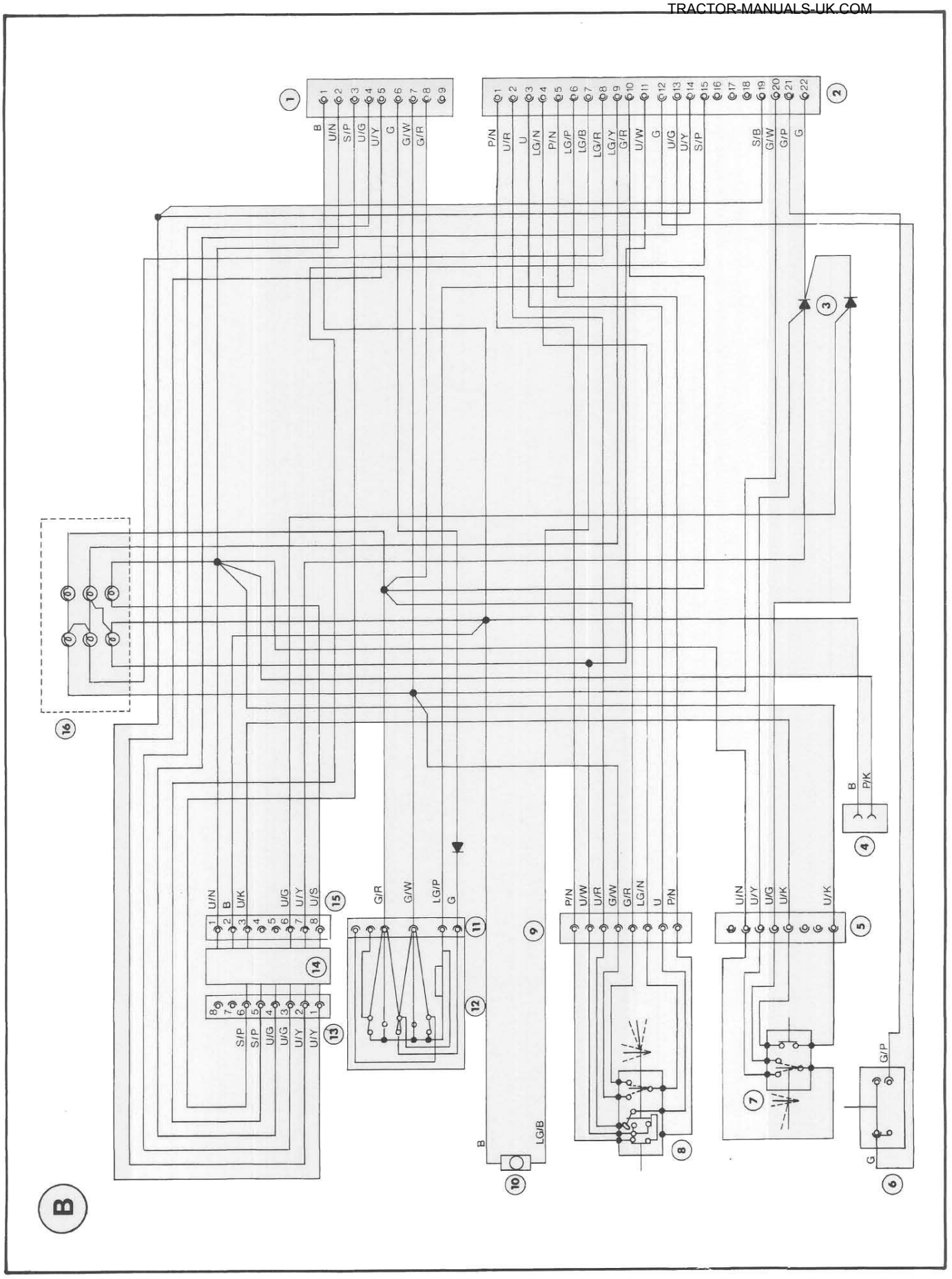


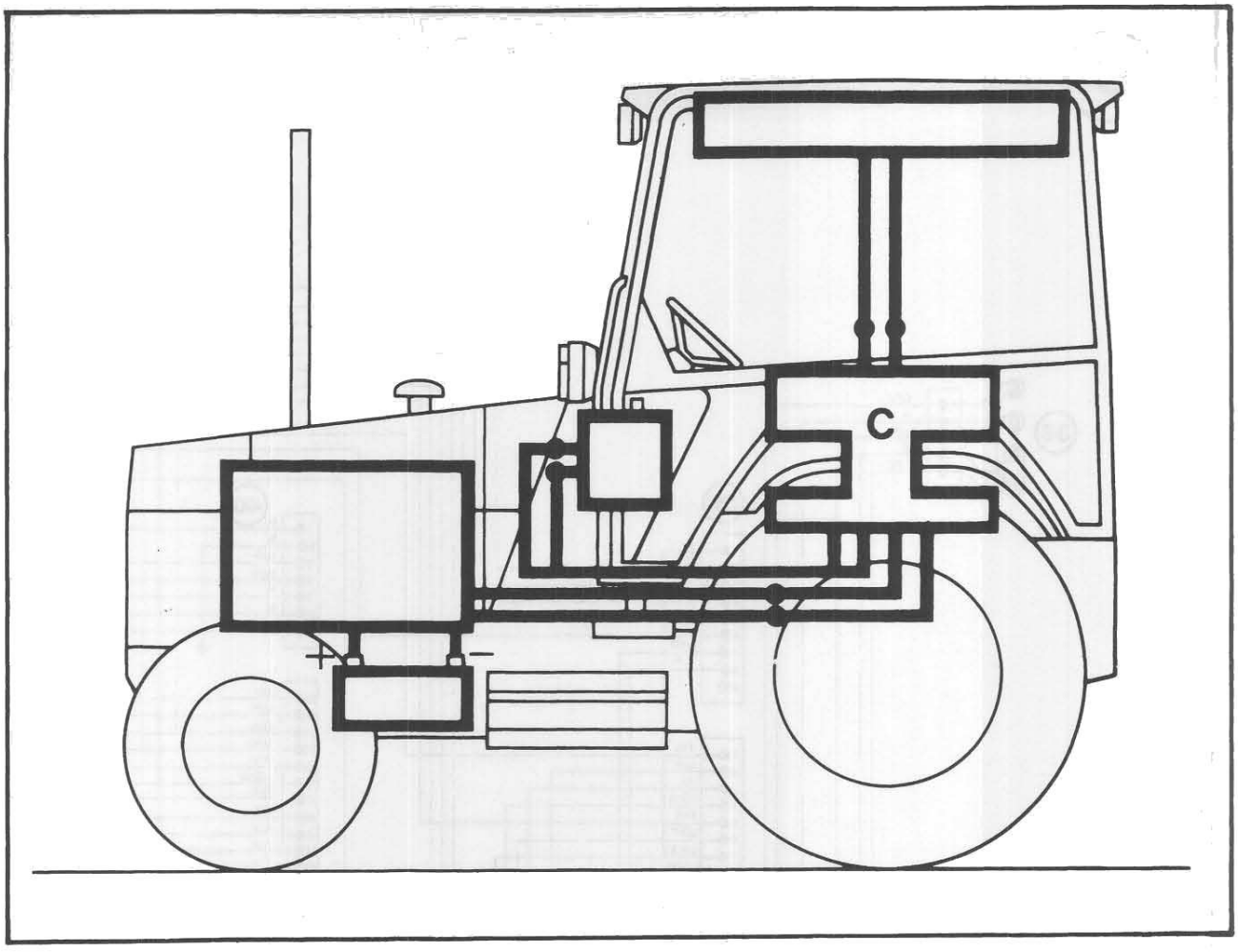
B. STEERING CONSOLE HARNESS

WIRING COLOUR CODES					
B	–	Black	P	–	Purple
G	–	Green	R	–	Red
K	–	Pink	S	–	Grey
LG	–	Light Green	U	–	Blue
N	–	Brown	W	–	White
O	–	Orange	Y	–	Yellow

B. STEERING CONSOLE HARNESS

1. Steering Console Connector (9 Pin)
2. Steering Console Connector (22 Pin)
3. Handbrake Warning Diodes
4. Socket
5. Connector
6. Stoplight Switch
7. Transmission Control Switch/Lever Assembly
8. Multifunction Switch
   (Horn/Turn Indicators/Headlight Dip & Flasher)
9. Connector
10. Screen Washer Motor
11. NASO Switch Connector (6 Pin)
12. NASO Flash Switch
13. Control Module Connector (8 Pin) (Grey Plastic)
14. Transmission Control Module
15. Control Module Connector (8 Pin) (Black Plastic)
16. Indicator Lights

