Diagnosis – Idle Quality

General Information

The idle quality test allows more in-depth diagnosis of such engine complaints such as rough idle, missing when idling, or delayed starting time. The test scope is divided into:

- Idle quality, engine speed per cylinder,
- Idle quality, burn time per cylinder,
- Idle quality, while starting.

The methods for using each test sequence are explained on the following pages.

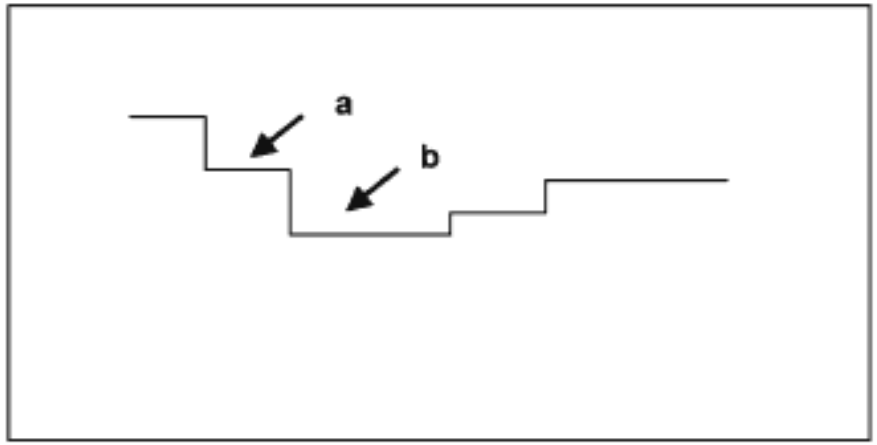
It is necessary in all three test sequences to evaluate the tabular examples and/or the graphic examples. The two should be compared and checked for agreement.

⚠

When evaluating the idle quality measurement, the following should be noted according to the number of cylinders the engine has:

- **4-Cylinder engine**

On 4-cylinder engines, the 2nd engine speed drop, or the following drop in the case of multiple failures, should be evaluated.
With multiple failures, the oscilloscope pattern should be read from the bottom up.



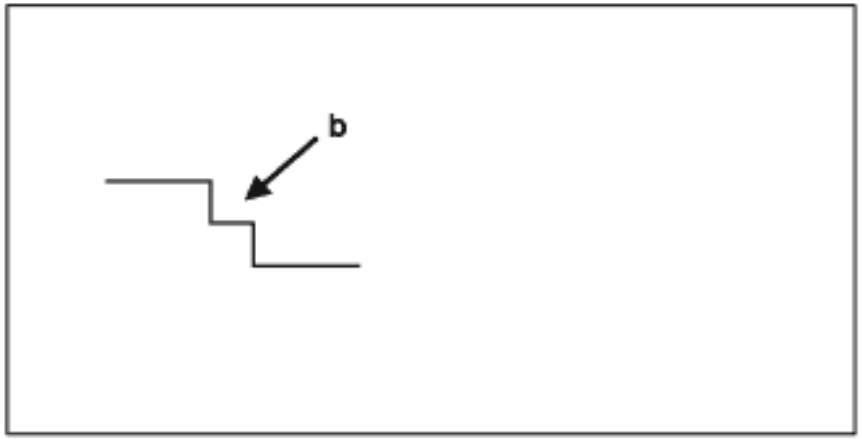
P07-C46.1

Figure 1
a Speed drop from previously firing cylinder
b Defective cylinder

Diagnosis – Idle Quality

- **6-Cylinder engine**

The first engine speed drop should be noted.

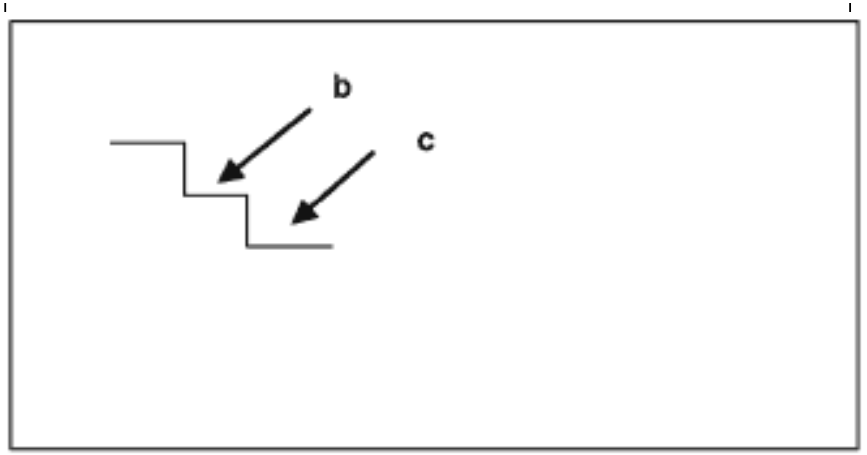


P07-C46.2

Figure 2
b Defective cylinder

- **8-Cylinder engine**

The first engine speed drop should be noted. The engine speed drop occurring after the defective cylinder can be ignored.



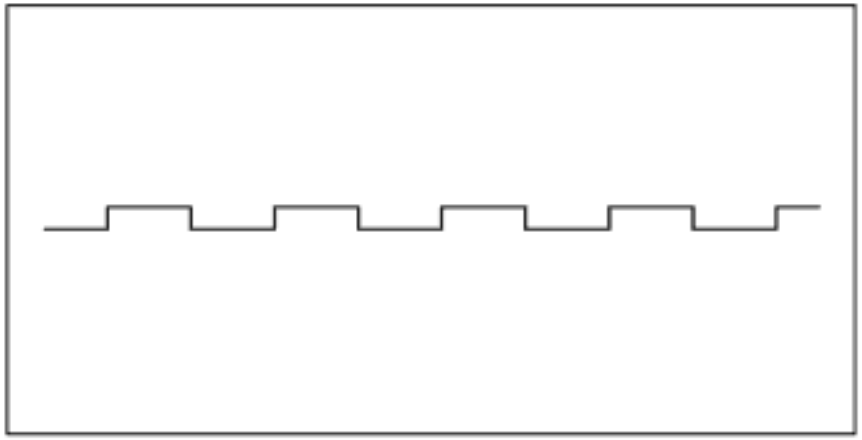
P07-C46.3

Figure 3
b Defective cylinder
c Effect on following cylinder

Diagnosis – Idle Quality

- **12-Cylinder engine**

Retrieving the idle measurement value is difficult due to the large number of cylinders and the simultaneous firing of both ignition circuits. During a smooth engine idle, a small engine speed difference may occur between the cylinder banks in the engine speed table and engine speed graphic. As can be seen in the table, the average engine speed change value of one cylinder bank may exhibit an engine speed decrease when compared to the previously ignited cylinder of the other bank (Figure 5). For this reason, idle quality interpretation via the table (arrows) and the engine speed graphic is more difficult.



P07-C46.4

Figure 4
Correct engine idle

Medium engine speed: 459 rpm

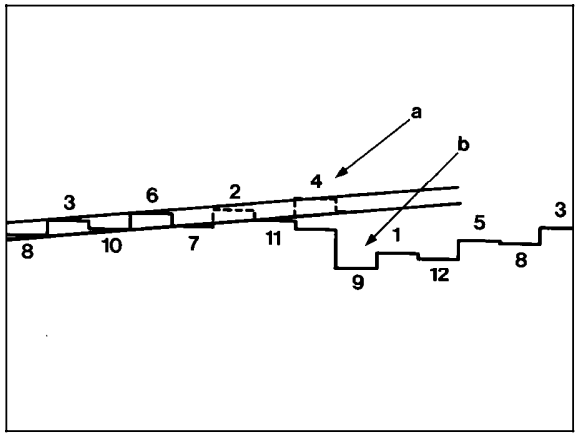
Cylinder	Average engine speed rpm	Average engine speed change rpm
1	664	6
12	658	–6 ◄
5	663	5
8	659	–4 ◄
3	665	6
10	660	–5 ◄
6	665	5
7	658	–7 ◄
2	664	6
11	658	–6 ◄
4	663	5
9	658	–5 ◄
MAX	665	
MIN	658	
DIFF	7	

Figure 5
Correct engine idle

Diagnosis – Idle Quality

- **12-Cylinder engine**

In certain cases, the problem may present itself differently from engine to engine. Therefore, it is almost impossible to determine fault assignment from the engine speed table.



P07-5976-13

Figure 6

a Defective cylinder
b Effect on following cylinder
----- Normal course

By tracking the engine speed of the individual cylinders (starting from the left column), it is shown in the examples given that cylinder 4 (Figure 7) and/or cylinder 10 (Figure 9) is the defective cylinder resulting in a engine speed decrease and engine running complaint.
One method to identify the correct cylinder is to print out the engine speed graphic and draw in two lines. The lines should intersect the trailing edge of individual engine speed segment for each cylinder bank (Figures 6 and 8).

