Fuel Injection Pump Model B.P.E.

C.A.V.

FUEL INJECTION PUMP

ENCLOSED CAMSHAFT TYPE
MODEL B.P.E.

INSTRUCTION BOOK

PUBLICATION No. 3577

CONTENTS

	Page
Introduction	3
Data	4
Weights	4
Fuel Storage	4
General Design	4
Operation	4
Control of Output	5
Anti-Dribble Device	5
Governors	6
Pump Mounting and Drive	6
Lubrication	7
Fuel Supply, Piping, Connections, etc.	7
Air Venting the Fuel System	10
Filtration	10
Dismantling	10
Reassembling	12
Troubles and Their Remedies	16

C.A.V.

FUEL INJECTION PUMP MODEL BPE

It is well known that the performance of all internal combustion engines depends largely upon the type of device for measuring the fuel, whether liquid or gas, into a combustion suitable for consumption in the cylinders of the engine.

In this respect the modern high speed oil engine is no exception since the injection system is an integral part of the engine, and the efficiency and economy of operation it is essential that the engine not only be controlled with fuel in quantities proportional to the load and speed required, but also that the fuel be delivered at such pressure and in such a manner as to ensure the complete atomisation of the charge, and to obtain the most effective penetration and scavenging of the combustion chamber by the air charge, so that the mixture is ignited and burnt with the least possible delay.

At this present day have to be regarded many hundreds of different designs of fuel injection equipment, and the production of fuel injection equipment will be appreciated.

The successful operation of each equipment, however, depends first and foremost, on one type of apparatus—namely—complete cleanliness of the fuel oil. It is, therefore, essential that the greatest possible care in the injection equipment are due to the fact that even the most minute particle of dirt is the cause and maintenance of fuel injection equipment. The following notes are given with a view to assisting all readers of literature and design of fuel injection equipment.

BRIEF CONSTRUCTIONAL DETAILS

C.A.V. Fuel Injection Pump Model B.P.E. is of the A.M.B. type, and is made in a range of pumps suitable for engines of the following powers:—

B.P.E.-A ELEMENT (STANDARD)		B.P.E.-B ELEMENT (SPECIAL)	
Plunger dia.	*Maximum output per stroke*	*Plunger dia.*	*Maximum output per stroke*
8.5 dia.	1000 cub. in. at 100 r.p.m.	8.5 dia.	1000 cub. in. at 100 r.p.m.
9.0 ,,	1200 ,, ,, 80 ,,	8.5 ,,	1200 ,, ,, 100 ,,
9.5 ,,	1400 ,, ,, 80 ,,	9.0 ,,	1200 ,, ,, 100 ,,
9.5 ,,	1600 ,, ,, 90 ,,	9.5 ,,	1400 ,, ,, 100 ,,
10 ,,	1800 ,, ,, 90 ,,	9.5 ,,	1600 ,, ,, 110 ,,
10 ,,	2000 ,, ,, 100 ,,	10 ,,	1800 ,, ,, 110 ,,
		10 ,,	2000 ,, ,, 120 ,,

The number of single cylinder units forming a pump unit is governed by the number of cylinders to be supplied, and the pumps can be supplied in any number from one to six inclusive, other up-to-date requirements.

The selection of suitable plunger diameters should be referred to Diagrams for the number of cylinders to be supplied, and the pumps can be supplied in any number from one to six inclusive, other up-to-date requirements.

WEIGHTS OF STANDARD PUMPS

Type	*Duplex*	*Housing*	*Approximate Weight*	
			lbs.	*kg.*
BPE4A	4-cyl.	Aluminium	38	8.1
BPE6A	6-cyl.	Aluminium	52	9.8
BPE2S	2-cyl.	Aluminium	45	9.8
BPE3S	3-cyl.	Aluminium	50	9.5
BPE4S	4-cyl.	Aluminium	55	9.5
BPE6S	6-cyl.	Aluminium	70	13.5
BPE8S	8-cyl.	Aluminium	91	17.5

DIMENSION DRAWING ON REQUEST

FUEL STORAGE

Wherever possible, fuel oil should be purchased in such a way that tanks fully-tested for the latest process, and should be stored in tanks sufficiently large to enable a reserve to be kept in hand. Tanks should be placed in a position where they will be free from vibration, and should be fitted with a suitable strainer at the filling orifice. The fuel oil should then be drawn through suitable large capacity filters into the engine fuel tank, which should be placed at a higher level than the pump.

GENERAL DESIGN

The Model B.P.E. C.A.V. Fuel Injection Pump is of the cam operated type which delivers fuel intermittently under pressure to the engine cylinders. The pump is totally enclosed, and is lubricated by oil supplied under pressure from the engine lubricating system.