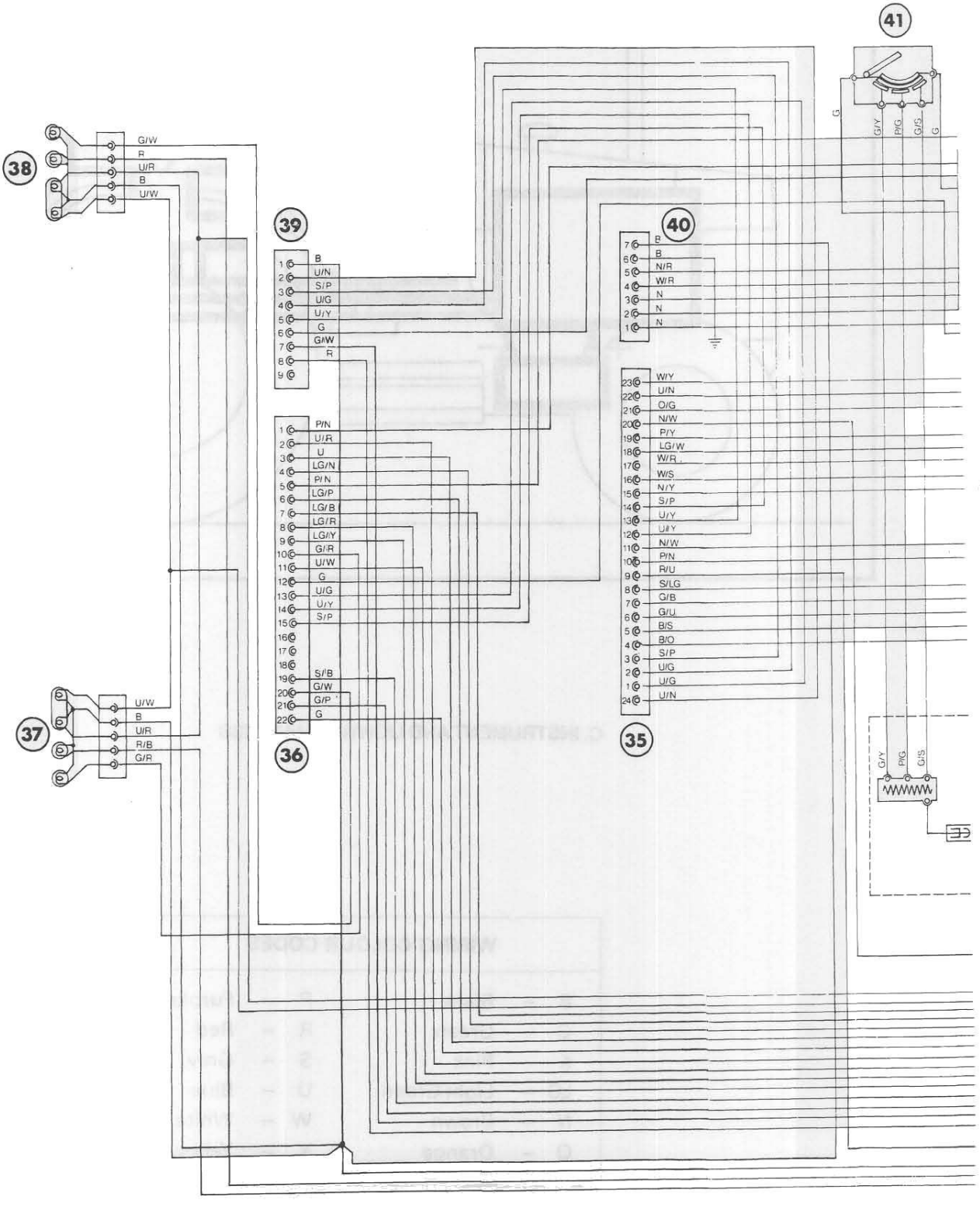


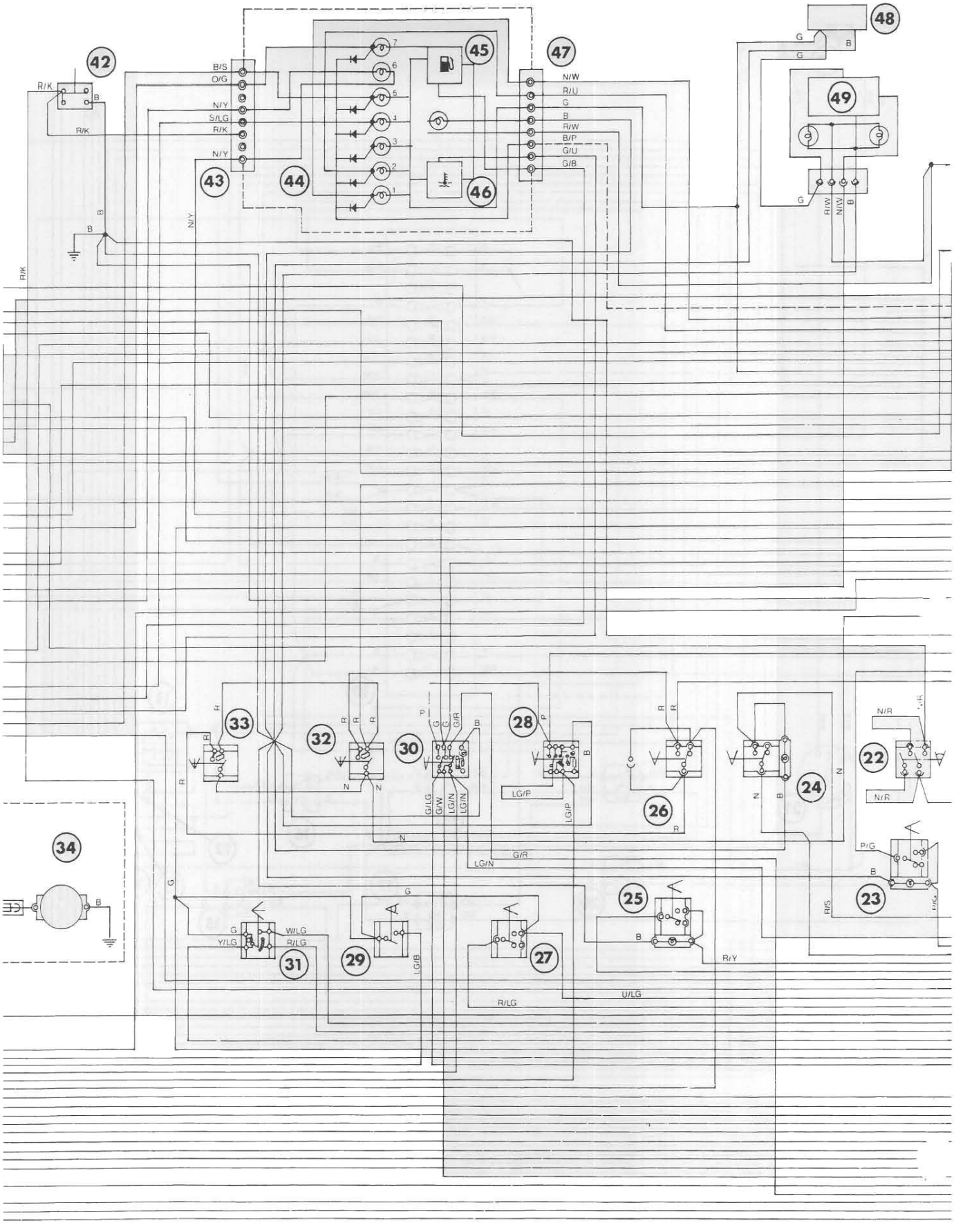


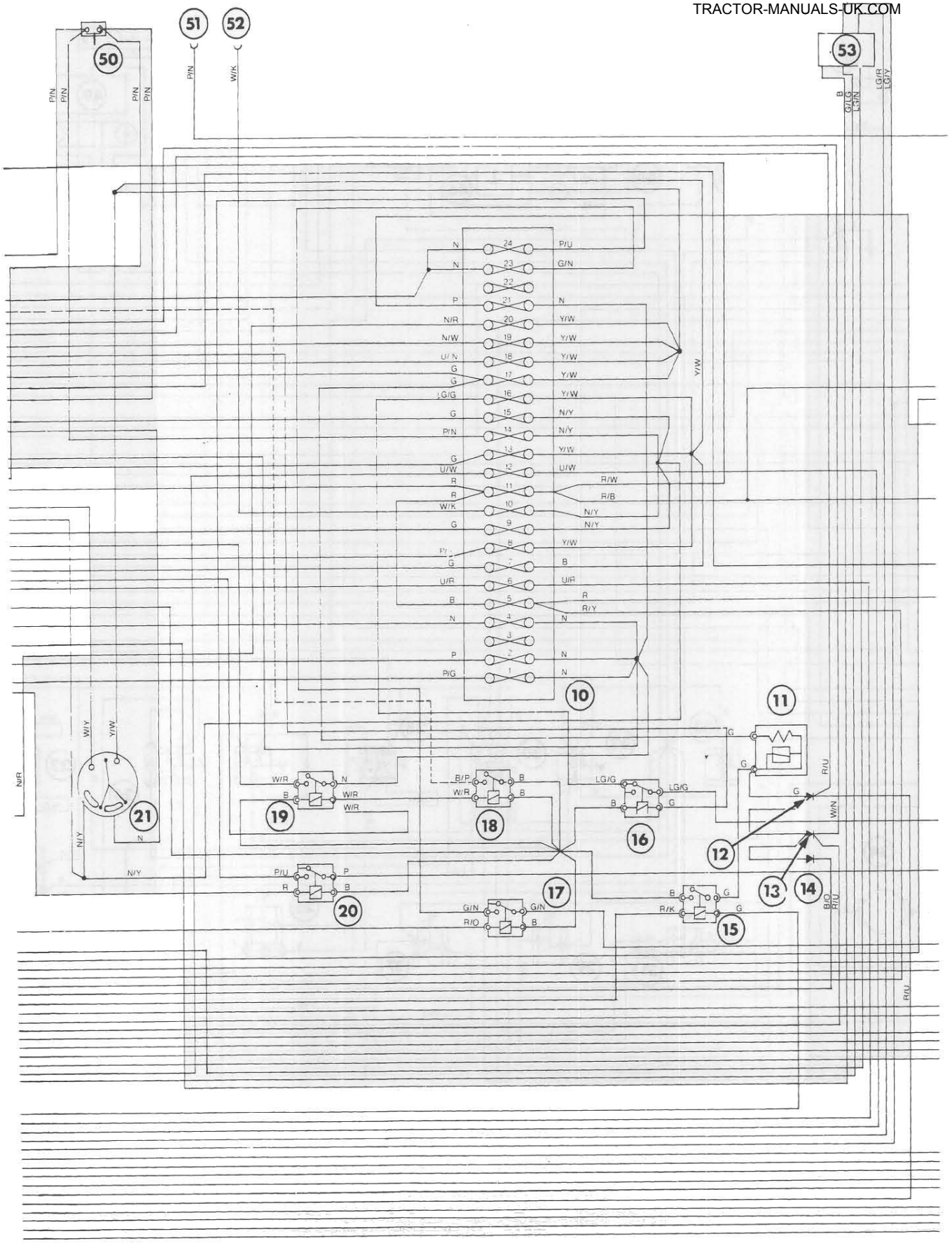
C. INSTRUMENT AND LIGHTING HARNESS

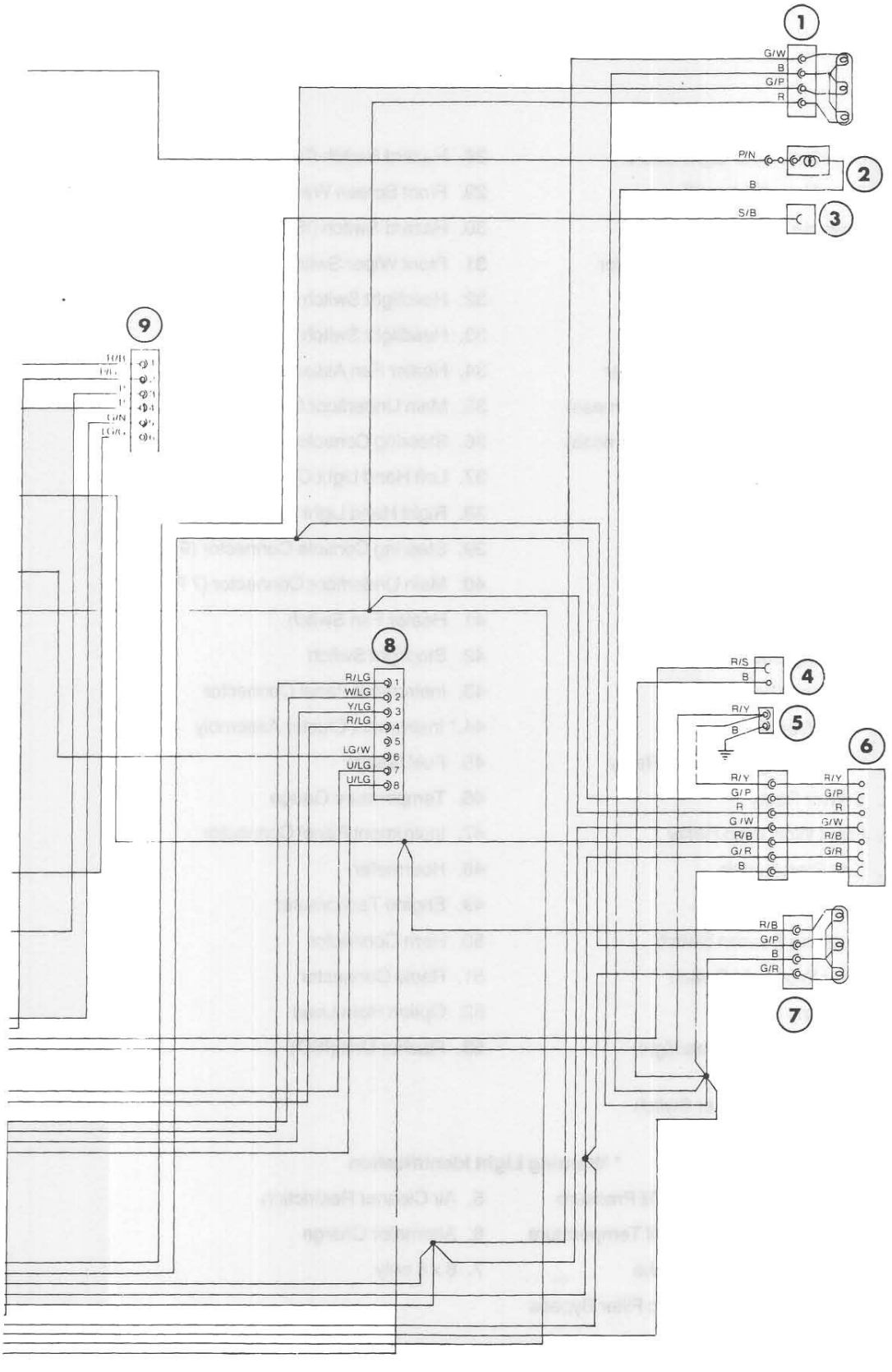
WIRING COLOUR CODES			
B – Black		P – Purple	
G – Green		R – Red	
K – Pink		S – Grey	
LG – Light Green		U – Blue	
N – Brown		W – White	
O – Orange		Y – Yellow	

C









C. INSTRUMENT AND LIGHTING HARNESS

1. Left Hand Rear Light Cluster
2. Rear Horn (Optional)
3. Reverse Alarm
4. External Work Light Connector
5. Fog Lamp Connector
6. Trailer Socket
7. Right Hand Rear Light Cluster
8. Connector 8 Pin (to Roof Harness)
9. Connector 6 Pin (to Roof Harness)
10. Fusebox
11. Buzzer
12. Diode (Trans. Temperature)
13. Diode (Engine Oil Pressure)
14. Diode (Engine Temperature)
15. Warning Buzzer Relay
16. Air Conditioning Relay
17. Rear Work Lamp Relay
18. Warning Light Earthing Relay
19. Starter Relay
20. Front Worklamp Relay
21. Key Start Switch
22. Thermostart Switch
23. Rotating Beacon Switch
24. Rear Worklight Switch
25. Foglamp Switch
26. Front Worklight/Headlight Selector Switch
27. Rear Screen Wiper Switch
28. Hazard Switch (NASO)
29. Front Screen Washer Switch
30. Hazard Switch (ISO)
31. Front Wiper Switch
32. Headlight Switch (NASO)
33. Headlight Switch (ISO)
34. Heater Fan Assembly
35. Main Underfloor Connector (24 Pin)
36. Steering Console Connector (22 Pin)
37. Left Hand Light Cluster
38. Right Hand Light Cluster
39. Steering Console Connector (9 Pin)
40. Main Underfloor Connector (7 Pin)
41. Heater Fan Switch
42. Stoplight Switch
43. Instrument Panel Connector
44.* Instrument Cluster Assembly
45. Fuel Gauge
46. Temperature Gauge
47. Instrument Panel Connector
48. Hourmeter
49. Engine Tachometer
50. Horn Connector
51. Radio Connector
52. Option Horn Lead
53. Flasher Unit (ISO)

*** Warning Light Identification**

1. Engine Oil Pressure
2. Trans. Oil Temperature
3. Handbrake
4. Hydraulic Filter Bypass
5. Air Cleaner Restriction
6. Alternator Charge
7. 8 x 8 only

PART 3
ELECTRICAL SYSTEM

Chapter 2
BATTERY

A. BATTERY – DESCRIPTION AND OPERATION

The lead acid type storage battery is installed in a compartment on the side of the left hand sub-frame. The battery provides a 12 volts system and is rated at 128 ampere hours. The battery is constructed with 6 cells, each cell producing 2.1 volts to produce a total battery output of 12.6 volts. The battery compartment is of robust construction to protect the battery from damage. The heavy lid, when closed, forms part of the step for gaining access to the cab.