Cylinder	Average engine speed rpm	Average engine speed change rpm
1	716	11
12	712	–4
5	723	11
8	721	–2
3	732	11
10	730	–2
6	740	10
7	734	–6
2	743	9
11	737	–6
4	730	–7 ← a
9	705	–25 ← b
MAX	743	
MIN	705	
DIFF	38	

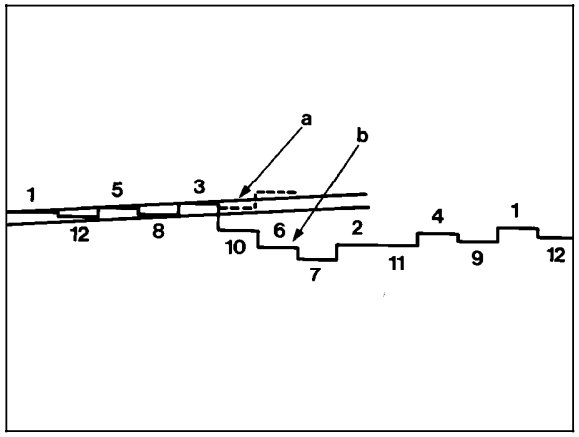
Figure 7

Cylinder 4 defective (right bank)

Diagnosis – Idle Quality

- **12-Cylinder engine**

The subsequent, and somewhat larger engine speed decline should not be observed for evaluation. In order simplify evaluation, the dotted course in the given example represents the engine speed sequence without a running complaint (Figure 4).



P07-5977-13

Figure 8

a Defective cylinder
b Effect on following cylinder
----- Normal course

Cylinder	Average engine speed rpm	Average engine speed change rpm
1	743	11
12	739	–4
5	748	9
8	744	–4
3	752	8
10	734	–10 ← a
6	722	–12 ← b
7	717	–5
2	727	10
11	724	–3
4	735	11
9	732	–3
MAX	752	
MIN	717	
DIFF	35	

Figure 9

Cylinder 10 defective (left bank)

Diagnosis – Idle Quality

Engine Speed per Cylinder

The “Engine Speed per Cylinder” table clearly shows that the cylinder with the lowest engine speed is the weakest.
As a result, the measured value is well suited as a confirmation in cases of frequent missing which can not be identified with certainty by use of the engine speed graphic example.
Since these values represent an average of individual values, intermittent missing can not be identified.
Intermittent misses can only be identified and evaluated by means of the sample graphic illustration.
Before starting repair work based on test results, the vehicle should be evaluated from the driver’s seat and compared to typical production vehicles.
(Vehicles with automatic transmissions should be evaluated with the transmission in a drive range.)
In such a case, test results can not replace individual judgment and the experience of a specialist.

a) 4-cylinder engine, example 1

In principle, the **average engine speed change or average engine speed difference** measurements should **not** be used to diagnose 4-cylinder engines for reasons of measuring technique.

The reason is:

The average speed change value of a properly functioning cylinder can indicate a high speed drop of the following cylinder, thereby leading to a false diagnosis.
In case of a failure, the average speed change value on 4-cylinder engines can not clearly indicate the defective cylinder.

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality table – Engine 102/111, Example 1

Cylinder	Average engine speed	Average engine speed change
1	785	1
3	776	– 9
4	784	8
2	784	0
Max	785	
Min	776	
Difference	9	

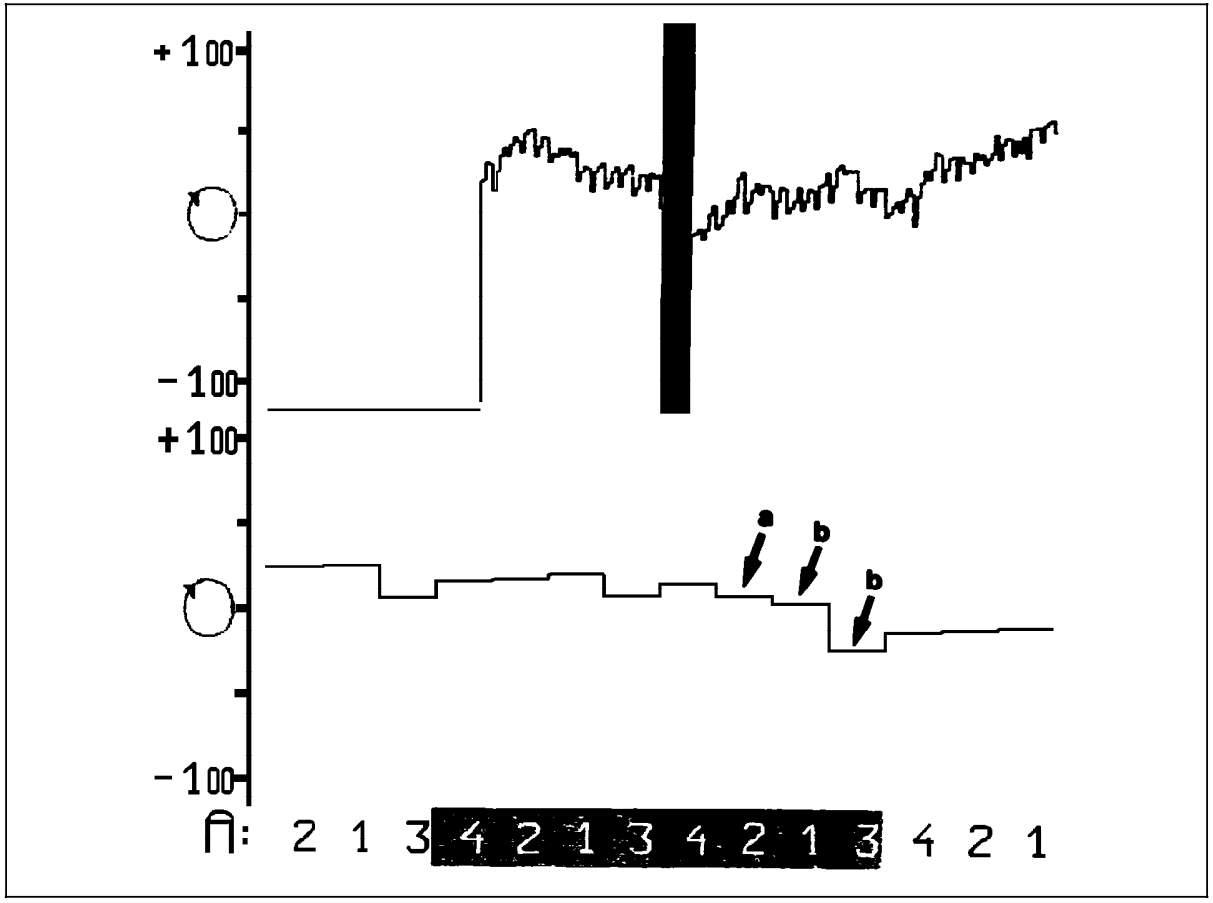
Note:
Brief or intermittent misfires can not be recognized from the table, for this purpose, the **scope pattern** must be used to identify the defective cylinder. The column “Average engine speed change” **must not be used** for the evaluation. A clear statement is only possible via the **Average engine speed**.

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle Quality Scope Pattern
Example 1 – Engine 102/111
On 4-cylinder engines the 2nd engine speed drop, or the following drop in the case of multiple failures, should be evaluated. The scope pattern must be read from **bottom to top**. In the example, cylinder 3 (arrow) is defective. **3rd engine speed drop**.

Average engine speed	768 rpm
Engine oil temperature	75 °C



P15-0408-57

Figure 10
a Engine speed drop from previously firing cylinder
b Defective cylinder

Diagnosis – Idle Quality

Engine Speed per Cylinder

Table Idle quality – Engine 102/111, Example 2

Cylinder	Average engine speed	Average engine speed change
1	999	5
3	994	– 5 Incorrect reading
4	**976**	**– 18 Defective cylinder**
2	994	18
Max	999	
Min	**976**	
Difference	23	

Note:
Brief or intermittent misfires can not be recognized from the table, for this purpose, the **scope pattern** must be used to identify the defective cylinder. The column “Average engine speed change” **must not be used** for the evaluation. A clear statement is only possible via the **Average engine speed**.