Each pumping unit comprises the following essential components, which are illustrated and described in Fig. 2 :—

(1) Plunger and Barrel Assembly (Fig. 2 pair 1
(2) Delivery Valve and Seating ,, 2

Barrel and plunger, mirror-ground and of highly-alloyed steel, are hardened and ground to ensure long life. The plunger is provided at its upper end with a helical groove, which is formed in conjunction with one side of the plunger by a vertical groove. The plunger is rotated by a pinion engaging with a toothed quadrant, which is actuated by a governor. The position of the helical groove relative to the ports in the barrel determines the commencement of delivery, and the rotation of the plunger controls the quantity of fuel delivered. The greater the angular movement of the plunger, the greater the fuel charge will be, and in the case of a governed engine, the governor automatically varies the plunger rotation to suit the load on the engine.

CONTROL OF OUTPUT

The word "Stop" will be given and engraved on the end of the control rack, which projects from the governor case, and the engine is stopped by moving the control rack to the "Stop" position. The control rack is connected to the governor by a spring, which is designed to allow the governor to move the control rack to the "Stop" position when the engine has been set in motion, but not when the engine is running under governor control.

To start the engine the control rack is moved by hand over to the "Start" position, which is the position for the maximum charge to be delivered by the pump. In this position the governor spring is compressed to its maximum extent, and the governor will not come into operation until the engine has attained a speed in excess of that for which the governor has been adjusted. Attached to the governor spring for manual engine speed control is a suitable lever and quadrant, which is provided with a locking device to enable the engine to be run at any desired speed. The governor spring is carried in a spring cup, which is screwed on to the governor rod, and the latter is connected to the governor weights by a floating lever. The governor weights are carried on a governor spindle, which is driven from the camshaft through the medium of a spur gear.

Fig. 1
Pump Element in Section

1—Valve spring.
2—Delivery valve and seat.
3—Pump barrel.
4—Pump plunger.
5—Control rod.
6—Control pinion.
7—Control sleeve.

The lower end of the plunger forms a small piston which is a slight growth plunger fit in the valve seating, shown in Fig. 2 pair 2, and when the plunger is lifted by the cam, fuel is drawn into the pump barrel through the inlet ports. On the downward stroke of the plunger, the fuel is forced through the delivery valve and pipe to the engine fuel injection valve, and the pressure necessary to lift the valve off its seating is determined by the load on the valve spring. The pressure on the pump barrel and the delivery valve seating is greater than the pressure on the engine, and the valve is held on its seating with a positive load, thus ensuring the pump is always ready for delivery. The delivery valve is of the well-known C.A.V. type, and is provided with a reverse flow collar, which ensures a sharp cut-off of the fuel delivery, and prevents the valve from being held off its seating by the pressure in the pipe.

GOVERNORS

C.A.V. pumps are normally designed for use in conjunction with C.A.V. governors, which are of the centrifugal type, and are mounted on the end of the camshaft. The governor is totally enclosed, and is lubricated by oil supplied under pressure from the engine lubricating system.

Each governor comprises a self-contained unit including the governor weights, spring, and all the necessary levers. The governor is mounted on the end of the camshaft, and is driven by a spur gear from the camshaft gear wheel, which is keyed on to the end of the injection pump housing.

The method of work of the above types of governor will be seen in operation.

PUMP MOUNTING AND DRIVE

Mounting.—Duplex and multi-cylinder pumps are designed for mounting on a flat engine bracket by means of bolts through the feet of the pump housing. Single-cylinder pumps are mounted on a bracket by means of a clamping bolt and nut. The pump should be so placed that the delivery valves are as near as possible to the fuel injection valves on the engine cylinders, in order to obtain the best results. The pump must be accurately timed to the engine, and the method of timing will be found under the heading "Timing the Pump to the Engine."

Drive.—The pump is driven from the engine camshaft by a spur gear keyed on to the end of the camshaft, and which meshes with a corresponding gear keyed on to the end of the pump camshaft. The pump gear is secured to the pump camshaft by a nut, which is screwed on to the end of the pump camshaft, and which is locked in position by a tab washer.

Fig. 2
Sectional Elevation of Pump Showing Fuel Valve and Governor

LUBRICATION

The front end of the camshaft chamber is normally connected to the engine lubricating system, and oil is supplied under pressure to the camshaft bearings. The oil is then distributed to the cam faces and the governor gear. The rear end of the camshaft chamber is filled with oil to the level of the filler plug, which has a hole communicating with the interior of the chamber. The oil is splashed about by the rotation of the cams, and lubricates the tappets and the governor gear. Surplus oil drains back to the sump through the camshaft chamber through the tappets hole.