The battery has three major functions:

- To provide a source of current for starting lighting and instrumentation.
- To help control the voltage in the electrical system.
- To provide current when the electrical demands exceed the alternator output.

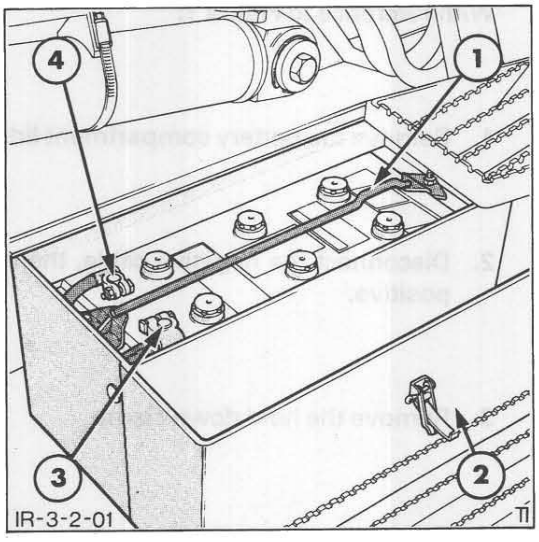


Figure 1
Battery Location

1. Hold Down Clamp
2. Foot Step/Compartment Front
3. Negative Terminal
4. Positive Terminal

Battery construction is such that each cell contains positive and negative plates alternately placed next to each other. Each positive plate is separated from a negative by a non-conducting porous separator which prevents the plates touching each other. If any positive or negative plates touch each other within a cell that cell will short circuit and will no longer be useful.

All the positive plates are welded to a post strap to form a positive group while the negative plates are connected to a similar strap for the negative group.

Each positive plate is composed of a lead grid with a lead peroxide coating while the negative plates are composed of a lead grid with a spongy lead pasted into the grid openings.

The liquid electrolyte in the battery is comprised of sulphuric acid and water mixed together to form a sulphuric acid solution.

B. BATTERY – MAINTENANCE AND TESTS

REMOVAL

With reference to Figure 1:

1. Remove the battery compartment lid.
2. Disconnect the negative cable, then the positive.
3. Remove the hold down clamp.
4. Remove the combined foot step/ compartment front.
5. Lift out the battery from the compartment.

SPECIFIC GRAVITY

The specific gravity of battery electrolyte indicates the state of charge. Fully charged the specific gravity of the electrolyte is approximately 1.280.

When a battery discharges, sulphuric acid in the electrolyte combines chemically with the plates, and this action lowers the specific gravity of the solution.

A battery hydrometer, Figure 2, will determine the specific gravity of the electrolyte in a cell, and the amount of unused sulphuric acid in the solution is a measure of the degree of charge of that cell.

The lower temperature at which a battery is required to operate the more necessary it is that the battery is maintained in a fully charged, condition. For example a battery with a low specific gravity of 1.225 at 27°C (80°F) will operate the starting motor at warm ambient temperatures but may fail, due to lower battery efficiency at a low temperature.

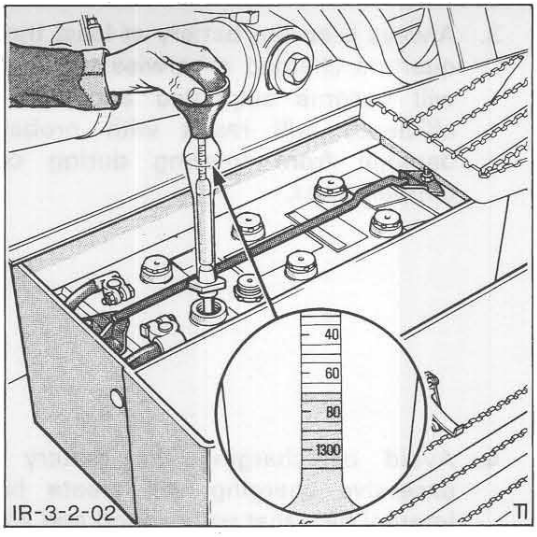


Figure 2
Battery Hydrometer

The following table lists the effect of temperature on the efficiency of a typical battery.

Temperature	Efficiency of a Fully Charged Battery
26.5°C (80°F)	100%
10.0°C (50°F)	82%
–1.0°C (30°F)	64%
–6.5°C (20°F)	58%
–12.0°C (10°F)	50%
–17.0°C (0°F)	40%
–23.0°C (–10°F)	33%

CHARGING

Maximum battery life can be obtained when the correct care and periodic inspection is given. It is important that output capacity should not be exceeded by constant and excessive overloading, and that charging requirements be maintained.

When servicing a battery the following steps should be observed:

1. Maintain the electrolyte to the recommended level which is generally approximately 0.25 in. (5.0 mm) above the plates otherwise the acid will reach a high concentration that will damage the separators and impair the performance of the plates.

2. Use only distilled water for topping up.

3. Always keep the battery at least three-quarters charged otherwise the plates will become sulphated and loss of efficiency will result with probable damage from freezing during cold temperatures.

4. Avoid overcharging the battery as excessive charging will create high internal heat that will expand and warp the plates or distort the battery case.

5. When fast charging ensure the battery temperature does not exceed 51.5°C (125°F).

6. Do not add sulphuric acid to a cell unless the electrolyte has been lost through spilling. Before replenishing ensure the solution is at the correct specific gravity.

A slow charge is the only method to be employed to fully charge a battery. A high rate charger can be used to quickly boost the battery capacity but this must be followed by a slow charge rate to bring the battery to full capacity.

Before charging a battery:

1. Thoroughly clean the battery casing, cell covers and terminals.

2. Check the level of the electrolyte in each cell and add distilled water as necessary.

3. With a slow charger use a rate of 3 to 4 amperes for the time necessary to bring the battery to full charge. This may take 24 hours or more if the battery is heavily sulphated. A severely sulphated battery might not accept a charge. When the battery is fully charged the cells will gas freely and the specific gravity will remain constant. Remove the charger after three consecutive hydrometer readings taken at hourly intervals indicate that the specific gravity has stopped rising.

4. When using a fast or high rate of charge carefully follow the manufacturer's instructions. High rate charging raises the temperature of the electrolyte and, unless a charger is equipped with an automatic time or temperature device, the electrolyte temperature could exceed 51.5°C (125°F) which may cause violent battery gassing.

WARNING: *When a battery is being charged an explosive gas is produced. Do not smoke or use an exposed flame when checking the electrolyte level.*

TESTS

Before commencing battery tests check the battery for clogged vents, corrosion, raised cell covers or a cracked case. The following tests are performed using a hydrometer, a battery starter tester (high-rate discharge tester) and a battery charger.

SPECIFIC GRAVITY: This test will determine the state of battery charge. Proceed as follows:

1. With the float in the vertical position take the reading at the level of the bottom of the curved portion of the liquid.

2. Adjust the hydrometer reading for electrolyte temperature variations by subtracting four points (0.004 specific gravity) for every 5.5°C (10°F) below the temperature at which the hydrometer is calibrated and by adding four points (0.004 specific gravity) for every 5.5°C (10°F) above this temperature.

The following are examples using a hydrometer calibrated at 30°C (86°F).

Example 1:
Temperature below 30°C (86°F)

Electrolyte temperature	19°C (66°F)
Hydrometer reading	1.270
Subtract $\frac{11.00}{5.5} \times 0.004$	0.008
Corrected Specific Gravity	1.262

Example 2:
Temperature above 30°C (86°F)

Electrolyte temperature	40°C (104°F)
Hydrometer reading	1.270
Add $\frac{10.0}{5.5} \times 0.004$	0.007
Corrected Specific Gravity	1.277

3. Use the table under to determine the state of charge.

State of Charge	Corrected Specific Gravity
100%	1.280
75%	1.230
50%	1.180
25%	1.130
Discharged	1.080

NOTE: *Specific Gravity should not vary more than 0.025 points between cells.*

4. If the specific gravity is 1.280 or more, the battery is fully charged.

5. Should the corrected specific gravity be below 1.280, charge the battery and inspect the charging system to determine the cause of low battery charge.

NOTE: *If distilled water has recently been added the battery should be put to work for a short period otherwise accurate hydrometer readings will not be obtained.*

CAPACITY: The battery capacity test is to determine if the battery has sufficient discharge capacity for the load imposed by the electrical accessories while turning the engine. The voltage reading obtained is used to determine the battery condition. Prior to testing ensure the electrolyte level is correct and the specific gravity of each cell is 1.225 or more. As required the batteries may be tested on or off the vehicle.

1. Set the current control switch of the battery starter tester (high rate discharge tester) to the 'off' position, and the voltage selector switch equal to or slightly higher than the rated battery voltage. Connect the tester positive leads to the battery positive terminal and the negative leads to the negative battery terminal.

2. Turn the current control knob until the ammeter reading is three times the ampere-hour rating of the battery and take the voltage reading.

- If the reading is 9.6 volts or more the battery has an acceptable output capacity and will readily accept a normal charge.

- If however the reading is below 9.6, test charge the battery as described, and repeat the capacity test.

IMPORTANT: *Do not leave the high discharge load on the battery for periods longer than 15 seconds.*

TEST CHARGING: This test is designed only for batteries that have failed the previous Capacity Test.

1. Attach the battery starter tester (high rate discharge tester) positive leads to the battery positive terminal and the negative leads to the battery negative terminal.

2. Connect the battery charger positive lead to the battery positive terminal and the negative lead to the battery negative terminal

3. Turn the charger timer past a '3 minutes' charge indication, and then back to the '3 minutes' mark.

4. Set the charging rate as close as possible to 75 amperes.

5. After three minutes at this fast charge take the voltmeter reading.

If the total voltage is over 15.5 volts, the battery is unsatisfactory and is probably sulphated or worn out and should be replaced.

- If the total voltage is under 15.5 volts, test individual cell voltages (if battery has external cell connections) with the charge still operating on fast charge. If cell voltages are uneven replace the battery.

- If the individual cell voltages are even, within 0.1 volt, test the specific gravity of each cell and re-charge the battery to the following scale:

Specific Gravity	Fast Charge Up To:
1.150 or less	60 Minutes
1.151 to 1.175	45 Minutes
1.176 to 1.200	30 Minutes
1.201 to 1.225	15 Minutes (Slow charge only)

NOTE: *When battery trouble is experienced the fan belt tension and the complete charging system should be checked.*

INSTALLATION

1. Installation of the battery is the removal procedure in reverse.

2. When connecting the battery leads ensure the positive terminal is connected first.

PART 3
ELECTRICAL SYSTEM

Chapter 3
STARTING SYSTEM

A. STARTING SYSTEM – DESCRIPTION AND OPERATION

The starting system consists of a starting motor, starting relay, key starting switch and heavy duty circuit wiring, Figure 1. An optional solenoid operated ether spray device which injects ether into the inlet manifold to assist the starting system during extreme cold weather is available. The ether spray can only be operated when the starter motor is turning.

The starting motor is a 5 in. (127 mm) diameter four pole four brush type using an integral solenoid contactor and positive engagement drive assembly, Figure 2.

The 5.0 in. (127 mm) starting motor solenoid incorporates two windings connected in parallel. One winding is the low resistance 'pull-in' coil, grounded through the motor, while the other is the high resistance 'hold-in' coil, grounded via the solenoid body.