Diagnosis – Idle Quality

Engine Speed per Cylinder

Table Idle quality – Engine 102 with Tandem Mass Flywheel, Example 3

Cylinder	Average engine speed	Average engine speed change
1	753	– 1
3	750	– 3
4	**739**	**– 11 Defective cylinder**
2	754	15
Max	754	
Min	739	
Difference	15	

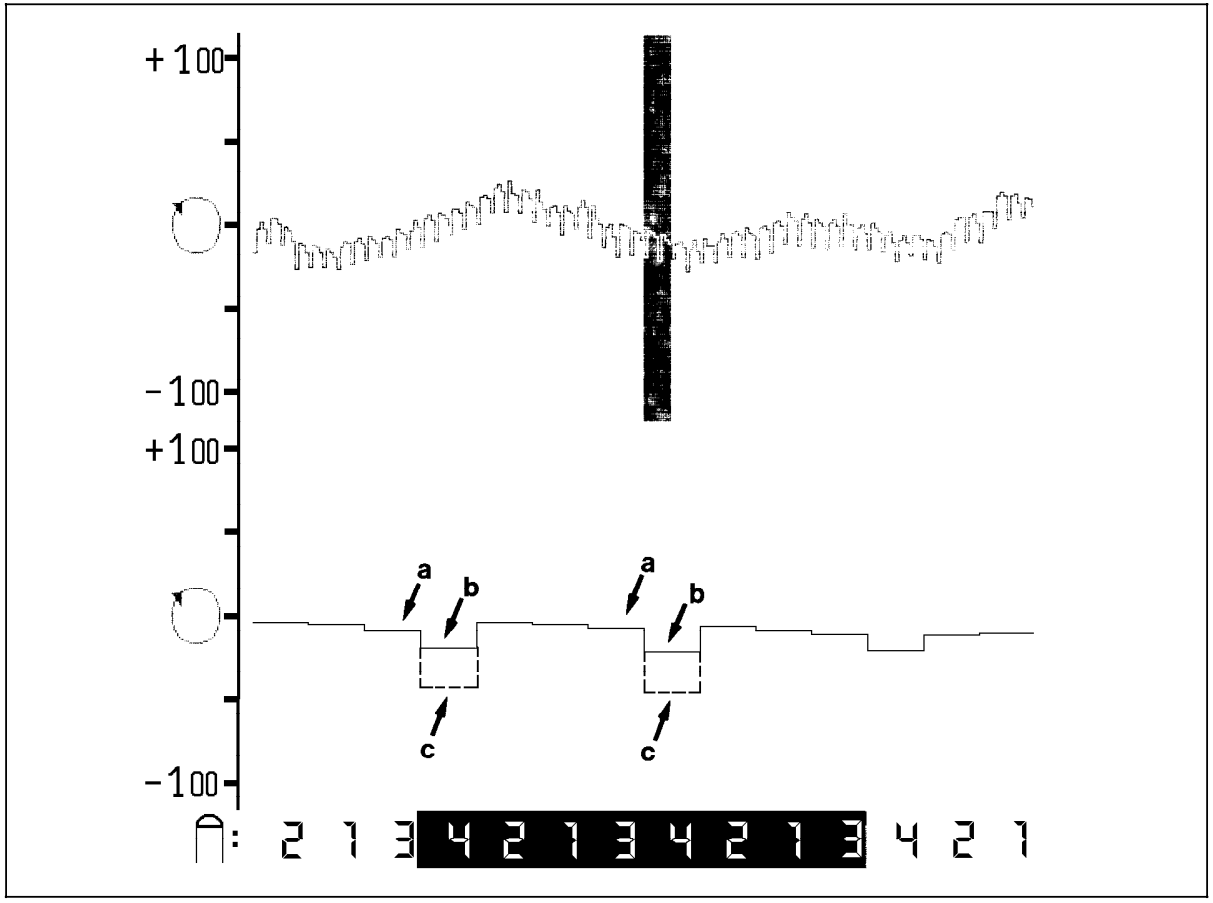
Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle Quality Scope Pattern
Engine 102 with Tandem Mass Flywheel
In the example, cylinder 4 is defective (arrow b), 2nd engine speed drop. On engines with tandem mass flywheel, the engine speed drop of a non-working cylinder is not shown as noticeably.

Average engine speed	735 rpm
Engine oil temperature	90 °C

The dotted area “c” shows the engine speed drop of an engine without tandem mass flywheel.



P07-5155-57

Figure 11

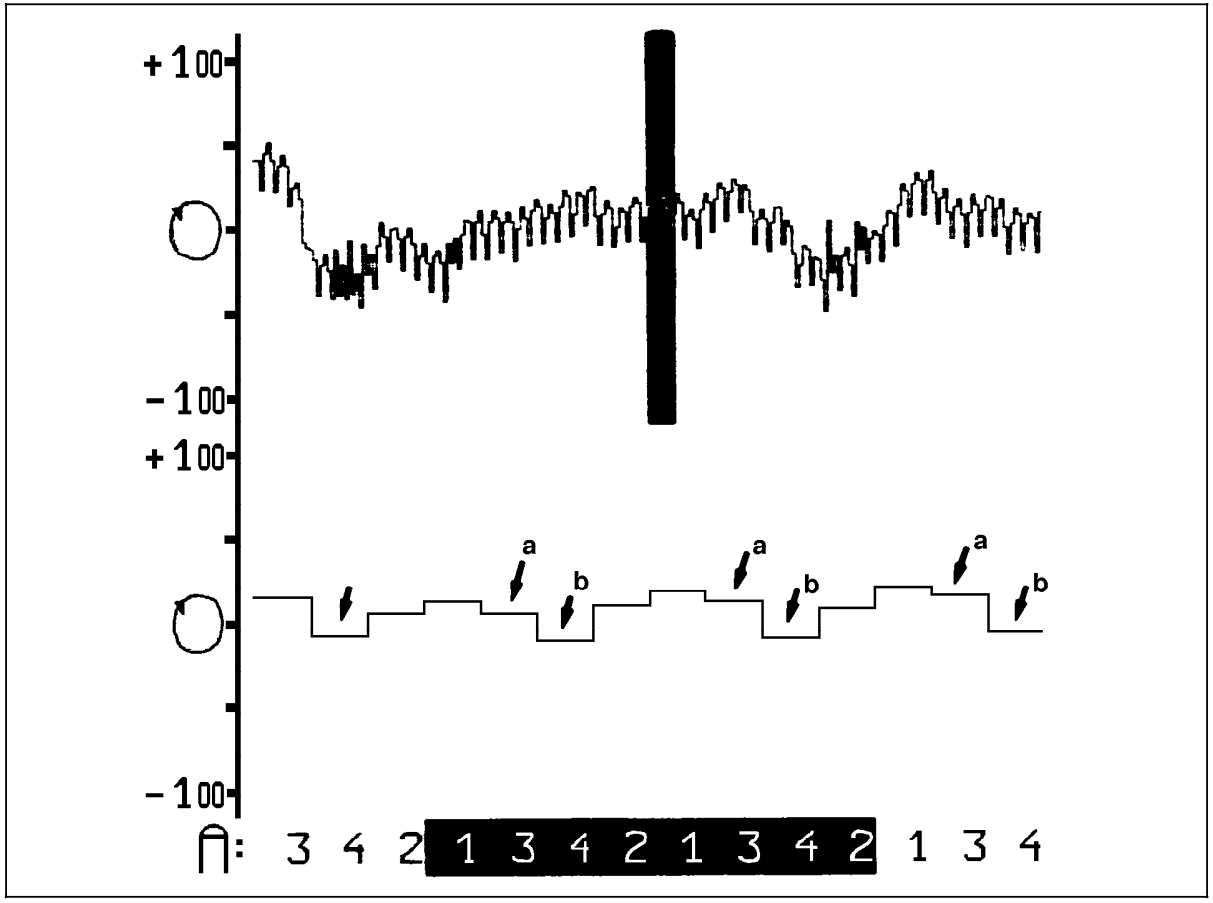
a Engine speed drop from previously firing cylinder (only one failure)
b Defective cylinder
c Engine speed drop of engine **without** tandem mass flywheel

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle Quality Scope Pattern
Engine 102 with Tandem Mass Flywheel
In the example, cylinder 4 is defective (arrow b), 2nd engine speed drop. The previous cylinder is also influenced. The scope pattern must be read **from bottom to top**.

Average engine speed	997 rpm
Engine oil temperature	75 °C



P15-0355-57

Figure 12

a Engine speed drop from previously firing cylinder (only one failure)
b Defective cylinder

Diagnosis – Idle Quality

Engine speed per cylinder

c) 6-Cylinder engine, Engine 103

In the example shown in the table below, the average engine speed for cylinder 6 is the lowest. The average engine speed change at cylinder 6 is clearly the greatest and can be used for the evaluation.
The engine speed drop is also clearly visible in the scope pattern.