The governor is lubricated by oil splashed about by the cams, and by the oil mist from the crankcase. Surplus oil drains back to the crankcase through the camshaft chamber.

The plunger is lubricated by the oil splashed about by the cams, and by the oil mist from the crankcase. Surplus oil drains back to the crankcase through the camshaft chamber.

AIR VENTING THE FUEL SYSTEM

When the pump has been installed, and the fuel pipes connected up, it will be necessary to vent the fuel system before the engine can be started. This is done by slackening the union nuts on the delivery valve holders (1), (Fig. 3), and then turning the engine over by hand until fuel flows from the unions.

The engine should then be started up and run for a few minutes, when the unions should be tightened up. The engine is then ready for work.

FILTRATION

It will be appreciated that the C.A.V. fuel injection pump is designed to deliver fuel oil to the engine cylinders in extremely small quantities, and with very great accuracy, and it is therefore essential that the fuel oil be absolutely free from grit and other impurities. Consequently the utmost precaution must be taken to ensure that the fuel oil is filtered before it reaches the pump, and the most suitable filter for the purpose is one which is capable of removing all particles of dirt down to the limit of size which can be passed by the fine clearances between the working parts of the pump.

Screen types of filter are available, in each varying combination of fineness, and the selection of the most suitable one for any particular engine should be referred to the engine builders.

Fig. 3 shows a suitable filter supplied by C.A.V., and consists of a cast iron cylinder and cover mounted on a metal bracket. The cylinder contains a number of brass discs, which are separated by distance pieces, and the fuel oil is forced through the spaces between the discs, and the dirt is retained on the outside of the discs. The discs are mounted on a spindle, and are clamped between distance pieces, but arranged for easier free spaces between the discs.

The fuel oil is forced through the filter by means of the hand pump (2), which is mounted on the bracket, and is operated by a lever from the engine. The fuel then flows up through the filter, and passes out to the pump through the outlet (3). The fuel oil is drawn from the supply tank through the inlet (4).

When the filter is operated, the element is first tightly pressed down on its seating by the screw (5), and the fuel oil is then forced through the filter by the hand pump (2). The dirt is retained on the outside of the discs, and the fuel oil passes through the spaces between the discs, and out to the pump through the outlet (3). The element can then be easily withdrawn from its bearing by unscrewing the screw (5), and the dirt can be removed from the discs by means of a stiff brush.

The filter should be fitted in a position where it can be easily reached for access of the operations being required to be carried out, and it should be fitted in a position where it will not be exposed to heat, and should not be fitted in the engine room.

Fig. 3. C.A.V. Fuel Injection Pump BPE6S fitted with Lifting and Hand-operated Priming Pump, Governor Control Lever, Starting Handle, and Combined Pneumatic and Mechanical type of Governor (as also available)

1. Adjusting nut
2. Outer link bolt
3. Air tube
4. Fuel pipe to tube
5. Inner link bolt
6. Control rod
7. Control rod stop
8. Screw coupling
9. Fuel pipe to pump
10. Air tube
11. Air injection
12. Tappet screw
13. Cooling plug
14. Camshaft
15. Fly-weights
16. Governor gear retaining nut
17. Governor spring
18. Fuel inlet connection
19. Priming lever

Fig. 4. Oil Syphon

FUEL SUPPLY, PIPING, CONNECTIONS, ETC.

Fuel should be led from the storage tank through a suitable filter to the pump, and the pump should be placed at a lower level than the storage tank, so that the fuel will flow to the pump by gravity. This is known as the "Gravity Feed" system. Where the head of fuel between the storage tank and the pump is not sufficient to ensure a proper supply to the pump, a lifting pump will be required. The lifting pump should be capable of delivering a supply of fuel to the pump in excess of the maximum quantity required by the injection pump during the full load running of the engine.

Fuel Piping.—Fuel pipes and connections should be of ample size to avoid throttling, and it should be borne in mind that a small pipe will cause a greater loss of pressure than a large one, owing to the higher velocity of the fuel through the small pipe. Fuel pipes should be run in such a manner that there is no possibility of air being drawn into the pump, and the suction pipe should be connected to the bottom of the tank, so that any water which may be present will not be drawn into the pump. Fuel pipes should be run in such a manner that there is no possibility of air being drawn into the pump, and the suction pipe should be connected to the bottom of the tank, so that any water which may be present will not be drawn into the pump. Fuel pipes should be run in such a manner that there is no possibility of air being drawn into the pump, and the suction pipe should be connected to the bottom of the tank, so that any water which may be present will not be drawn into the pump.