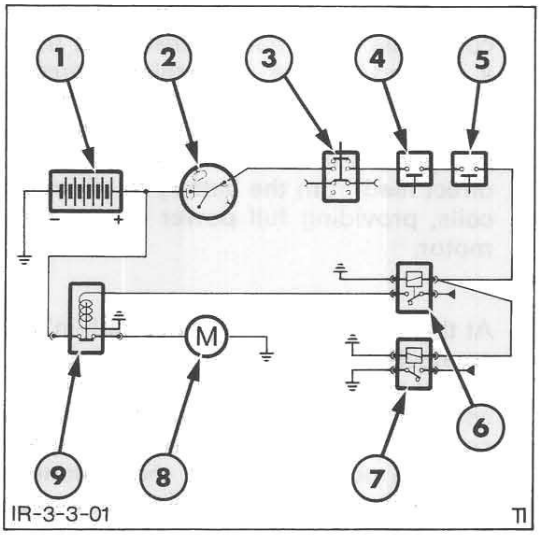


Figure 1
Starting System – Schematic Form

1. Battery
2. Key Start Switch
3. P.T.O. Safety Start Switch (455C)
4. Safety Start Switch
5. Safety Start Switch
6. Starting Motor Relay
7. Instrumentation Earth Relay
8. Starting Motor
9. Starting Motor Relay

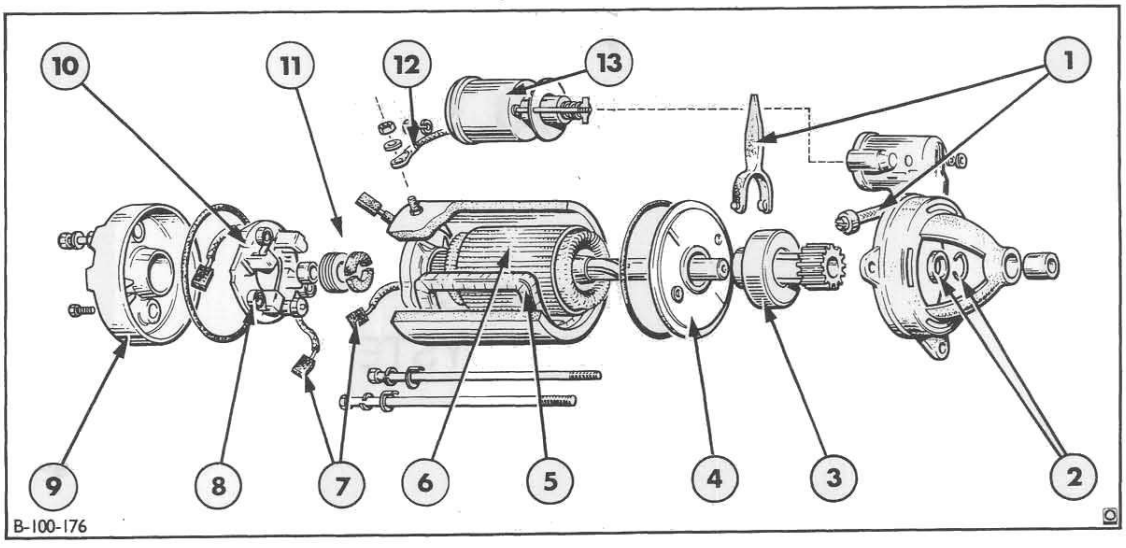


Figure 2
Starting Motor – Exploded View

1. Lever Assembly
2. Collar and Ring
3. Drive Assembly
4. Plate
5. Field Coil Assembly
6. Armature Assembly
7. Brush Assembly
8. Brush Spring
9. Brush Plate Assembly
10. Brush Holder
11. Brake
12. Solenoid Plate
13. Solenoid Assembly

When the key start switch is closed, with the transmission in neutral, the solenoid coils are energized and the solenoid plunger is magnetically attracted into the solenoid core. This movement, transmitted through a pivoted linkage mechanism, forces the drive pinion into mesh with the flywheel ring gear. On full engagement, the solenoid plunger closes a set of contacts to give a direct feed from the battery to all four field coils, providing full power to the starting motor.

At this point, one end of the 'pull-in' coil is connected to battery positive through the starter switch circuit, while the other end is connected to positive through the solenoid contacts. The 'pull-in' coil is thus by-passed, drawing no current, and the 'hold-in' coil alone keeps the solenoid plunger engaged.

The starter incorporates a single set of contacts and a two-piece solenoid plunger, which completely closes the contacts even if the pinion and ring gear teeth are misaligned. When this happens, an engagement spring is compressed which forces the pinion into full engagement as soon as the starter begins to turn.

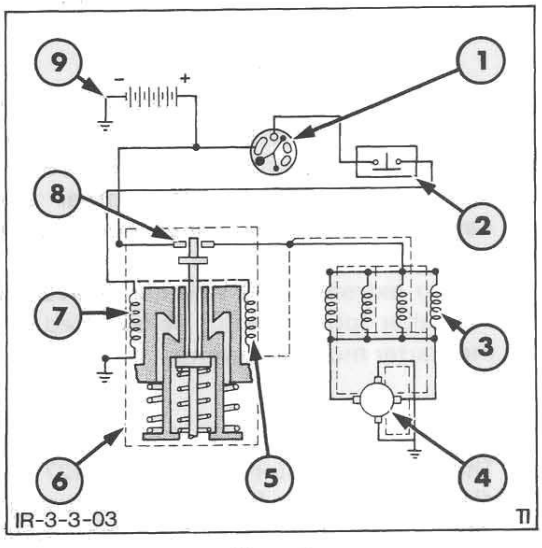


Figure 3
Solenoid Operation – Schematic Form

1. Key Starter Switch
2. Safety Start Switch
3. Field Coils
4. Armature
5. Pull-in Coil
6. Starting Motor Solenoid
7. Hold-in Coil
8. Contacts
9. Battery

When the key start switch is released, power to the solenoid and motor is removed. The solenoid return spring, acting through the pivoted linkage mechanism, pulls the drive pinion out of mesh and reopens the solenoid contacts.

Incorporated in the drive pinion assembly is a roller clutch device. This device prevents the armature from rotating excessively if the pinion remains in mesh with the flywheel ring gear after the engine has started.

B. STARTING MOTOR – OVERHAUL

STARTING SYSTEM TEST

For easier and rapid diagnosis and for most conclusive test results, it is recommended that a battery-starter tester (high-rate discharge tester) incorporating a 0–20 volt voltmeter and a 0–500 amp ammeter be used to diagnose starting system problems.

When using test equipment, follow the manufacturer's recommended test procedures. If test equipment is not available, comply with the following test procedures and refer to starting system specifications. See "Specifications" – Chapter 5. Using a standard voltmeter (0–20 volts) and ammeter (0–500 amps) the starting motor can be checked for proper operation without removing it from the engine, by using the following procedure.

Before testing:

- Check that the battery is fully charged.
- Check the complete starting system wiring circuit for frayed or broken wires or for loose connections,
- Check the engine is not seized.

Starting Motor Circuit Current Draw

1. Disconnect the battery ground (negative) cable from the battery.
2. Disconnect the battery positive cable from the starter solenoid. Connect the ammeter positive lead to the battery positive terminal and the ammeter negative lead to the solenoid input terminal.

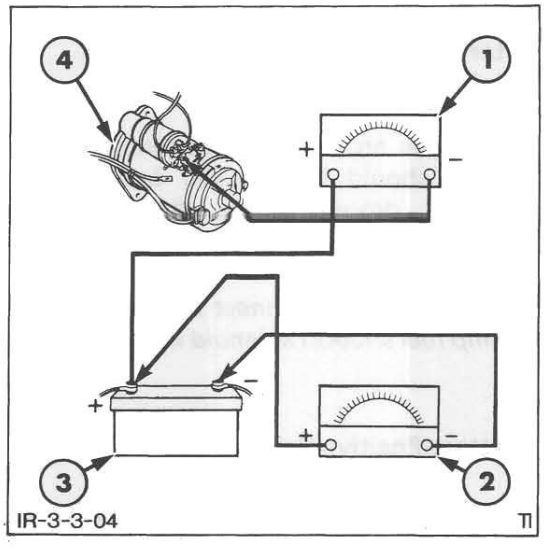


Figure 4
Circuit Current Draw Test

1. Ammeter
2. Voltmeter
3. Battery
4. Starting Motor

3. Reconnect the battery ground (negative) cable to the battery negative terminal.

4. Connect the voltmeter positive lead to the battery positive terminal and the voltmeter negative lead to the battery negative terminal.

5. Disconnect the wire from the fuel injection pump shut-off solenoid.

6. Crank the engine while observing the voltmeter and ammeter readings. See 'Specifications' – Chapter 5.

- If the current draw is within specifications, the starting motor is functioning properly. Proceed to 'Starting System Circuit Resistance'.

- If the current draw is greater than specified, check the circuit as outlined below. If the starting system circuit tests are satisfactory the starting motor is defective and must be disassembled to determine the cause.

- If the current draw is less than specified, the starting motor is defective and must be disassembled to determine the cause.

Starting System Circuit Resistance (Voltage Drop)

If there is an excessive current draw, the circuit should be checked by recording voltage drops across the individual components in the circuit.

IMPORTANT: *Disconnect the fuel injection pump fuel shut-off solenoid wire.*

Battery Positive Cable:

1. Connect the voltmeter positive lead to the battery positive terminal.

2. Connect the voltmeter negative lead to the starting motor solenoid battery terminal.

3. Crank the engine while observing the voltmeter reading. If the voltage exceeds 0.2 volt, check and tighten the cable connections. Recheck the voltage; if still excessive install a new cable assembly.

Starting Motor Ground Connections:

1. Connect the voltmeter positive lead to the starting motor frame.

2. Connect the voltmeter negative lead to the engine block.

3. Crank the engine while observing the voltmeter reading. If the voltmeter reading exceeds 0.2 volts check the ground connections between the starting motor flange and the rear engine plate.

Battery Ground Cable:

1. Connect the voltmeter positive lead to the engine block.

2. Connect the voltmeter negative lead to the battery negative terminal.

3. Crank the engine while observing the voltmeter reading. If the reading exceeds 0.2 volt, check and tighten the ground cable connections. Recheck the voltage; if it is still excessive, install a new ground cable assembly.

REMOVAL

If a starting motor failure is suspected, perform the starting motor tests, as outlined in this Chapter, before removing the starting motor. To remove the starting motor, proceed as follows:

With reference to Figure 5:

1. Disconnect the battery ground (negative) cable from the battery.

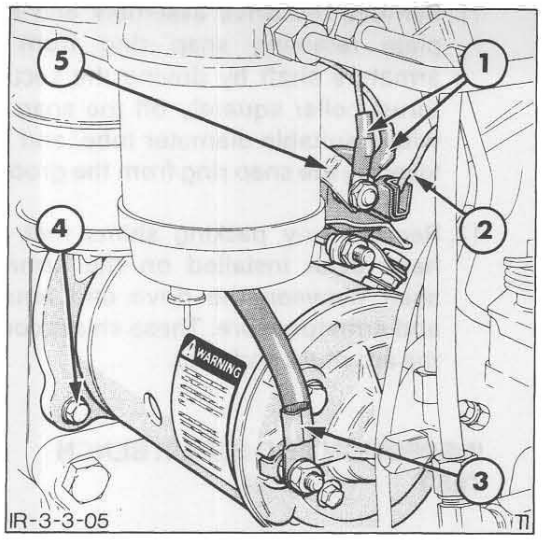


Figure 5
Starting Motor Assembly

1. Feed to Wiring Harness
2. Safety Start Wire
3. Negative Ground Cable
4. Retaining Bolts
5. Positive Feed to Solenoid

2. Disconnect the starting motor ground cable from the starting motor brush end plate.

3. Disconnect the positive battery cables from the solenoid and the solenoid coil feed wire.

4. Remove the starting motor mounting bolts and remove the starting motor.

DISASSEMBLY

With reference to Figure 6:

1. Support the starting motor in a soft jawed vice. Do not overtighten the vice.

2. Remove the copper link connecting the solenoid terminal S2 to the motor casing mounted terminal. Remove the flexible link connecting the solenoid S1 terminal to the first part field coil inside the casing.

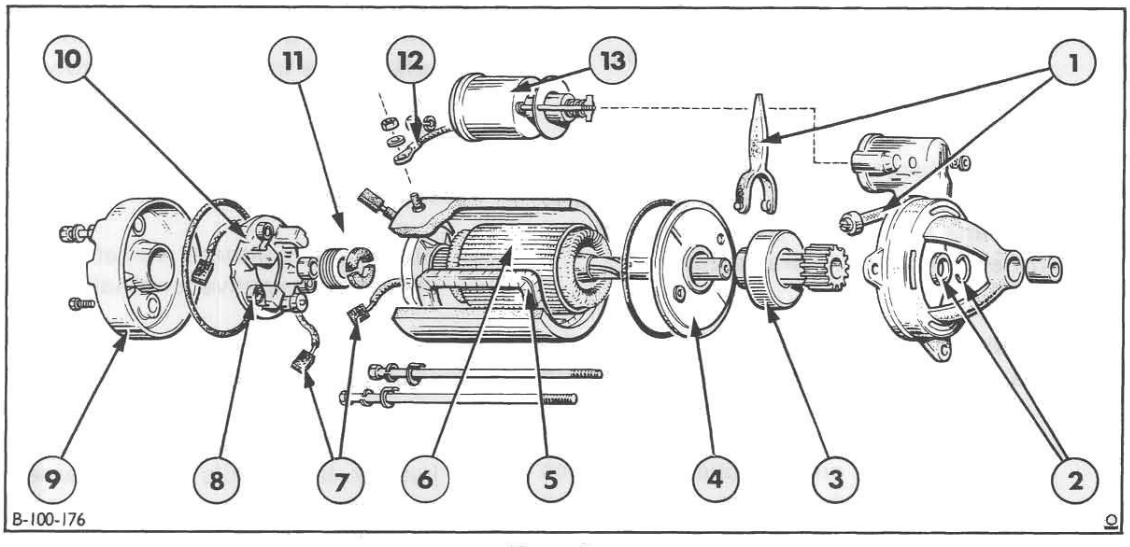


Figure 6
Starting Motor – Exploded View

1. Lever Assembly
2. Collar and Ring
3. Drive Assembly
4. Plate
5. Field Coil Assembly
6. Armature Assembly
7. Brush Assembly
8. Brush Spring
9. Brush Plate Assembly
10. Brush Holder
11. Brake
12. Solenoid Plate
13. Solenoid Assembly

3. Remove the solenoid retaining stud nuts and washers and withdraw the solenoid. Note that the plunger will remain in the drive engagement lever.