Table Idle quality

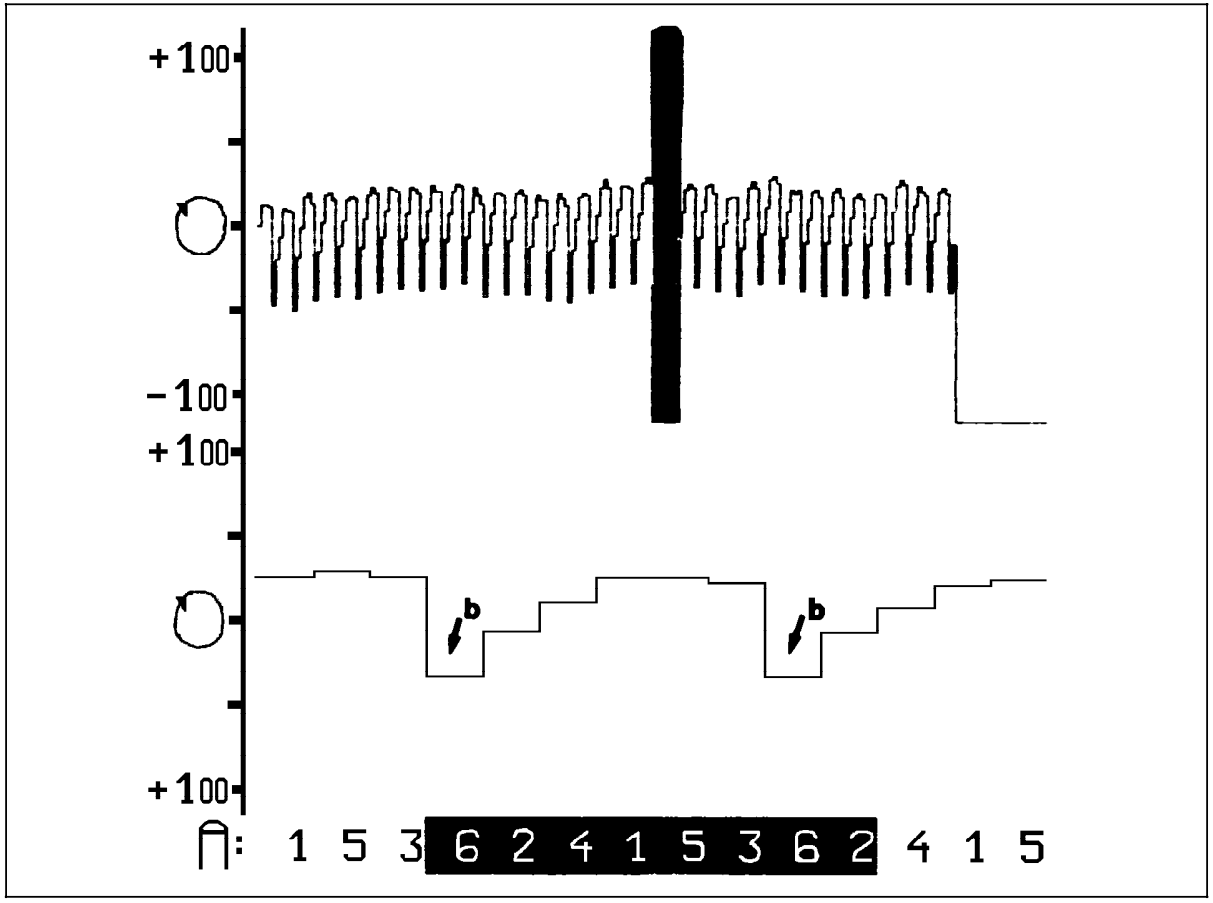
Cylinder	Average engine speed	Average engine speed change
1	727	14
5	728	1
3	**726**	– 2
6	**670**	**– 56 Defective cylinder**
2	698	28
4	713	15
Max	728	
Min	670	
Difference	58	

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 103
In this example it is clear that cylinder 6 (Arrow) is defective.

Closed throttle engine speed	712 rpm
Engine oil temperature	70 °C



P15-0357-57

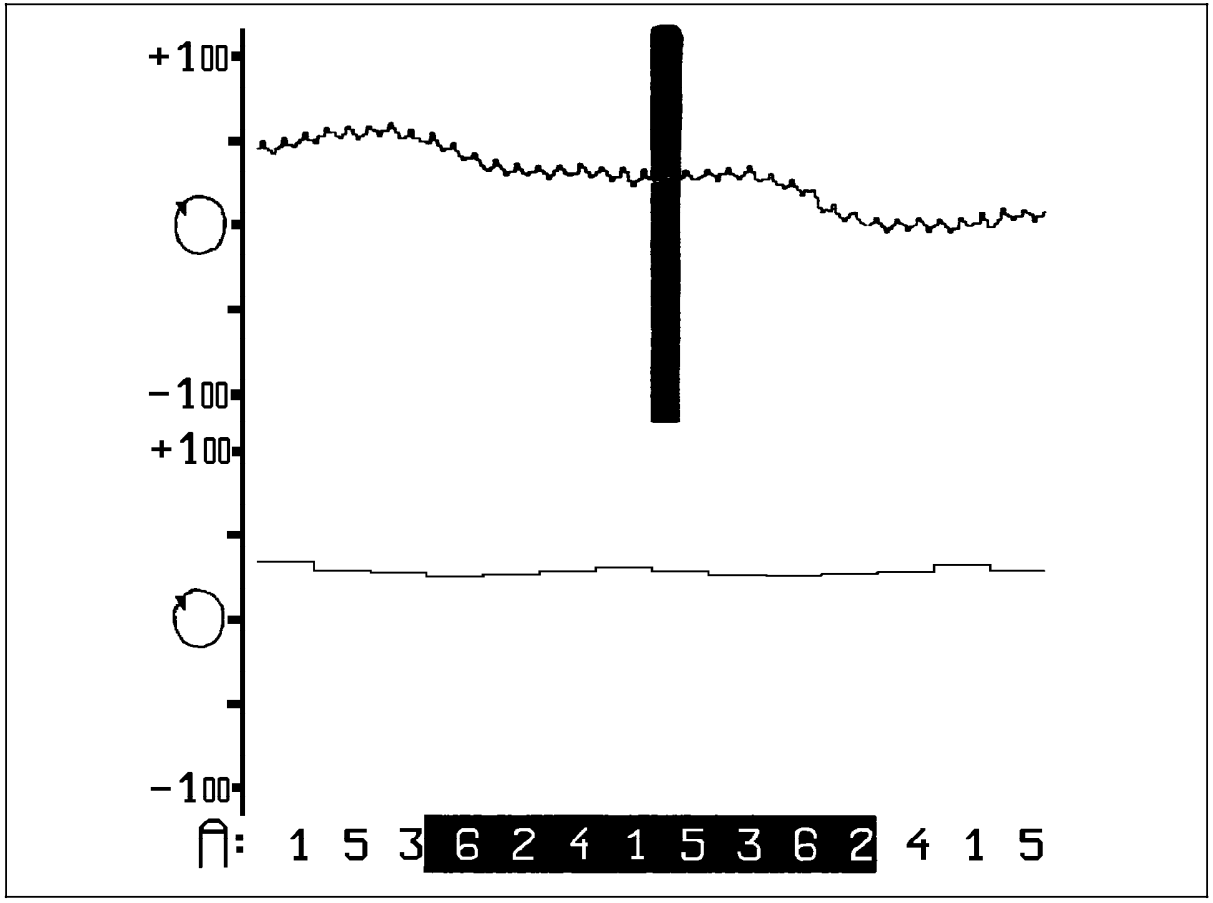
Figure 13
b Defective cylinder

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 104
In this example the engine operation is correct.

Closed throttle engine speed	712 rpm
Engine oil temperature	70 °C



P15-0356-57

Figure 14

Diagnosis – Idle Quality

Engine Speed per Cylinder

d) 8-Cylinder engine, Engine 116/117

In principle, the average engine speed change or average engine speed difference value measured should **not** be used for diagnosis of 8 cylinder engines.

Cause:

The engine speed difference value can indicate an excessive engine speed drop on the cylinder following a strong cylinder, thus leading to a faulty diagnosis.

The engine speed difference value can not be traced **with certainty** to the **defective cylinder**.

In the example shown in the table, the average engine speed for cylinder 6 is the lowest. However, the average engine speed change for cylinder 8 is the greatest.
Since the greatest engine speed drop occurs at cylinder 8, cylinder 8 is the defective cylinder. Cylinder 6, which follows, is affected by cylinder 8 and should be ignored.