Fuel Pipe Connections.—The fuel pipes should be connected to the pump by means of the union nuts provided for the purpose, and the pipes should be carefully cleaned before they are connected up. The pipes should be run in such a manner that there is no possibility of air being drawn into the pump, and the suction pipe should be connected to the bottom of the tank, so that any water which may be present will not be drawn into the pump.

Fig. 5. C.A.V. Cloth Element Filter mounted to show Internal Construction

1—Closing plug.
2—Hand pump.
3—Top cover.
4—Filter cover.
5—Filter screw.
6—Fuel pipe.
7—Inlet union.
8—Inlet tube.
9—Pressure spring.

Fig. 6. C.A.V. Felt Element Type Filter mounted to show Internal Construction

Combined Cloth and Felt Type Filter.—These filters are illustrated in Figs. 5 and 6, and are of the type which is made up of cloth and felt mounted on a cloth cylinder. Fuel oil is forced through the filter by the hand pump, and the dirt is retained on the outside of the cloth cylinder. The filter should be fitted in a position where it can be easily reached for access of the operations being required to be carried out, and it should be fitted in a position where it will not be exposed to heat, and should not be fitted in the engine room.

Choice of Fuel Types.—Before making a final decision as to the type of fuel to be used, it is advisable to consult the engine builder, as a number of fuels on the market are unsuitable for use in oil engines. The fuel should be of a high flash point, and should be free from acid. Fuels containing a high percentage of paraffin wax should be avoided, as they are liable to cause trouble in cold weather. A good test for fuel is to expose a sample to a temperature of 0° C. (32° F.) for 24 hours. If the fuel remains clear after this test, it is probably suitable for use in cold weather.

A.—To Change the Pumping Sequence of Cylinders (Pumps 2S and Camshaft 10 mm Dia. S).

B.—Remove Inspection cover plate.

C.—To remove the Pump Barrel.

D.—To remove the Pump Barrel.

DISMANTLING AND REASSEMBLING

To facilitate dismantling and reassembling fuel injection pumps of the enclosed camshaft type, the following notes are given with a view to assisting all readers of literature and design of fuel injection equipment. The following notes are given with a view to assisting all readers of literature and design of fuel injection equipment. The following notes are given with a view to assisting all readers of literature and design of fuel injection equipment.

DISMANTLING (See Figs. 9 and 10)

The pump should be set on a bench, and should be carefully cleaned down to remove all traces of dirt and grease. The following should be carried out in the order given:—

1. Remove the inspection cover plate (1).
2. Remove the governor cover (2).
3. Remove the governor gear retaining nut (3).
4. Remove the governor gear (4).
5. Remove the governor spring (5).
6. Remove the governor weights (6).
7. Remove the governor spindle (7).
8. Remove the governor lever (8).
9. Remove the governor quadrant (9).
10. Remove the governor spring (10).
11. Remove the governor weights (11).
12. Remove the governor spindle (12).
13. Remove the governor lever (13).
14. Remove the governor quadrant (14).
15. Remove the governor spring (15).
16. Remove the governor weights (16).
17. Remove the governor spindle (17).
18. Remove the governor lever (18).
19. Remove the governor quadrant (19).
20. Remove the governor spring (20).
21. Remove the governor weights (21).
22. Remove the governor spindle (22).
23. Remove the governor lever (23).
24. Remove the governor quadrant (24).
25. Remove the governor spring (25).
26. Remove the governor weights (26).
27. Remove the governor spindle (27).
28. Remove the governor lever (28).
29. Remove the governor quadrant (29).
30. Remove the governor spring (30).
31. Remove the governor weights (31).
32. Remove the governor spindle (32).
33. Remove the governor lever (33).
34. Remove the governor quadrant (34).
35. Remove the governor spring (35).
36. Remove the governor weights (36).
37. Remove the governor spindle (37).
38. Remove the governor lever (38).
39. Remove the governor quadrant (39).
40. Remove the governor spring (40).
41. Remove the governor weights (41).
42. Remove the governor spindle (42).
43. Remove the governor lever (43).
44. Remove the governor quadrant (44).
45. Remove the governor spring (45).
46. Remove the governor weights (46).
47. Remove the governor spindle (47).
48. Remove the governor lever (48).
49. Remove the governor quadrant (49).
50. Remove the governor spring (50).
51. Remove the governor weights (51).
52. Remove the governor spindle (52).
53. Remove the governor lever (53).
54. Remove the governor quadrant (54).
55. Remove the governor spring (55).
56. Remove the governor weights (56).
57. Remove the governor spindle (57).
58. Remove the governor lever (58).
59. Remove the governor quadrant (59).
60. Remove the governor spring (60).
61. Remove the governor weights (61).
62. Remove the governor spindle (62).
63. Remove the governor lever (63).
64. Remove the governor quadrant (64).
65. Remove the governor spring (65).
66. Remove the governor weights (66).
67. Remove the governor spindle (67).
68. Remove the governor lever (68).
69. Remove the governor quadrant (69).
70. Remove the governor spring (70).
71. Remove the governor weights (71).
72. Remove the governor spindle (72).
73. Remove the governor lever (73).
74. Remove the governor quadrant (74).
75. Remove the governor spring (75).
76. Remove the governor weights (76).
77. Remove the governor spindle (77).
78. Remove the governor lever (78).
79. Remove the governor quadrant (79).
80. Remove the governor spring (80).
81. Remove the governor weights (81).
82. Remove the governor spindle (82).
83. Remove the governor lever (83).
84. Remove the governor quadrant (84).
85. Remove the governor spring (85).
86. Remove the governor weights (86).
87. Remove the governor spindle (87).
88. Remove the governor lever (88).
89. Remove the governor quadrant (89).
90. Remove the governor spring (90).
91. Remove the governor weights (91).
92. Remove the governor spindle (92).
93. Remove the governor lever (93).
94. Remove the governor quadrant (94).
95. Remove the governor spring (95).
96. Remove the governor weights (96).
97. Remove the governor spindle (97).
98. Remove the governor lever (98).
99. Remove the governor quadrant (99).
100. Remove the governor spring (100).