4. Remove the solenoid plunger from the drive engagement lever by gripping the plunger and lifting up the front end and releasing it from the drive engagement lever.

5. Remove the sealing grommet which is wedged between the drive end housing and motor casing.

6. Remove the motor casing, end plate and drive end housing through bolts and also remove the two recessed screws from the end plate which retain the brush gear assembly to the inner face of the end cover.

7. The commutator end cover assembly consisting of a sealing ring, brake shoe assembly, steel thrust washer, fibre packing washer and bearing brush can now be removed leaving the brush gear in its operating position on the commutator.

NOTE: *At this stage of disassembly, inspect the brushes and commutator and determine if these are the cause of failure. Further inspection details follow.*

8. Pull the commutator end of the armature shaft from the casing until the brush gear and commutator are fully exposed. Using a wire hook lift the brush springs and remove the brushes from the brush carriers. Remove the brush gear assembly.

9. Withdraw the motor casing from the armature and drive end bracket.

10. Unscrew the drive engagement lever eccentric pivot pin from the drive end housing.

11. Remove the drive assembly and inner plate retaining snap ring from the armature shaft by driving the securing thrust collar squarely off the snap ring with a suitable diameter tube, and then levering the snap ring from the groove.

12. Remove any packing shims that may have been installed on the armature shaft between the drive end housing and armature core. These shims control the armature end float.

INSPECTION AND REPAIR BENCH TEST

With a standard voltmeter (0–20 volts) proceed as follows:

1. Inspect the surface of the commutator for burned spots. If burned spots are evident, install a new armature.

Testing Armature for Short Circuits:

In order to test the armature for short circuits, use suitable armature testing equipment or a 'growler' and follow the manufacturer's instructions on how to test for short circuits.

Testing Armature for Grounded Circuits:

1. Attach the voltmeter negative lead to the battery negative terminal.

2. Attach a jumper lead to the battery positive terminal.

3. Touch the armature core with the jumper lead while at the same time touching a commutator segment with the voltmeter positive lead. Test each segment of the commutator in this manner.

4. Observe the voltmeter and note if a voltage reading occurs. If voltage is evident, the armature windings are grounded and a new armature must be installed.

Testing Field Coils for Open Circuits

1. Connect the voltmeter positive lead to the starting motor field terminal.
2. Connect the voltmeter negative lead to the battery negative terminal.
3. Attach a jumper lead between the battery positive terminal and to one of the insulated brushes. The voltmeter should indicate battery voltage.
4. Repeat the complete test with the jumper lead connected to the other insulated brush. The voltmeter should indicate battery voltage.
5. Disconnect the voltmeter positive lead from the starting motor field terminal and connect it to the eyelet wire. Connect the jumper lead between the battery positive terminal and, in turn, to each of the insulated brushes. The voltmeter should indicate battery voltage.

NOTE: *If no voltage is indicated in Steps 3, 4 and 5, an open circuit exists in the field coils and new coils must be installed.*

Testing Field Coils for Grounded Circuits

1. Connect and voltmeter positive lead to the starting motor field terminal.
2. Connect the voltmeter negative lead to the battery negative terminal.
3. Attach a jumper lead between the battery positive terminal and the starting motor frame.
4. The voltmeter reading should indicate zero voltage. If a reading is indicated, the field coils are grounded and new coils must be installed.

Brush Inspection

To gain access to the brushes, complete steps 1 to 7 of the disassembly procedure.

1. Check the movements of the brushes in their holders. If the brushes are sticking, clean them with a suitable solvent and if necessary, smooth the sides of the brushes with a fine abrasive or a smooth file.
2. Check the brushes for wear, if they are worn to less than the length specified, install new brushes see 'Specifications' – Chapter 5.
3. Check the brush spring tension by positioning a spring scale hook under the brush spring. Pull the spring scale radially. Install new springs if the tension is less than specified. See 'Specifications' – Chapter 5.
4. Install a new brush end plate assembly if the insulators between the field brush holders and the end plate are defective.

Brush Removal and Installation

1. Unsolder the field brush leads from the field coils.
2. Unsolder the ground brush leads from the brush holders.
3. Install the new brushes, soldering the leads using a 300 watt soldering iron and resin core solder.
4. Ensure the new brushes move freely in the holders. If necessary, smooth the sides of the brushes with a fine abrasive or a smooth file.

Armature Assembly and Armature Bushing

1. Inspect the armature for damage to the core and wire areas. If damaged install a new armature; do not attempt to machine the core.

2. Using 'Vee'-blocks and a dial indicator check the armature shaft runout. Install a new armature if the runout is greater than that specified or if the shaft is badly worn. See 'Specifications' – Chapter 5.

3. Examine the armature shaft bushing in the brush end plate. If the bushing is worn or scored install a new bushing.

4. Inspect the brake shoes in the brush end plate. If worn or damaged, install new parts.

5. Inspect the bushing in the inner plate. If worn or scored, install a new bushing.

6. Inspect the bushing in the drive end housing. If the bushing is worn or scored, install a new bushing.

7. Clean the commutator with a suitable solvent and inspect the surface for pits and burned spots.

8. Using 'Vee'-blocks and a dial indicator, check the commutator runout. If the runout is more than specified, turn down the commutator using a lathe and sharp cutting tool. Rotate the armature at a high speed and take light cuts with the tool. Then polish the surface with fine glasspaper or emery cloth. See 'Specifications' – Chapter 5.

NOTE: *Do not reduce the diameter of the commutator to less than the dimension specified or a new armature must be installed. The insulation slots must not be undercut.*

9. Perform the armature ground test.

Field Coils

Check the field coils for open or grounded circuits. If faulty install new coils as follows:

1. Unsolder the field coil leads from the field terminal.

2. Unsolder the eyelet cable from the field coil connection.

3. Remove the pole shoe screws.

4. Remove the insulation band.

5. Remove the pole shoes and field coils from the starting motor frame.

6. Position the new field coils over the pole shoes and place the coils in the starting motor frame.

7. Place the insulation band in position.

8. Install the pole shoe retaining screws. While tightening the screws, tap the starting motor frame with a soft-faced hammer to align and set the pole shoes. Once installed, stake the screws to prevent them from loosening.

9. Resolder the field coil leads to the starting motor field terminal using resin core solder.

10. Resolder the eyelet cable connections.

11. Check the field coils for grounding.

Drive Assembly

Check the operation of the roller clutch. The pinion should rotate clockwise only. If the pinion is stuck or rotates in both directions, or if the pinion teeth are damaged, install a new drive assembly.

If damaged pinion teeth are evident, check the flywheel ring gear teeth. See PART 1, 'ENGINE SYSTEM'.

RE-ASSEMBLY

1. Re-assembly of the starting motor follows the disassembly procedure in reverse.

NOTE: *Before the drive end housing can be firmly seated, the slot in the inner plate must be aligned with the pin on the drive end housing and the slot in the starting motor casing.*

Prior to installation, the pinion clearance, armature end play and starting motor no load function must be tested.

Setting the Pinion Clearance –

1. Secure the starting motor in a vice equipped with soft jaws.

2. Using a 6 volt source, connect a jumper lead through an open switch between the source and the solenoid switch terminal (spade connector). Connect another lead from the source to the starting motor ground terminal.

3. Measure the pinion clearance by inserting a feeler gauge, of the specified thickness, between the pinion gear and the armature shaft collar then close the switch. Lightly press the pinion towards the armature to take up any slack in the drive linkage and check the clearance. For the correct pinion clearance, see 'Specifications' – Chapter 5.

4. If the clearance is incorrect, loosen the drive lever eccentric pivot pin locknut and turn the pin clockwise to increase the clearance or counterclockwise to reduce the clearance.

NOTE: *Ensure the head of the arrow marked on the pivot pin is set between the arrows cast on the drive end housing. If this condition cannot be achieved, renew the drive linkage assembly.*

5. After setting the clearance hold the pivot pin in position with a screwdriver and tighten the locknut to the correct torque, see 'Specifications' – Chapter 5.

Setting the Armature End Play –

1. Secure the starting motor in a vice equipped with soft jaws and attach a dial indicator to the drive end housing flange. Locate the dial indicator pointer on the end of the armature shaft.

2. Move the armature shaft forward by pressing on the stop collar. Set the indicator dial to zero.

3. Push the armature shaft rearwards and record the gauge reading.

4. If the end play is greater than specified, see 'Specifications' – Chapter 5, disassemble the starting motor and install shims between the armature core and the centre bearing plate. The shims are available in thicknesses of 0.005 in. (0.127 mm) and 0.010 in. (0.254 mm).

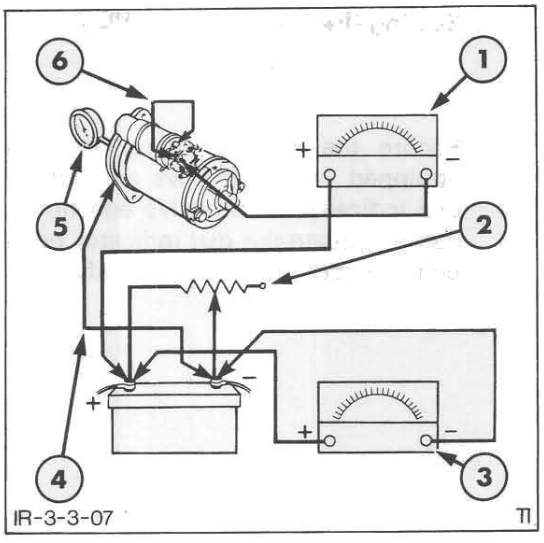


Figure 7
Starting Motor No-Load Test

1. Ammeter
2. Variable Load Resistor
3. Voltmeter
4. Jumper Cable
5. Hand Tachometer
6. Jumper Lead

Starting Motor No-Load Test

With reference to Figure 7.

NOTE: *A fully-charged battery and a battery starter tester (high rate-discharge tester) with a carbon pile (variable load resistor) should be used to perform this test.*

1. Secure the starting motor in a vice equipped with soft jaws.
2. Connect the battery negative cable to the starting motor mounting flange.

   Connect a short jumper lead between the solenoid battery and solenoid switch terminals.
3. Connect the voltmeter positive lead to the battery positive terminal, the voltmeter negative lead to the battery negative terminal, the ammeter positive lead to the battery positive terminal and the ammeter negative lead to the solenoid battery or starting motor terminal.
4. Hold a hand tachometer on the end of the armature shaft. Actuate the starting motor by adjusting the carbon pile to give 12 volts. When the armature rotates between 5500 and 7600 rev/min. the maximum current draw should not exceed 110 amperes.
5. If the starting motor does not perform to specification, check for grounded field coils, a rubbing armature or a distorted armature shaft.

PART 3
ELECTRICAL SYSTEMS

Chapter 4
CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR

A. CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – DESCRIPTION AND OPERATION

Ford Tractors feature a negative ground, alternating current charging system comprising an alternator, alternator regulator, storage battery and the necessary wires to connect the circuit.

Alternators provide a higher maximum output than the equivalent direct current generators and also increased charge rates at lower engine speeds.

Unlike a direct current generator, the alternator does not require a commutator and can be run safely at higher speeds.

This Chapter concerns the overhaul and repair of the A127 55 Amp alternator which features an integral regulator.

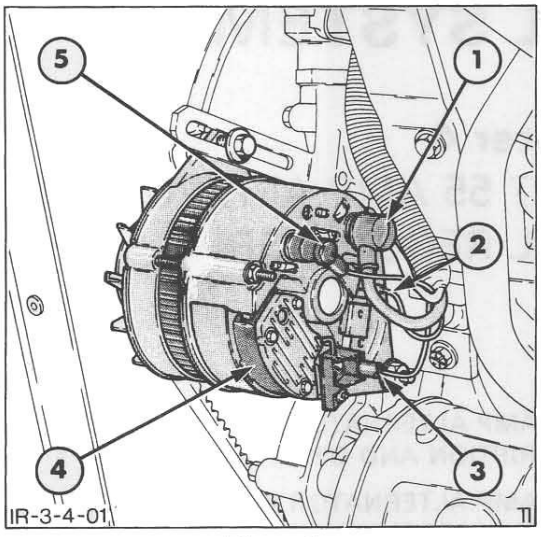


Figure 1
Alternator Installed on Tractor

1. Output Lead
2. Charge Indicator Lead
3. Battery Temperature Sensor Lead
4. Regulator and Brushbox
5. Tachometer Pick Up Lead

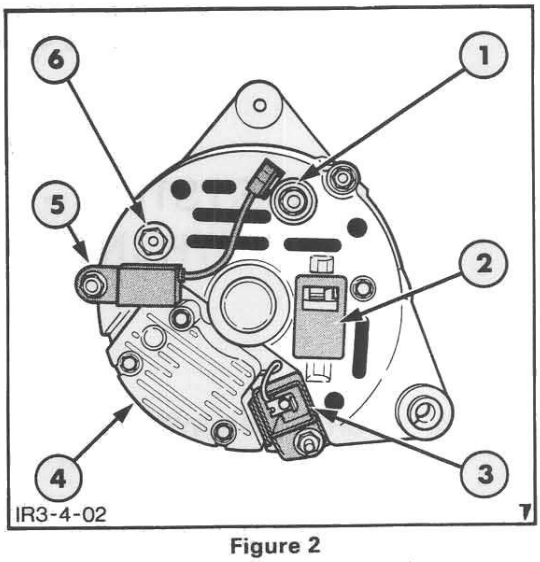


Figure 2
Alternator Terminal Identification

1. Main Output Terminal (+ve)
2. IND (Charge Indicator) Terminal
3. Battery Temperature Sensing Terminal
4. Regulator and Brushbox
5. Radio Interference Suppressor (where fitted)
6. Phase (Tachometer Pick Up) Terminal

The alternator is mounted at the front of the engine being belt driven from the crankshaft pulley, Figure 1.