Table Idle quality

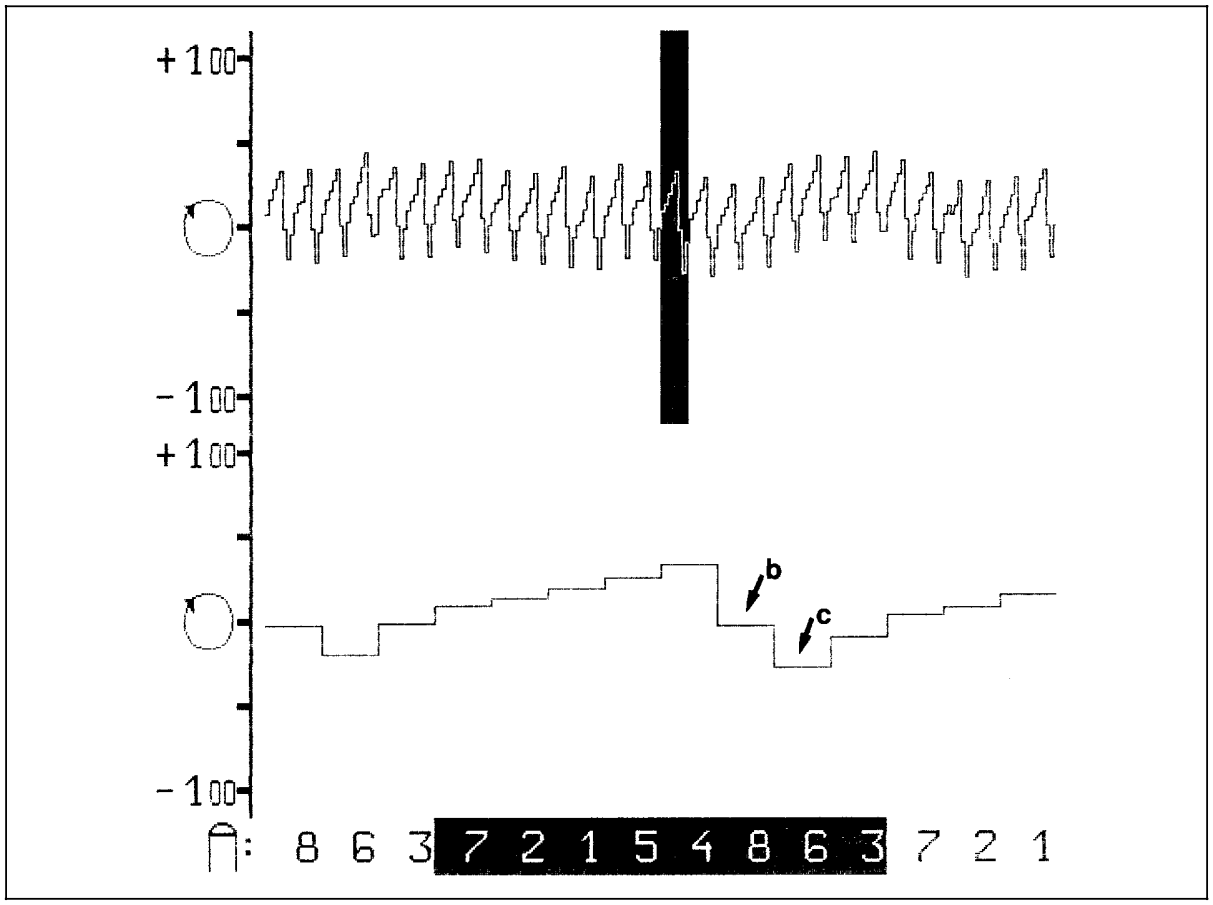
Cylinder	Average engine speed	Average engine speed change
1	704	4
5	712	8
4	720	8
8	**686**	**– 34 Defective cylinder**
6	**668**	– 18 Effect from cylinder 8
3	684	16
7	695	11
2	700	5
Max	720	
Min	668	
Difference	52	

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 116/117
During diagnosis, evaluate the largest engine speed drop (long edge, arrow) on the display and confirm with the table, if necessary.
An intermittent miss can only be determined from the graphic since the table can not indicate intermittent misses. This is dependent on the frequency of the miss.

Closed throttle engine speed	690 rpm
Engine oil temperature	85 °C



P15-0358-57

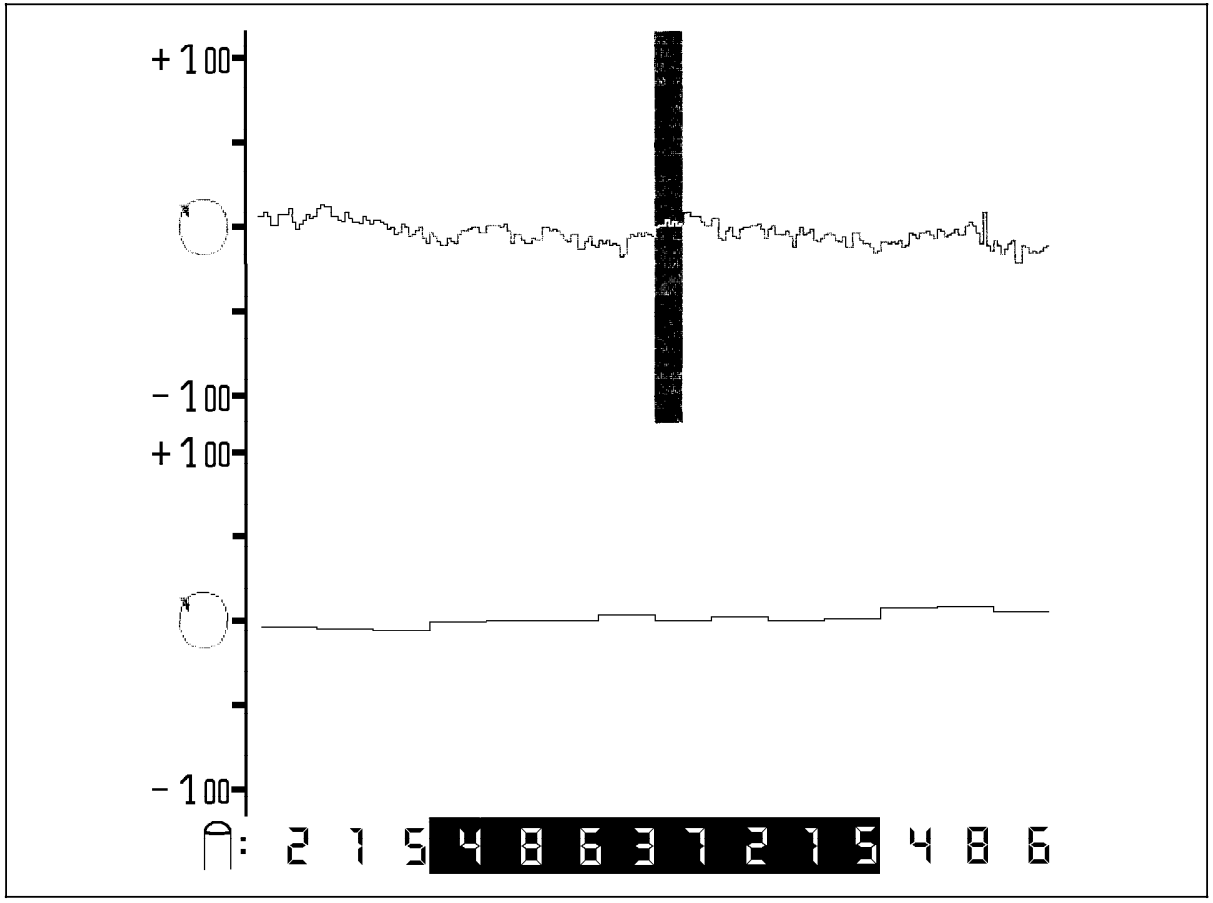
Figure 15
b Defective cylinder
c Effect on following cylinder

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 116/117
In this example the engine operation is correct.