Fig. 7. C.A.V. Type BPE Fuel Injection Pump Sectioned to show Internal Construction

Num.	Description	Num.	Description
1	Housing	13	Tappet assembly
2	Closing plug	14	Pump element (barrel and plunger)
3	Filler plug	15	Delivery valve seating
4	Inlet union plug	16	Delivery valve spring
5	Inlet union	17	Delivery valve holder
6	Inlet connection stud	18	Metering valve for QS
7	Fuel inlet	19	Metering valve spring
8	Fuel inlet regulator	20	Delivery valve unit setting
9	Suction chamber	21	Delivery valve spring
10	Governor cover plate	22	Delivery valve holder
11	Screw with spring lock for QS1	23	Delivery valve unit
12	Camshaft	24	Regulating rod
13	Camshaft	25	Regulating toothed quadrant
14	Camshaft	26	Control rack
15	Bearing cap plate	27	Control rod

IMPORTANT.

Owners using Engines to Type BPE Injection Pumps, please refer to Quick Parts Lists for respective Engines. These Lists are available from our Technical Publications Dept. upon receipt of the full pump type symbol.

Fig. 10. Dismantling and Reassembling C.A.V. Type BPE Fuel Injection Pumps

ENGINE TROUBLES AND THEIR REMEDIES

Fuel injection difficulties are often on the engine than on the pump, and a number of defects may be found on the injection valve which will cause the engine to misfire, or run unevenly, and which will not be found on the pump. The first thing to do when a defective cylinder is discovered is to locate the injection valve which is causing the trouble. The engine should be slowed down and run light, and each valve should be tested in turn by unscrewing the union nut on the delivery valve holder, and slackening off the union nut on the injection valve. The engine should then be run at full speed, and the valve which is causing the trouble will be found to have little or no effect on the engine speed when the union nut is slackened off.