The alternator terminals are identified in Figure 2.

With reference to Figure 3, the alternator comprises principally:

- Rotor
- Stator
- Rectifier Pack
- Regulator/Brush Box

ROTOR

The rotor and brushgear provide the magnetic field of the alternator unlike a direct current generator where the field is stationary.

The rotor is belt driven from the engine through a pulley clamped to the rotor shaft which runs in heavy-duty sealed roller bearings. An integral fan, adjacent to the pulley, draws cooling air through the alternator.

Current is supplied to, and returned from, the rotor field coil via two carbon brushes which bear against slip rings on the rotor shaft.

As current passes through the copper wire of the rotor field coil a magnetic field is produced and contained within an armature formed into pole shoes. The configuration of the pole shoes ensures concentration of the magnetic field.

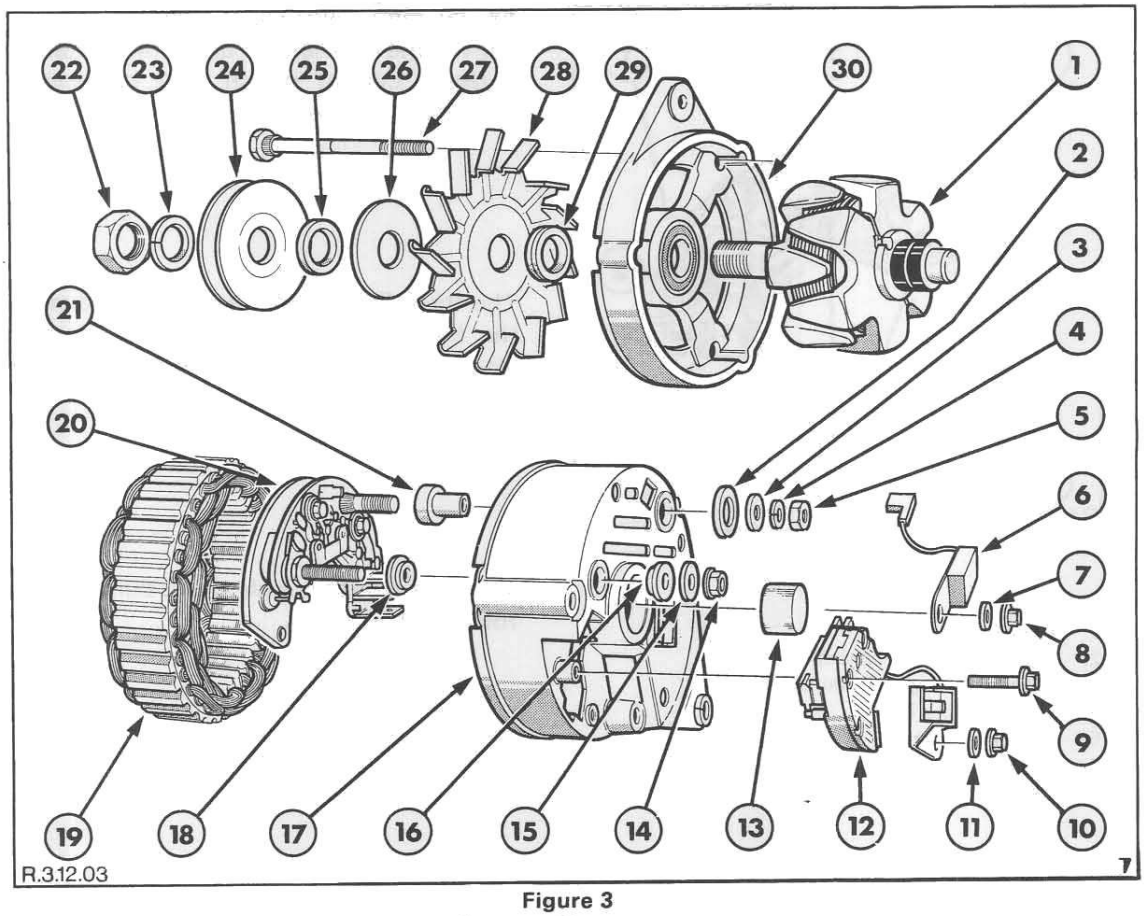


Figure 3
Alternator Components

1. Rotor
2. Insulator
3. Washer
4. Spring Washer
5. Nut
6. Suppressor
7. Washer
8. Nut
9. Bolt
10. Nut
11. Washer
12. Regulator/Brushbox
13. Bearing
14. Nut
15. Washer
16. Insulator
17. Rear End Bracket
18. Insulator
19. Stator
20. Rectifier
21. Insulator
22. Nut
23. Washer
24. Pulley
25. Spacer
26. Washer
27. Through Bolt
28. Fan
29. Double Spacer
30. End Bracket

STATOR

The stator contains the windings into which current is induced by the revolving magnetic field of the rotor.

The stator is fabricated from laminations of thin steel pressings onto which three separate wires are wound. The laminations are specially formed to concentrate and collect the magnetic field.

During each complete revolution of the rotor, all three stator windings have induced currents passing first in one direction and then the other; in other words a 3-phase alternating current.

Because alternating current is generated in a series of pulsations, the rotor features six pairs of poles to provide an overall smoother output. For every revolution of the rotor the output characteristic of each stator winding completes six cycles.

Alternating current (A.C.) is unsuitable for charging the battery, which requires pure direct current (D.C.). Therefore, the three stator windings are connected to a rectifier pack which rectifies or converts the alternator output to direct current.

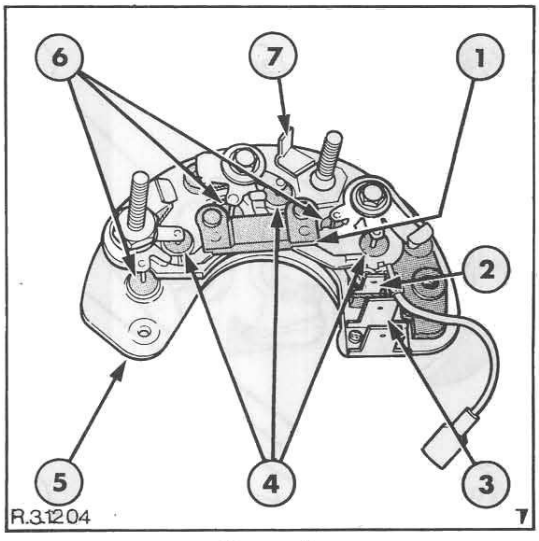


Figure 4
Rectifier Assembly

1. Field Diode Module
2. IND (Indicator) Terminal
3. Alternator Output Terminal (+ve)
4. Positive Plate Diodes
5. Negative Plate
6. Positive Plate Diodes
7. Radio Interference Suppressor Terminal

RECTIFIER

The rectifier consists of a pack of six output diodes and a module containing three field diodes, Figure 4.

NOTE: *A diode is basically an electronic 'check valve' which allows current to flow in one direction only.*

Three of the six output diodes are mounted in a positive plate and three in a negative plate. The two plates are separated and terminal links enable each of the three stator output wires to connect to a different diode in each plate.

As the rotor revolves, the diodes rectify or convert the alternating current of the stator to a direct current which may be used to effectively charge the battery.

The three field diodes are contained within the field diode module, each of the three stator output wires connects to one of these diodes.

The field diodes supply direct current to the rotor field winding.

REGULATOR AND BRUSHES

The regulator controls and maintains the alternator output voltage at a safe working level.

The regulated voltage level is established in manufacture and cannot be adjusted in service: The regulator components are housed in a sealed assembly which is integral with the alternator brush box.

Individual brush box and regulator components are not serviceable and have to be replaced as a complete assembly.

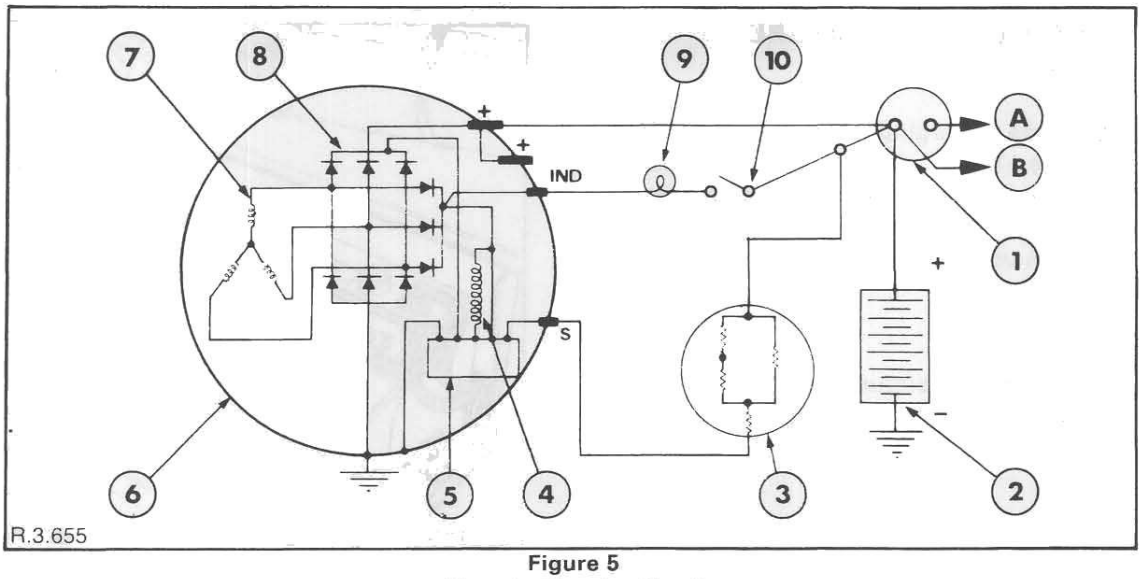


Figure 5
Alternator Charging Circuit
(With Battery Temperature Compensation)

A. To Starter Motor
B. To Load
1. Solenoid
2. Battery
3. Battery Temperature Sensor
4. Rotor Field Winding
5. Regulator
6. Frame
7. Stator Output Windings
8. Rectifier Pack
9. Charge Indicator Light
10. Key Start Switch

ALTERNATOR OPERATION

With reference to Figure 5.

When the key start switch is turned on a small current flows from the battery through the rotor field winding. The circuit is made via the charge indicator warning light, alternator terminal IND, the rotor field winding, the alternator regulator and ground.

At this stage the warning light is illuminated and the rotor partially magnetised.

When the engine is started and the partially magnetised rotor revolves within the stator windings a 3-phase alternating current is generated. A constant portion of the generated current is converted to direct current by the three field diodes incorporated in the rectifier pack.

This direct current is fed back to supplement the current flowing through the rotor field winding.

This action results in an ever-increasing magnetic influence of the rotor along with an associated rapid rise in generated output current and voltage.

During the rise in generated output voltage (reflected at terminal IND) the brilliance of the warning light is reduced and when the voltage at the IND terminal equates to that at the battery side of the warning light the lamp is extinguished.

The voltage continues to rise until the predetermined regulated voltage level is reached.

In the event of drive belt breakage the voltage will not build up within the alternator and so the charge indicator light will remain on to indicate failure.

Where a tachometer is installed on the vehicle the engine speed is sensed using the phase terminal on the alternator. Electrical pulses from the alternator which are proportional to engine speed are converted by the tachometer to display engine speed.

BATTERY TEMPERATURE COMPENSATION

Because charging systems are directly affected by changes in battery temperature and loading, the alternator charging system features combined battery temperature and system voltaged sensing.

A circular temperature sensing pad is located in contact with the side of the battery, Figure 6.

The sensor detects any changes in battery temperature and relays this information to the voltage regulator which adjusts the charge rate accordingly.