Closed throttle engine speed	665 rpm
Engine oil temperature	85 °C



P15-0359-57

Figure 16

Diagnosis – Idle Quality

Engine Speed per Cylinder

e) 8-Cylinder Engine, Engine 119

Table Idle quality

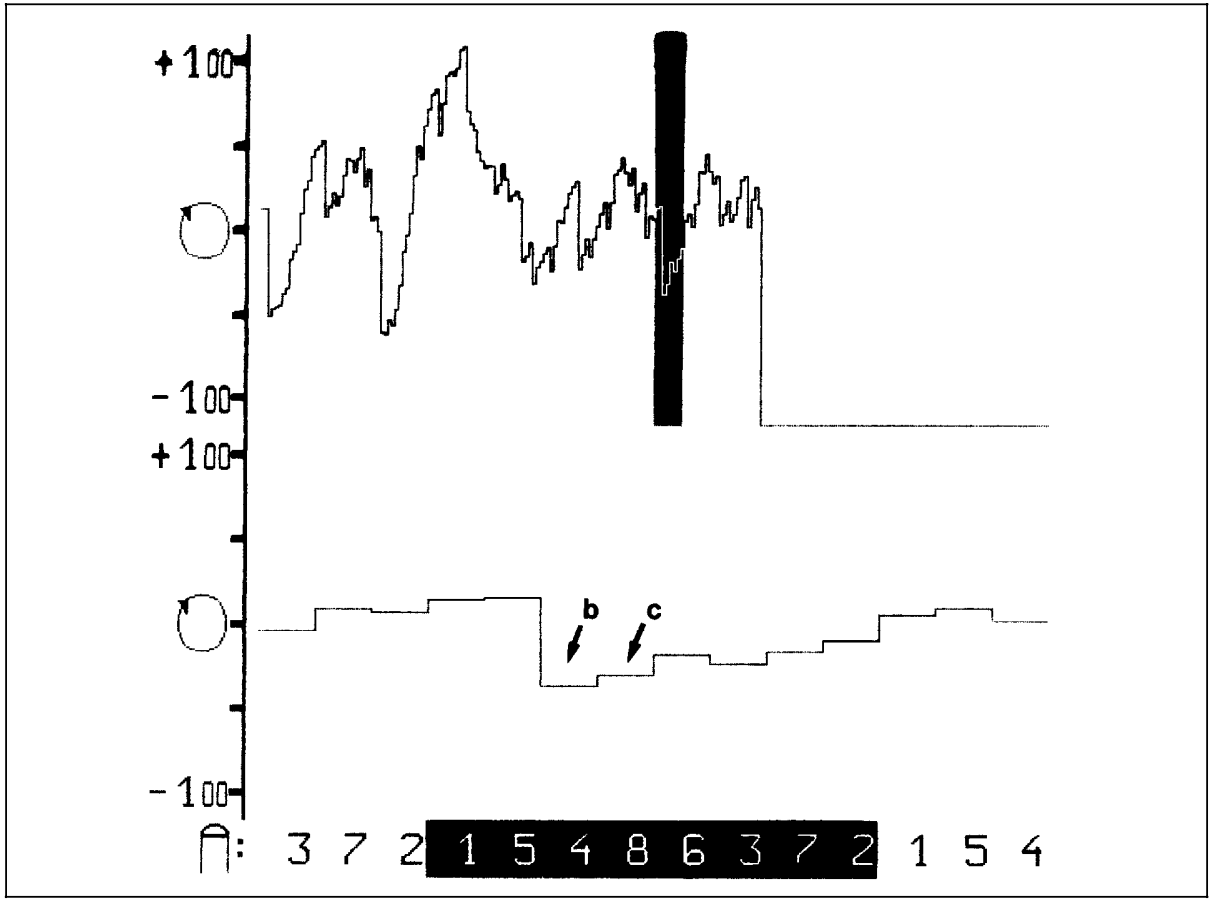
Cylinder	Average engine speed	Average engine speed change
1	658	3
5	656	– 2
4	660	4
8	658	– 2
6	659	1
3	656	– 3
7	660	4
2	655	– 5
Max	660	
Min	655	
Difference	5	

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 119

Closed throttle engine speed	690 rpm
Engine oil temperature	85 °C



P15-0365-57

Figure 17

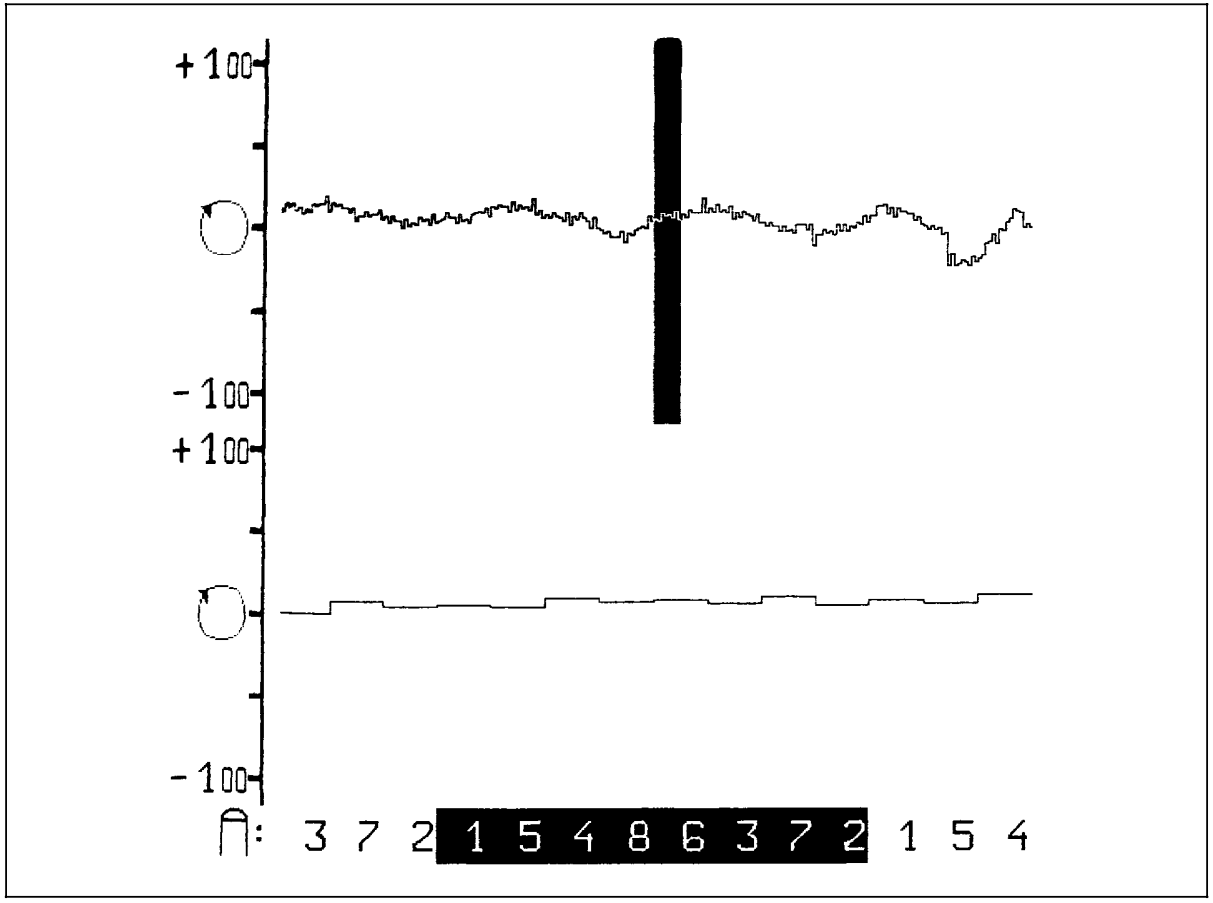
b Defective cylinder
c Effect on following cylinder

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 119
In this example the engine operation is correct.