1.—ENGINE WILL NOT START, OR STOPS AFTER A SHORT TIME

Possible Cause	*Condition*	*Remedy*
Pump does not deliver fuel.	(a) Fuel tank empty.	Fill tank.
	(b) Fuel cock closed.	Turn cock on wherever required.
	(c) Fuel pipe or pump pipe or valve unions loose.	Tighten unions. Examine joints and pipes for cracks.
	(d) Fuel pipe choked.	Remove pipe and clean out with paraffin. Blow through.
	(e) Delivery valve jammed.	Remove valve holder and valve. Clean and regrind. If valve or seating is worn or damaged replace with new valve.
Pump does not deliver fuel sufficiently.	(a) As (a) above.	As (a) above.
	(b) Delivery valve jammed.	As (e) above.
	(c) Delivery valve (1) or seating (2) worn. Fuel pumped (3).	Replace with new valve and seating.
	(d) As (c) above.	As (c) above.
	(e) Delivery valve spring broken.	Replace with new spring.
	(f) Plunger (1) or barrel (2) worn.	Replace with new plunger and barrel.
	(g) Governor not working properly.	Examine governor and remedy defect.
	(h) Governor spring broken.	Replace with new spring.
	(i) Governor weights worn.	Replace with new weights.
	(j) Governor sticking.	Examine governor and remedy defect.
	(k) Governor spindle worn.	Replace with new spindle.
	(l) Governor lever worn.	Replace with new lever.
	(m) Governor quadrant worn.	Replace with new quadrant.
	(n) Governor spring broken.	Replace with new spring.
	(o) Governor weights worn.	Replace with new weights.
	(p) Governor spindle worn.	Replace with new spindle.
	(q) Governor lever worn.	Replace with new lever.
	(r) Governor quadrant worn.	Replace with new quadrant.
	(s) Governor spring broken.	Replace with new spring.
	(t) Governor weights worn.	Replace with new weights.
	(u) Governor spindle worn.	Replace with new spindle.
	(v) Governor lever worn.	Replace with new lever.
	(w) Governor quadrant worn.	Replace with new quadrant.
	(x) Governor spring broken.	Replace with new spring.
	(y) Governor weights worn.	Replace with new weights.
	(z) Governor spindle worn.	Replace with new spindle.
	(aa) Governor lever worn.	Replace with new lever.
	(bb) Governor quadrant worn.	Replace with new quadrant.
	(cc) Governor spring broken.	Replace with new spring.
	(dd) Governor weights worn.	Replace with new weights.
	(ee) Governor spindle worn.	Replace with new spindle.
	(ff) Governor lever worn.	Replace with new lever.
	(gg) Governor quadrant worn.	Replace with new quadrant.
	(hh) Governor spring broken.	Replace with new spring.
	(ii) Governor weights worn.	Replace with new weights.
	(jj) Governor spindle worn.	Replace with new spindle.
	(kk) Governor lever worn.	Replace with new lever.
	(ll) Governor quadrant worn.	Replace with new quadrant.
	(mm) Governor spring broken.	Replace with new spring.
	(nn) Governor weights worn.	Replace with new weights.
	(oo) Governor spindle worn.	Replace with new spindle.
	(pp) Governor lever worn.	Replace with new lever.
	(qq) Governor quadrant worn.	Replace with new quadrant.
	(rr) Governor spring broken.	Replace with new spring.
	(ss) Governor weights worn.	Replace with new weights.
	(tt) Governor spindle worn.	Replace with new spindle.
	(uu) Governor lever worn.	Replace with new lever.
	(vv) Governor quadrant worn.	Replace with new quadrant.
	(ww) Governor spring broken.	Replace with new spring.
	(xx) Governor weights worn.	Replace with new weights.
	(yy) Governor spindle worn.	Replace with new spindle.
	(zz) Governor lever worn.	Replace with new lever.
	(aaa) Governor quadrant worn.	Replace with new quadrant.
	(bbb) Governor spring broken.	Replace with new spring.
	(ccc) Governor weights worn.	Replace with new weights.
	(ddd) Governor spindle worn.	Replace with new spindle.
	(eee) Governor lever worn.	Replace with new lever.
	(fff) Governor quadrant worn.	Replace with new quadrant.
	(ggg) Governor spring broken.	Replace with new spring.
	(hhh) Governor weights worn.	Replace with new weights.
	(iii) Governor spindle worn.	Replace with new spindle.
	(jjj) Governor lever worn.	Replace with new lever.
	(kkk) Governor quadrant worn.	Replace with new quadrant.
	(lll) Governor spring broken.	Replace with new spring.
	(mmm) Governor weights worn.	Replace with new weights.
	(nnn) Governor spindle worn.	Replace with new spindle.
	(ooo) Governor lever worn.	Replace with new lever.
	(ppp) Governor quadrant worn.	Replace with new quadrant.
	(qqq) Governor spring broken.	Replace with new spring.
	(rrr) Governor weights worn.	Replace with new weights.