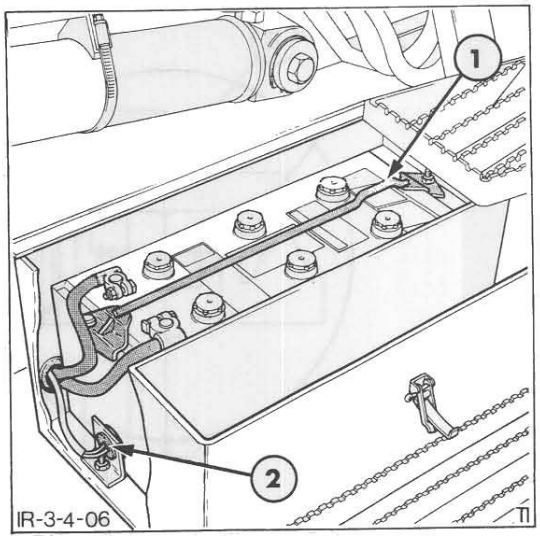


Figure 6
Battery Temperature Sensor

1. Battery
2. Sensor

B. CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – SERVICE PRECAUTIONS, PRELIMINARY CHECKS, INITIAL TESTS AND ALTERNATOR COMPONENT TESTS

SERVICE PRECAUTIONS

To avoid damage to the components of the alternator charging system, service precautions must be observed as follows:

- **NEVER** make or break any of the charging circuit connections, including the battery, when the engine is running.
- **NEVER** short any of the charging components to ground.
- **ALWAYS** disconnect the battery ground cable when installing or removing the alternator.
- **ALWAYS** disconnect the battery ground cable (negative) when charging the battery in the tractor using a battery charger.
- **ALWAYS** observe correct polarity when installing the battery or using a slave battery to start the engine.

CONNECT POSITIVE TO POSITIVE AND NEGATIVE TO NEGATIVE

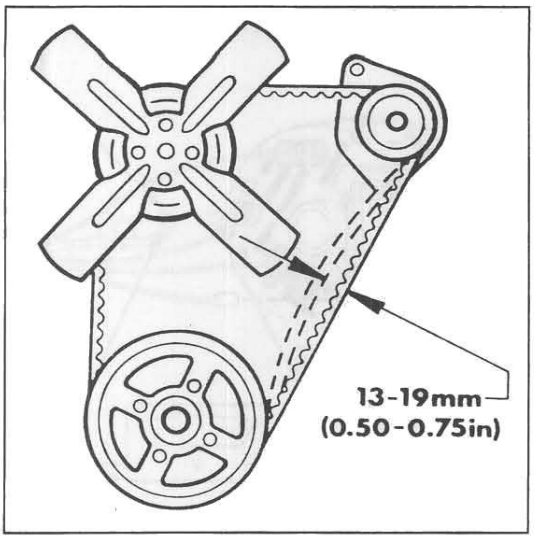


Figure 7
Drive Belt Deflection

PRELIMINARY CHECKS

Prior to electrical testing, thoroughly inspect the charging and electrical system.

Check all leads and connections for continuity and tightness.

1. Check the Battery

With an hydrometer, check the battery is at least 70% charged and in good condition.

2. Check the Drive Belt

Ensure the alternator drive belt and pulley are in satisfactory condition. Allow 0.50 – 0.75 in. (13 – 19 mm) deflection when moderate finger pressure is applied to the longest run of the belt, Figure 7.

3. Check the Warning Light

Turn on the key start switch and check the warning light is fully illuminated.

If the warning light is not fully illuminated, check the bulb. If the bulb is not the cause of the fault, carry out the Alternator Output Lead Test as detailed under "Initial Tests" in this Chapter.

If the warning light is illuminated, start the engine and run above the idling speed when the warning light should be extinguished.

If the warning light does not go out, stop the engine and remove the charge indicator lead. If the warning light is extinguished a faulty temperature sensor or alternator component is indicated. Conduct the "Battery Temperature Sensor Circuit Test" and "Alternator Components Tests" as detailed in this Chapter.

If the warning light remains illuminated, check for a shorting to frame in the area between the charge indicator lead and the warning light.

INITIAL TESTS

The initial tests may be performed without removing any of the charging circuit components from the tractor and enable the following items to be checked:

- Alternator Output Lead
- Battery Temperature Sensor Circuit
- Alternator Charging Current and Controlled Voltage
- Alternator Charging Circuit Voltage Drop
- Alternator Maximum Output Performance

Test equipment required:

- Voltmeter (0-30 Volts Moving Coil Type)
- Millivoltmeter (0-1 Volt)
- Ammeter (0-70 Amperes Moving Coil Type)
- 1.5 Ohm 70 Amperes Variable Load Resistor
- Jumper Lead (0.25in. [6.35mm] Male to Female Blade Terminal)

NOTE: *Most commercial test equipment incorporates several testing devices within a single unit. Use such equipment according to the manufacturer's instructions.*

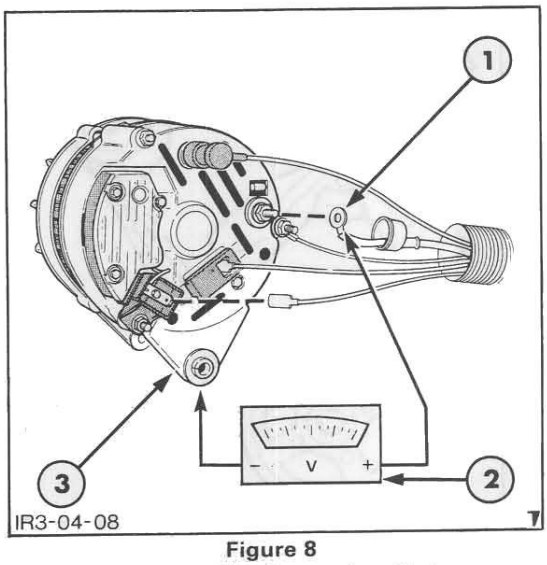


Figure 8
Alternator Plug Connections Test

1. Output Lead
2. Voltmeter (0-30 Volts)
3. Alternator Frame

1. Alternator Output Lead Test

With reference to Figure 8

1. Turn the key start switch on but do not start the engine.

2. Remove the output lead from the alternator and connect a voltmeter between the output lead and the alternator frame (negative side of voltmeter to frame). Battery voltage should be registered.

If battery voltage is not registered, a continuity fault in the external cable circuitry must be traced and remedied, refer to the circuit diagram shown in Figure 5.

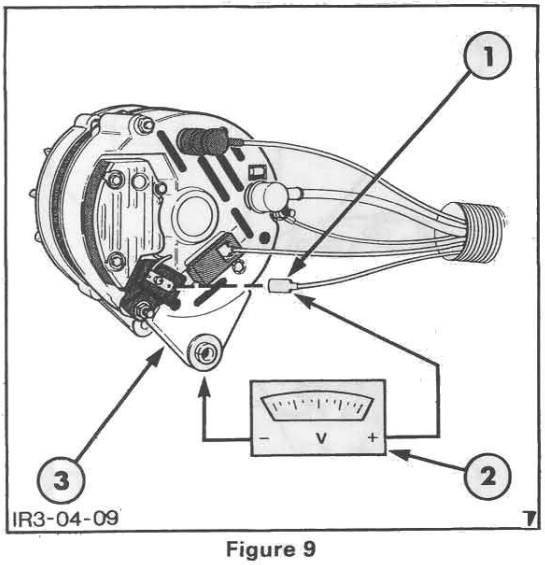


Figure 9
Battery Temperature Sensor Circuit Test

1. Battery Temperature Sensor Lead
2. Voltmeter (0-30 Volts)
3. Alternator Frame

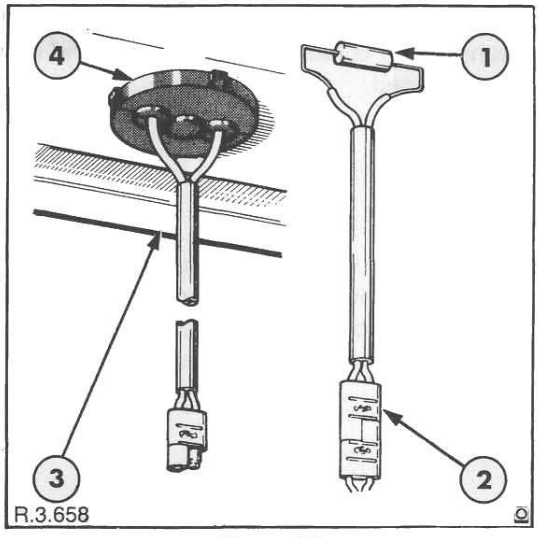


Figure 10
Connection of 205 Ohm Test Resistor

1. 205 Ohm Resistor
2. Harness to Sensor Plug
3. Battery Tray
4. Temperature Sensor

3. Connect one end of a jumper lead to the charge indicator lead and the other end to the alternator frame. The warning light should be illuminated.

4. Disconnect the jumper lead and reconnect the indicator lead to the alternator "IND" terminal.

NOTE: *If the warning light fails to illuminate when the lead is reconnected to the alternator, a fault is indicated in the alternator regulator or rotor circuits. Ensure the alternator "IND" terminal is clean and then conduct the "Alternator Component Tests" as detailed in this Chapter.*

2. Battery Temperature Sensor Circuit Test

With reference to Figure 9.

1. Remove the sensor lead from the alternator battery temperature sensing terminal which protrudes from the regulator box on an orange fly lead.

2. Connect a voltmeter between the sensor lead and the alternator (negative side of voltmeter to frame). Battery voltage should be registered.

If battery voltage is not registered, disconnect the harness to sensor plug and connect a 205 ohm resistor across the plug terminal, Figure 10.

NOTE: *It is recommended that a permanent test piece be made by removing the plug and leads from an old sensor unit and connecting a 205 ohm resistor as shown in Figure 10.*

If battery voltage is now registered, the sensor unit is faulty (open circuit) and must be replaced.

If battery voltage is not registered a continuity fault in the external circuitry must be traced and rectified. Reconnect the sensor and confirm battery voltage is registered.

NOTE: *It is very difficult to test prove the effective resistance of a temperature sensor. If such a unit is suspected of being faulty it should be replaced and proved in service.*

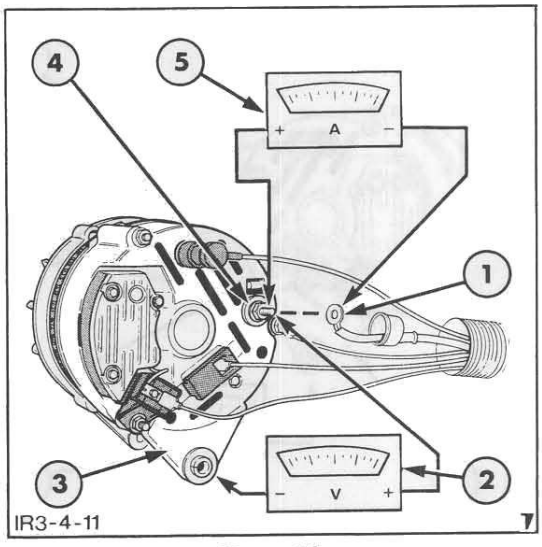


Figure 11
Charging Current and Controlled Voltage Tests

1. Output Lead
2. Ammeter
3. Alternator Frame
4. Main Output Terminal
5. Voltmeter (0-30 Volts)

3. Charging Current and Controlled Voltage Tests

With reference to Figure 11.

1. Ensure all tractor electrical components are switched off and the key start switch is in the "off" position.

2. Disconnect the battery ground cable (negative) and remove the main output lead from the alternator.

3. Securely connect an ammeter negative side to the connector plug main terminal and positive side to the alternator output terminal.

4. Connect a voltmeter between the alternator output terminal and the frame (negative side to frame).

5. Reconnect the battery and turn the key start switch to the "on" position.

6. Start the engine and increase the speed to 2000 rev/min. and observe the ammeter and voltmeter readings.

If the ammeter registers a charging current stop the engine.

If the ammeter registers zero amperes a faulty alternator component is indicated. Turn off the engine and conduct the "Alternator Component Tests" as detailed in this Chapter.

7. Disconnect the harness to sensor plug and connect a 205 ohm resistor across the plug terminals. Refer to Figure 10.

8. Restart the engine and increase the speed to 2000 rev/min. Observe the ammeter and voltmeter readings.

   The voltmeter should register in excess of the battery voltage and when the ammeter reading falls below 10 amperes, the voltmeter reading should stabilise at 13.6-14.4 volts.

   If the voltmeter reading exceeds 14.4 volts, the alternator regulator must be replaced as described in this Chapter. (When a new regulator has been installed, conduct Tests 4 and 5).

   If the voltmeter reading is below 13.6 volts a faulty alternator component or a high resistance fault in the external connections of the charging system is indicated.

9. Stop the engine.

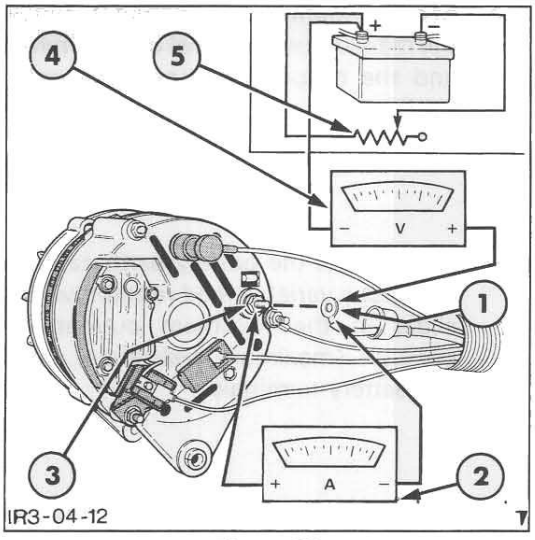


Figure 12
Insulated – side Volt Drop Test
(Inset showing connection of Millivoltmeter and Variable Load Resistor to Battery)

1. Output Lead
2. Ammeter
3. Main Output Terminal
4. Millivoltmeter (0-1 Volt)
5. Variable Load Resistor

4. Charging Circuit Volt Drop Tests
(a) Insulated-side Volt Drop Tests

With reference to Figure 12.