Closed throttle engine speed	654 rpm
Engine oil temperature	85 °C



P15-0386-57

Figure 18

Diagnosis – Idle Quality

Engine Speed per Cylinder

f) 12-Cylinder Engine, Engine 120

Table Idle quality

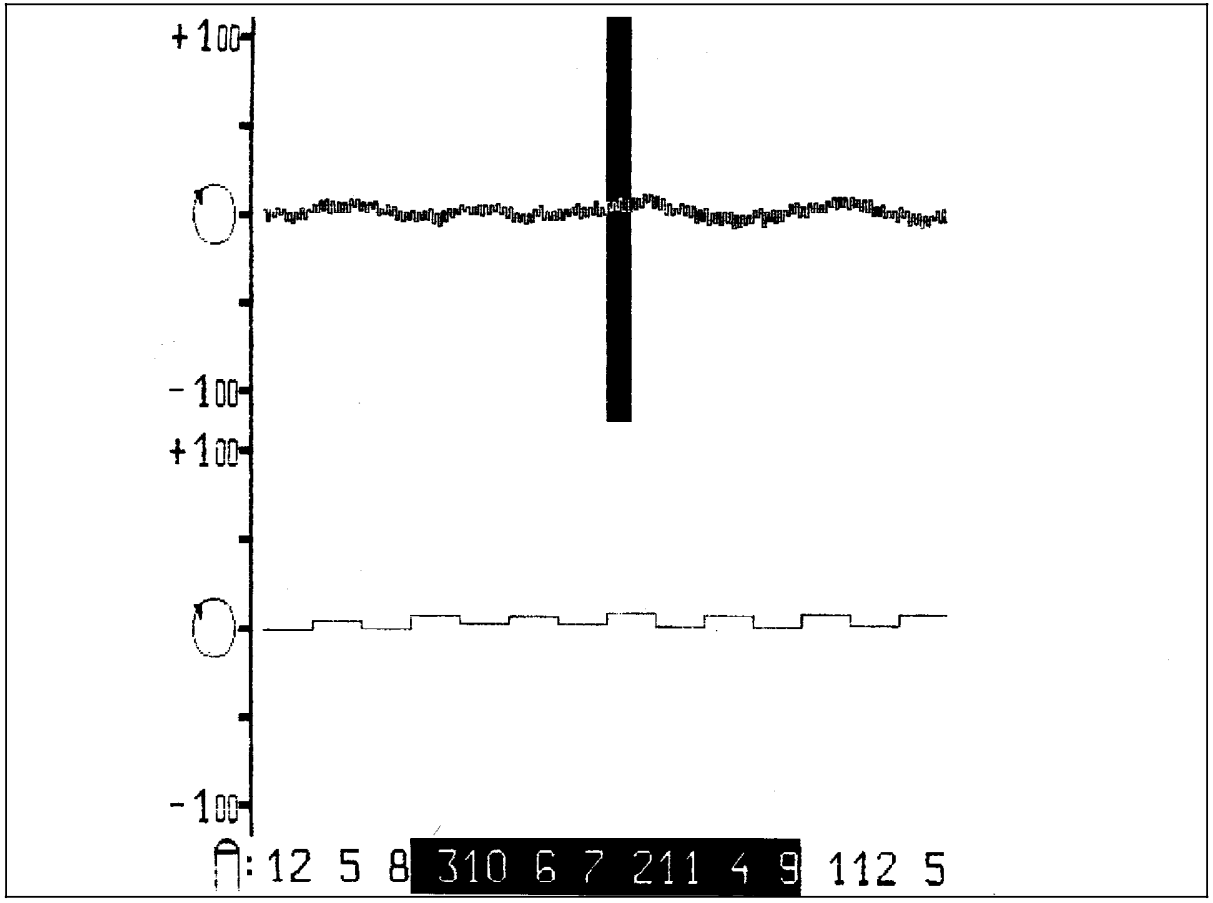
Cylinder	Average engine speed	Average engine speed change
1	664	6
12	658	– 6
5	663	5
8	659	– 4
3	665	6
10	660	– 5
6	665	5
7	658	– 7
2	664	6
11	658	– 6
4	663	5
9	658	– 5
Max	665	
Min	658	
Difference	7	

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 120
In this example the engine operation is correct.

Closed throttle engine speed	659 rpm
Engine oil temperature	85 °C



P07-5978-57

Figure 19

Diagnosis – Idle Quality

Engine Speed per Cylinder

f) 12-Cylinder Engine (Engine 120)

Table Idle quality

Cylinder 4 defective (right bank)

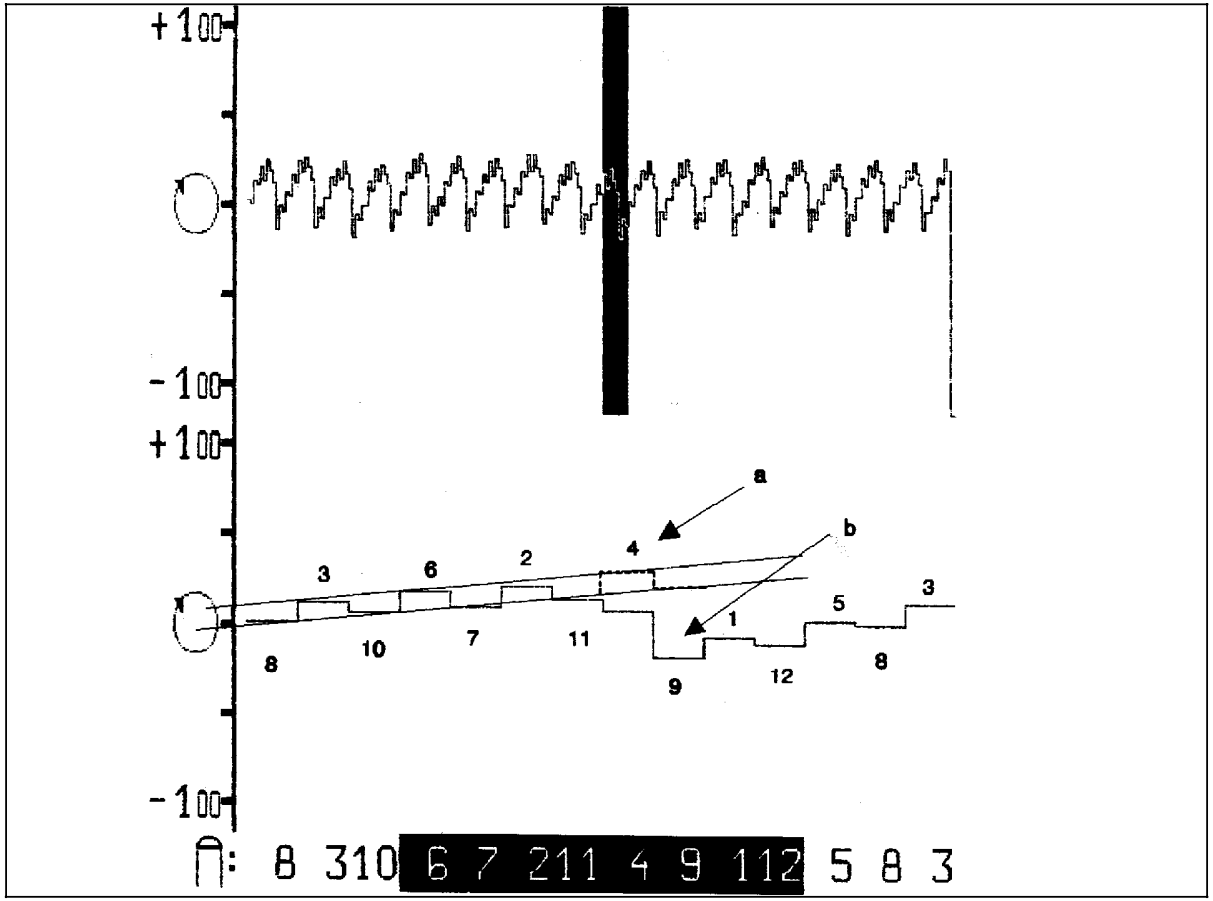
Cylinder	Average engine speed	Average engine speed change
1	716	11
12	712	– 4
5	723	11
8	721	– 2
3	732	11
10	730	– 2
6	740	10
7	734	– 6
2	743	9
11	737	– 6
4	730	– 7 Defective cylinder
9	705	– 25 Effect on following cylinder
Max	743	
Min	705	
Difference	38	

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 120

Closed throttle engine speed	723 rpm
Engine oil temperature	approx. 75 °C



P07-5975-57

Figure 20
Cylinder 4 defective (right bank)

a	Defective cylinder
b	Effect on following cylinder
------	Normal course (w/o defective cylinder)

Diagnosis – Idle Quality

Engine Speed per Cylinder

f) 12-Cylinder Engine, Engine 120
Table Idle quality

Cylinder 10 defective (left bank)