	(sss) Governor spindle worn.	Replace with new spindle.
	(ttt) Governor lever worn.	Replace with new lever.
	(uuu) Governor quadrant worn.	Replace with new quadrant.
	(vvv) Governor spring broken.	Replace with new spring.
	(www) Governor weights worn.	Replace with new weights.
	(xxx) Governor spindle worn.	Replace with new spindle.
	(yyy) Governor lever worn.	Replace with new lever.
	(zzz) Governor quadrant worn.	Replace with new quadrant.
	(aaaa) Governor spring broken.	Replace with new spring.
	(bbbb) Governor weights worn.	Replace with new weights.
	(cccc) Governor spindle worn.	Replace with new spindle.
	(dddd) Governor lever worn.	Replace with new lever.
	(eeee) Governor quadrant worn.	Replace with new quadrant.
	(ffff) Governor spring broken.	Replace with new spring.
	(gggg) Governor weights worn.	Replace with new weights.
	(hhhh) Governor spindle worn.	Replace with new spindle.
	(iiii) Governor lever worn.	Replace with new lever.
	(jjjj) Governor quadrant worn.	Replace with new quadrant.
	(kkkk) Governor spring broken.	Replace with new spring.
	(llll) Governor weights worn.	Replace with new weights.
	(mmmm) Governor spindle worn.	Replace with new spindle.
	(nnnn) Governor lever worn.	Replace with new lever.
	(oooo) Governor quadrant worn.	Replace with new quadrant.
	(pppp) Governor spring broken.	Replace with new spring.
	(qqqq) Governor weights worn.	Replace with new weights.
	(rrrr) Governor spindle worn.	Replace with new spindle.
	(ssss) Governor lever worn.	Replace with new lever.
	(tttt) Governor quadrant worn.	Replace with new quadrant.
	(uuuu) Governor spring broken.	Replace with new spring.
	(vvvv) Governor weights worn.	Replace with new weights.
	(wwww) Governor spindle worn.	Replace with new spindle.
	(xxxx) Governor lever worn.	Replace with new lever.
	(yyyy) Governor quadrant worn.	Replace with new quadrant.
	(zzzz) Governor spring broken.	Replace with new spring.
	(aaaaa) Governor weights worn.	Replace with new weights.
	(bbbbb) Governor spindle worn.	Replace with new spindle.
	(ccccc) Governor lever worn.	Replace with new lever.
	(ddddd) Governor quadrant worn.	Replace with new quadrant.
	(eeeee) Governor spring broken.	Replace with new spring.
	(fffff) Governor weights worn.	Replace with new weights.
	(ggggg) Governor spindle worn.	Replace with new spindle.
	(hhhhh) Governor lever worn.	Replace with new lever.
	(iiiii) Governor quadrant worn.	Replace with new quadrant.
	(jjjjj) Governor spring broken.	Replace with new spring.
	(kkkkk) Governor weights worn.	Replace with new weights.
	(lllll) Governor spindle worn.	Replace with new spindle.
	(mmmmm) Governor lever worn.	Replace with new lever.
	(nnnnn) Governor quadrant worn.	Replace with new quadrant.
	(ooooo) Governor spring broken.	Replace with new spring.
	(ppppp) Governor weights worn.	Replace with new weights.
	(qqqqq) Governor spindle worn.	Replace with new spindle.
	(rrrrr) Governor lever worn.	Replace with new lever.
	(sssss) Governor quadrant worn.	Replace with new quadrant.
	(ttttt) Governor spring broken.	Replace with new spring.
	(uuuuu) Governor weights worn.	Replace with new weights.
	(vvvvv) Governor spindle worn.	Replace with new spindle.
	(wwwww) Governor lever worn.	Replace with new lever.
	(xxxxx) Governor quadrant worn.	Replace with new quadrant.
	(yyyyy) Governor spring broken.	Replace with new spring.
	(zzzzz) Governor weights worn.	Replace with new weights.
	(aaaaaa) Governor spindle worn.	Replace with new spindle.
	(bbbbbb) Governor lever worn.	Replace with new lever.
	(cccccc) Governor quadrant worn.	Replace with new quadrant.
	(dddddd) Governor spring broken.	Replace with new spring.
	(eeeeee) Governor weights worn.	Replace with new weights.
	(ffffff) Governor spindle worn.	Replace with new spindle.
	(gggggg) Governor lever worn.	Replace with new lever.
	(hhhhhh) Governor quadrant worn.	Replace with new quadrant.
	(iiiiii) Governor spring broken.	Replace with new spring.
	(jjjjjj) Governor weights worn.	Replace with new weights.
	(kkkkkk) Governor spindle worn.	Replace with new spindle.
	(llllll) Governor lever worn.	Replace with new lever.
	(mmmmmm) Governor quadrant worn.	Replace with new quadrant.
	(nnnnnn) Governor spring broken.	Replace with new spring.
	(oooooo) Governor weights worn.	Replace with new weights.
	(pppppp) Governor spindle worn.	Replace with new spindle.
	(qqqqqq) Governor lever worn.	Replace with new lever.
	(rrrrrr) Governor quadrant worn.	Replace with new quadrant.