1. Ensure the key start switch is in the "off" position.

2. Disconnect the battery ground cable (negative) and remove the output lead from the alternator.

3. Connect a millivoltmeter between the battery positive terminal and the alternator output lead (positive side to lead).

4. Securely connect an ammeter between the main output terminal of the alternator and the output lead (negative side to lead).

5. Re-connect the battery earth cable and connect a variable load resistor, with the slider in the minimum current draw position (maximum resistance), across the battery terminals.

6. Start the engine and increase the speed to 2000 rev/min.

7. Slowly increase the current loading of the resistor (decrease resistance) until the ammeter registers 55 amperes.

8. Observe the millivoltmeter reading which should not exceed 400 millivolts.

If the reading is in excess of 400 millivolts, a high resistance fault is indicated in the external circuitry.

If the required alternator output cannot be achieved, and the millivoltmeter reading is less than 400 millivolts, then a faulty alternator component is indicated. Conduct the "Alternator Component Tests" as detailed in this Chapter.

9. Stop the engine.

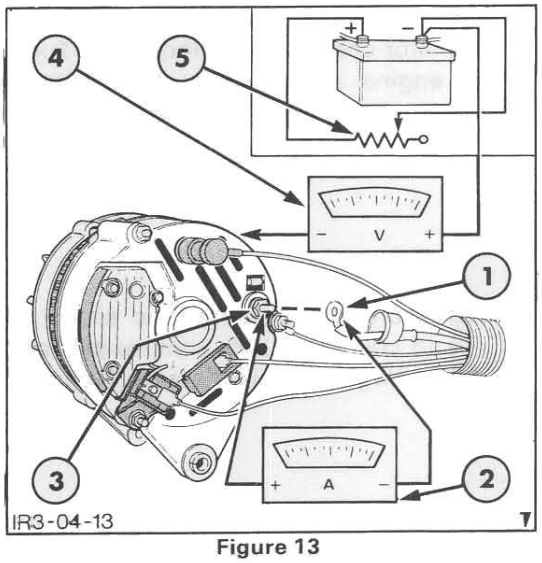


Figure 13
Ground-side Volt Drop Test
(Inset showing connection of Millivoltmeter and Variable Load Resistor to Battery)

1. Output Lead
2. Ammeter
3. Main Output Terminal
4. Millivoltmeter (0-1 Volt)
5. Variable Load Resistor

(b) Ground-side Volt Drop Test

With reference to Figure 13.

1. Ensure the key start switch is in the "off" position.

2. The circuit is the same as that used in the previous test except for the millivoltmeter which is now connected between the battery negative terminal and the alternator frame (negative side to frame).

NOTE: *Ensure the variable load resistor is in the minimum current draw position (maximum resistance).*

3. Start the engine and increase the speed to 2000 rev/min.

4. Slowly increase the current loading of the resistor (decrease resistance) until the ammeter registers 55 amperes.

5. Observe the voltmeter reading which should not exceed 200 millivolts.

If the reading is in excess of 200 millivolts, a high resistance fault is indicated in the external circuitry.

If the required alternator output cannot be achieved, and the millivoltmeter reading is less than 200 millivolts, then a faulty alternator component is indicated. Conduct the "Alternator Component Tests" as detailed in this Chapter.

6. Stop the engine.

5. Alternator Maximum Output Performance Test

With reference to Figure 14.

1. Ensure the key start switch is in the "off" position.

2. Disconnect the battery ground cable (negative) and the output lead from the alternator.

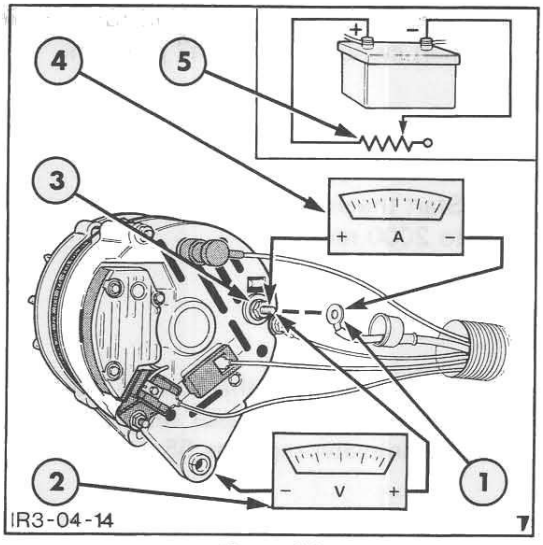


Figure 14
Maximum Output Performance Test
(Inset showing connection of Variable Load Resistor to Battery)

1. Output Lead
2. Voltmeter (0-30 Volts)
3. Main Output Terminal
4. Ammeter
5. Variable Load Resistor

3. Securely connect an ammeter negative side to the connector plug main terminal and positive side to the alternator output terminal

4. Connect a voltmeter between the alternator output terminal and the frame (negative side to frame).

5. Disconnect the harness to battery sensor plug and connect a 205 ohm resistor across the plug terminals. Refer to Figure 12.

6. Reconnect the battery and turn the key start switch to the "on" position.

7. Start the engine and increase the speed to 2000 rev/min.

8. Slowly increase the current loading of the resistor (decrease resistance) until the ammeter registers 55 amperes.

9. Observe the voltmeter reading which should not fall below 13.6 volts.

If the reading falls below 13.6 volts a faulty alternator component is indicated. Conduct the "Alternator Component Tests" as detailed in this Chapter.

NOTE: *The component tests may be performed without removing the alternator from the tractor. Testing of any other alternator components will necessitate removal of the alternator from the tractor. Refer to "Overhaul – Electrical Tests" as detailed in this Chapter.*

IMPORTANT: *Prior to removal of the output lead from the alternator ensure the key start switch is in the "off" position and the battery ground cable (negative) is disconnected.*

ALTERNATOR COMPONENT TESTS

The component tests, which should only be conducted if the INITIAL TESTS have indicated a faulty alternator component, enable the following items to be checked:

- Regulator
- Rotor Field Winding Continuity
- Brushes-and-Springs and Rotor Slip Rings

Test equipment required:

- 12 Volt Battery
- 12 Volt 2.2 Watt Test Lamp

1. Regulator and Rotor Field Circuit Test

With reference to Figure 15.

1. Connect a 12 volt battery and a 2.2 watt test lamp in series between the "IND" (indicator) terminal and the alternator frame (negative side to frame).

2. Connect a 205 ohm resistor between the positive terminal of the battery and the sensor terminal.

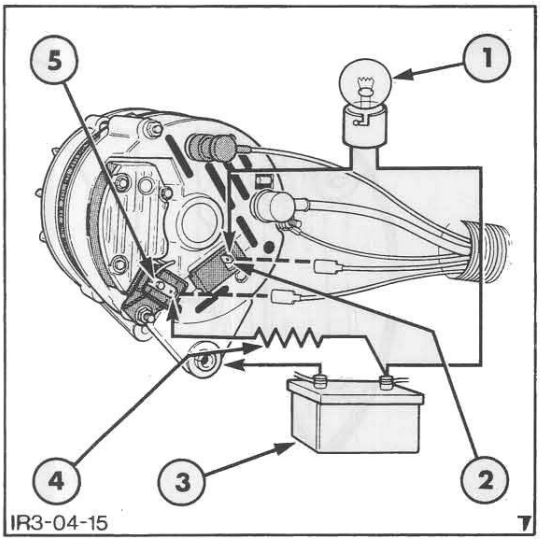


Figure 15
Regulator and Rotor Field Circuit Test

1. 2.2 Watt Test Lamp
2. IND (Indicator) Terminal
3. 12 Volt Battery
4. 205 Ohm Resistor
5. Sensor Terminal

The test lamp should be illuminated.

If the test lamp is not illuminated, a fault is indicated in the rotor circuit. Check brushes, slip rings and continuity of rotor field windings.

If examination indicates these parts are satisfactory the regulator is suspect.

2. Rotor Field Winding Continuity Test

With reference to Figure 16.

1. Remove the regulator and brushbox assembly as described in this Chapter.

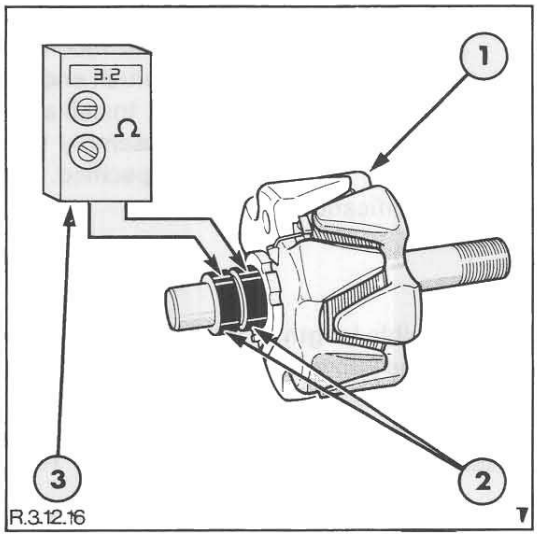


Figure 16
Rotor Field Winding Continuity Test

1. Rotor
2. Slip Rings
3. Ohmmeter

2. Connect an ohmmeter between the two slip rings. The resistance should read 3.2 ohms.

If the resistance is outside of the specification renew the rotor as detailed in the following Overhaul Section.

3. Brushes and Rotor Slip Rings

1. Remove the regulator and brushbox assembly as described in this Chapter.

2. Ensure the brushes and slip-rings are clean and check for freedom of movement of the brushes in the brushbox moulding.

3. Check the brush spring pressure with a push type spring gauge and record the spring pressure when the brush end face is flush with the moulding. Install a new regulator and brushbox assembly if the pressure is less than specified. See "Specifications".

If the visible length of the brushes in the free position is less than 0.25 in. (5 mm) this is a probable cause of non-continuity in the field circuit and the regulator and brushbox assembly should be renewed Figure 17.

NOTE: *The brushes are an integral part of the regulator and brushbox assembly and cannot be replaced as individual items.*

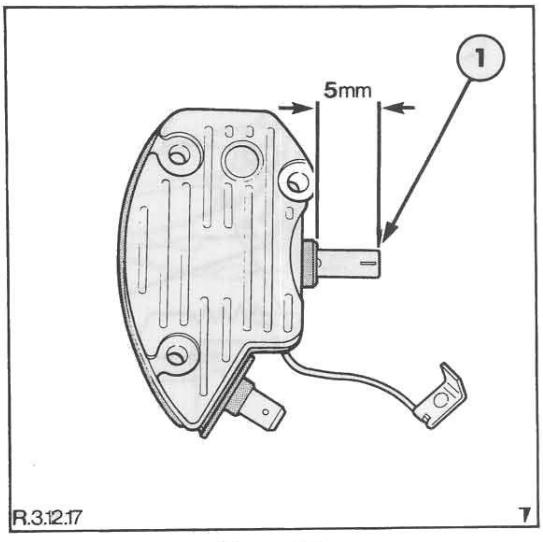


Figure 17
Regulator and Brushbox Assembly

1. Brushes

C. CHARGING SYSTEM – A127 55 AMP ALTERNATOR WITH INTEGRAL REGULATOR – OVERHAUL

REMOVAL

1. Disconnect the battery ground cable (negative).

2. Remove the engine side panel.

3. Disconnect all leads to the alternator. Refer to Figure 18.

4. Withdraw the adjustment and mounting bolts and remove the alternator from the tractor.

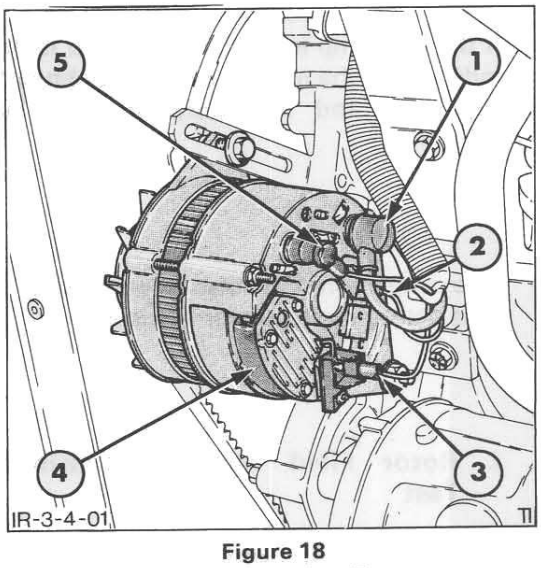


Figure 18
Alternator Installed on Tractor

1. Output Lead
2. Charge Indicator Lead
3. Battery Temperature Sensor Lead
4. Regulator and Brushbox
5. Tachometer Pick Up Lead