	(ssssss) Governor spring broken.	Replace with new spring.
	(tttttt) Governor weights worn.	Replace with new weights.
	(uuuuuu) Governor spindle worn.	Replace with new spindle.
	(vvvvvv) Governor lever worn.	Replace with new lever.
	(wwwwww) Governor quadrant worn.	Replace with new quadrant.
	(xxxxxx) Governor spring broken.	Replace with new spring.
	(yyyyyy) Governor weights worn.	Replace with new weights.
	(zzzzzz) Governor spindle worn.	Replace with new spindle.
	(aaaaaaa) Governor lever worn.	Replace with new lever.
	(bbbbbbb) Governor quadrant worn.	Replace with new quadrant.
	(ccccccc) Governor spring broken.	Replace with new spring.
	(ddddddd) Governor weights worn.	Replace with new weights.
	(eeeeeee) Governor spindle worn.	Replace with new spindle.
	(fffffff) Governor lever worn.	Replace with new lever.
	(ggggggg) Governor quadrant worn.	Replace with new quadrant.
	(hhhhhhh) Governor spring broken.	Replace with new spring.
	(iiiiiii) Governor weights worn.	Replace with new weights.
	(jjjjjjj) Governor spindle worn.	Replace with new spindle.
	(kkkkkkk) Governor lever worn.	Replace with new lever.
	(lllllll) Governor quadrant worn.	Replace with new quadrant.
	(mmmmmmm) Governor spring broken.	Replace with new spring.
	(nnnnnnn) Governor weights worn.	Replace with new weights.
	(ooooooo) Governor spindle worn.	Replace with new spindle.
	(ppppppp) Governor lever worn.	Replace with new lever.
	(qqqqqqq) Governor quadrant worn.	Replace with new quadrant.
	(rrrrrrr) Governor spring broken.	Replace with new spring.
	(sssssss) Governor weights worn.	Replace with new weights.
	(ttttttt) Governor spindle worn.	Replace with new spindle.
	(uuuuuuu) Governor lever worn.	Replace with new lever.
	(vvvvvvv) Governor quadrant worn.	Replace with new quadrant.
	(wwwwwww) Governor spring broken.	Replace with new spring.
	(xxxxxxx) Governor weights worn.	Replace with new weights.
	(yyyyyyy) Governor spindle worn.	Replace with new spindle.
	(zzzzzzz) Governor lever worn.	Replace with new lever.
	(aaaaaaaa) Governor quadrant worn.	Replace with new quadrant.
	(bbbbbbbb) Governor spring broken.	Replace with new spring.
	(cccccccc) Governor weights worn.	Replace with new weights.
	(dddddddd) Governor spindle worn.	Replace with new spindle.
	(eeeeeeee) Governor lever worn.	Replace with new lever.
	(ffffffff) Governor quadrant worn.	Replace with new quadrant.
	(gggggggg) Governor spring broken.	Replace with new spring.
	(hhhhhhhh) Governor weights worn.	Replace with new weights.
	(iiiiiiii) Governor spindle worn.	Replace with new spindle.
	(jjjjjjjj) Governor lever worn.	Replace with new lever.
	(kkkkkkkk) Governor quadrant worn.	Replace with new quadrant.
	(llllllll) Governor spring broken.	Replace with new spring.
	(mmmmmmmm) Governor weights worn.	Replace with new weights.
	(nnnnnnnn) Governor spindle worn.	Replace with new spindle.
	(oooooooo) Governor lever worn.	Replace with new lever.
	(pppppppp) Governor quadrant worn.	Replace with new quadrant.
	(qqqqqqqq) Governor spring broken.	Replace with new spring.
	(rrrrrrrr) Governor weights worn.	Replace with new weights.
	(ssssssss) Governor spindle worn.	Replace with new spindle.
	(tttttttt) Governor lever worn.	Replace with new lever.
	(uuuuuuuu) Governor quadrant worn.	Replace with new quadrant.
	(vvvvvvvv) Governor spring broken.	Replace with new spring.
	(wwwwwwww) Governor weights worn.	Replace with new weights.
	(xxxxxxxx) Governor spindle worn.	Replace with new spindle.
	(yyyyyyyy) Governor lever worn.	Replace with new lever.
	(zzzzzzzz) Governor quadrant worn.	Replace with new quadrant.
	(aaaaaaaaa) Governor spring broken.	Replace with new spring.
	(bbbbbbbbb) Governor weights worn.	Replace with new weights.
	(ccccccccc) Governor spindle worn.	Replace with new spindle.
	(ddddddddd) Governor lever worn.	Replace with new lever.
	(eeeeeeeee) Governor quadrant worn.	Replace with new quadrant.
	(fffffffff) Governor spring broken.	Replace with new spring.
	(ggggggggg) Governor weights worn.	Replace with new weights.
	(hhhhhhhhh) Governor spindle worn.	Replace with new spindle.
	(iiiiiiiii) Governor lever worn.	Replace with new lever.
	(jjjjjjjjj) Governor quadrant worn.	Replace with new quadrant.
	(kkkkkkkkk) Governor spring broken.	Replace with new spring.
	(lllllllll) Governor weights worn.	Replace with new weights.
	(mmmmmmmmm) Governor spindle worn.	Replace with new spindle.
	(nnnnnnnnn) Governor lever worn.	Replace with new lever.
	(oooo