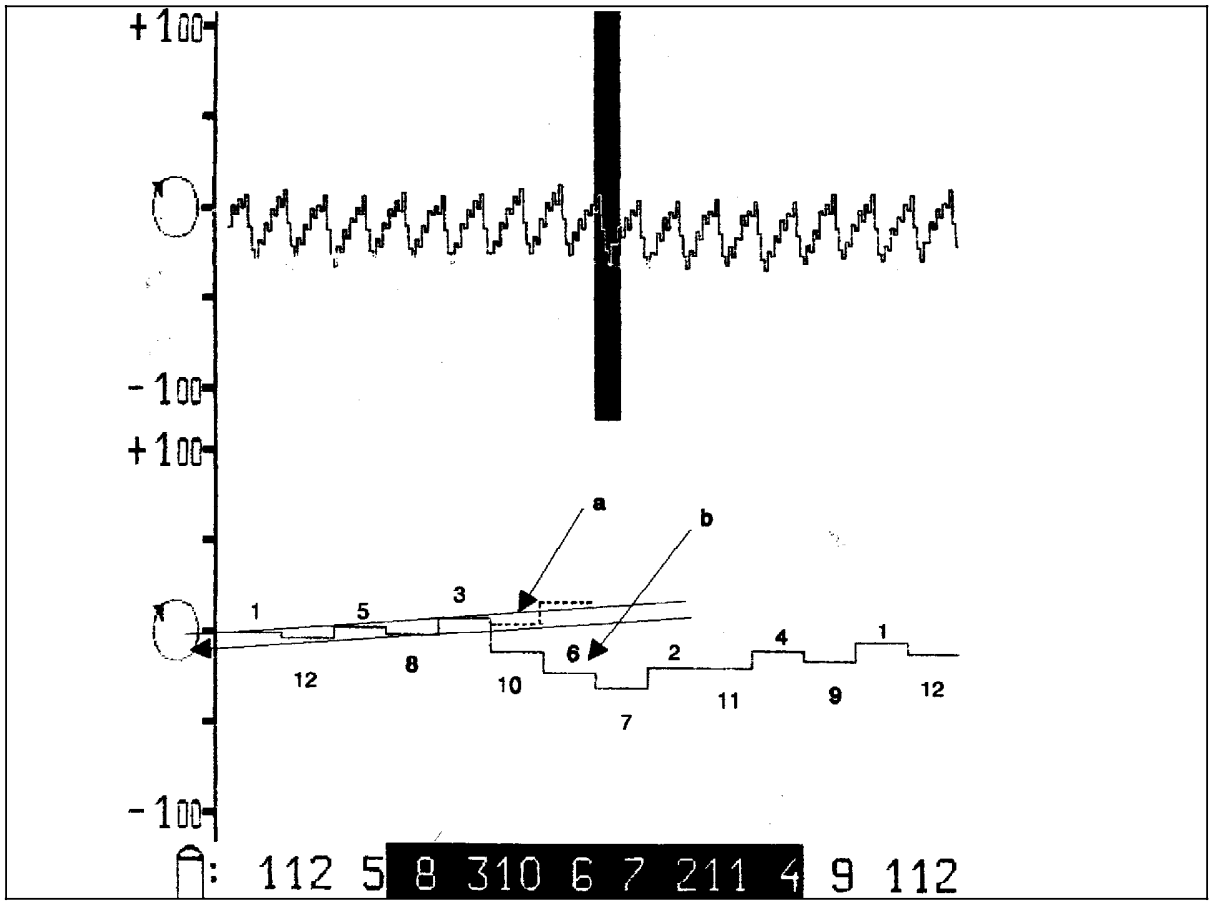
Cylinder	Average engine speed	Average engine speed change	
1	743	11	
12	739	– 4	
5	748	9	
8	744	– 4	
3	752	8	
10	734	– 18	Defective cylinder
6	722	–12	Effect on following cylinder
7	717	– 5	
2	727	10	
11	724	– 3	
4	735	11	
9	732	– 3	
Max	752		
Min	717		
Difference	35		

Diagnosis – Idle Quality

Engine Speed per Cylinder

Idle quality scope pattern, Engine 120

Closed throttle engine speed	723 rpm
Engine oil temperature	approx. 75 °C



P07-5974-57

Figure 21
Cylinder 10 defective (left bank)
a Defective cylinder
b Effect on following cylinder
---- Normal course (w/o defective cylinder)

Diagnosis – Idle Quality

Burn Time per Cylinder
(only with Bear engine analyzer)

This test is intended as an initial measurement similar to the idle quality test. Positive or negative variations, which always occur at the same cylinder, indicate a problem in the ignition system which will not always necessarily result in an engine speed drop. However, engine missing may occur at higher mileage.

⚠

Burn time per cylinder, Engine 104/111 HFM-SFI can be tested with HHT starting 01/94.

Major positive or negative variations may be caused by carbon fouled spark plugs (e. g. short-distance driving).
The vehicle should be driven for a longer distance to obtain a more exact diagnosis.
The variations shown in the table do not result in an unacceptable engine speed drop.

Table Idle quality, Engine 102

Cylinder	Average engine speed	Average engine speed change
1	683	– 4
3	684	1
4	686	2
2	687	1
Max	687	
Min	683	
Difference	4 – Difference value still acceptable	

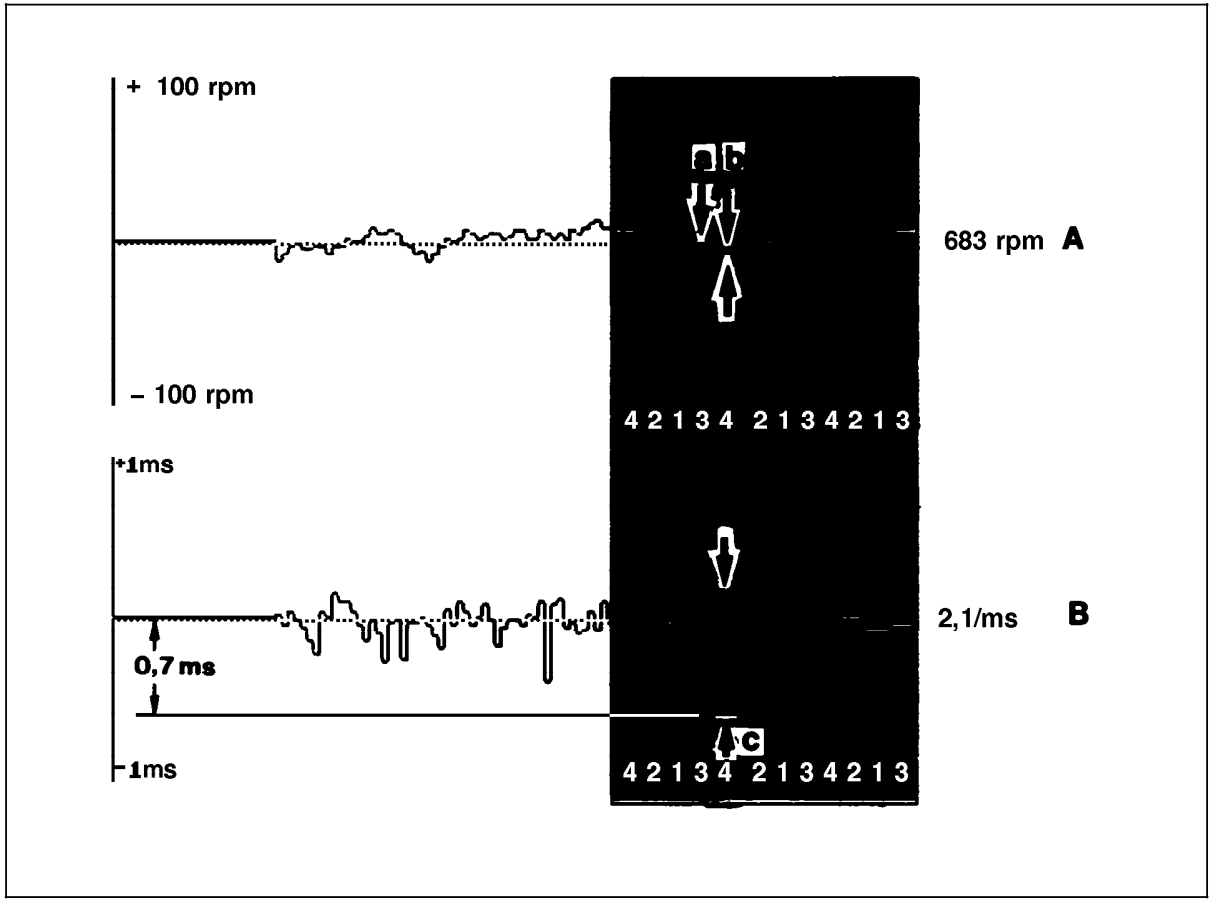
Diagnosis – Idle Quality

Burn Time per Cylinder

Variations >± 0.5 ms per cylinder should be confirmed by additional measurements such as **oscilloscope and secondary ignition system table.**

Scope pattern, Engine 102

A –	Average engine speed	683 rpm
	Engine oil temperature	75 °C
B –	Average burn time/cylinder	2.1 ms



U15-0413-57

Figure 22

a Engine speed drop caused by preceding cylinder
b Defective cylinder
c Ignition malfunction caused by carbon or oil fouled spark plug. Possible defective insulation on secondary side.

Diagnosis – Idle Quality

While Starting

The program "**Idle Quality**" can be used as a "**Starting Test**" to quickly isolate leaking injection valves.

Preconditions:

- Warm up engine to at least 80 °C engine oil temperature.
- Shut off engine for at least 15 minutes. Observe "Complaint related notes."
- Select idle quality program, the program "Idle quality".
- Starting test appears only when engine is turned off.
- Start engine and follow instructions displayed on engine analyzer.

⚠

The idle quality table must not be used for analysis.
The fault indications can only be determined from the scope pattern (see example 4-, 6- and 8-Cylinder engine).

The example shows a 4 cylinder engine
Idle quality table, Engine 102

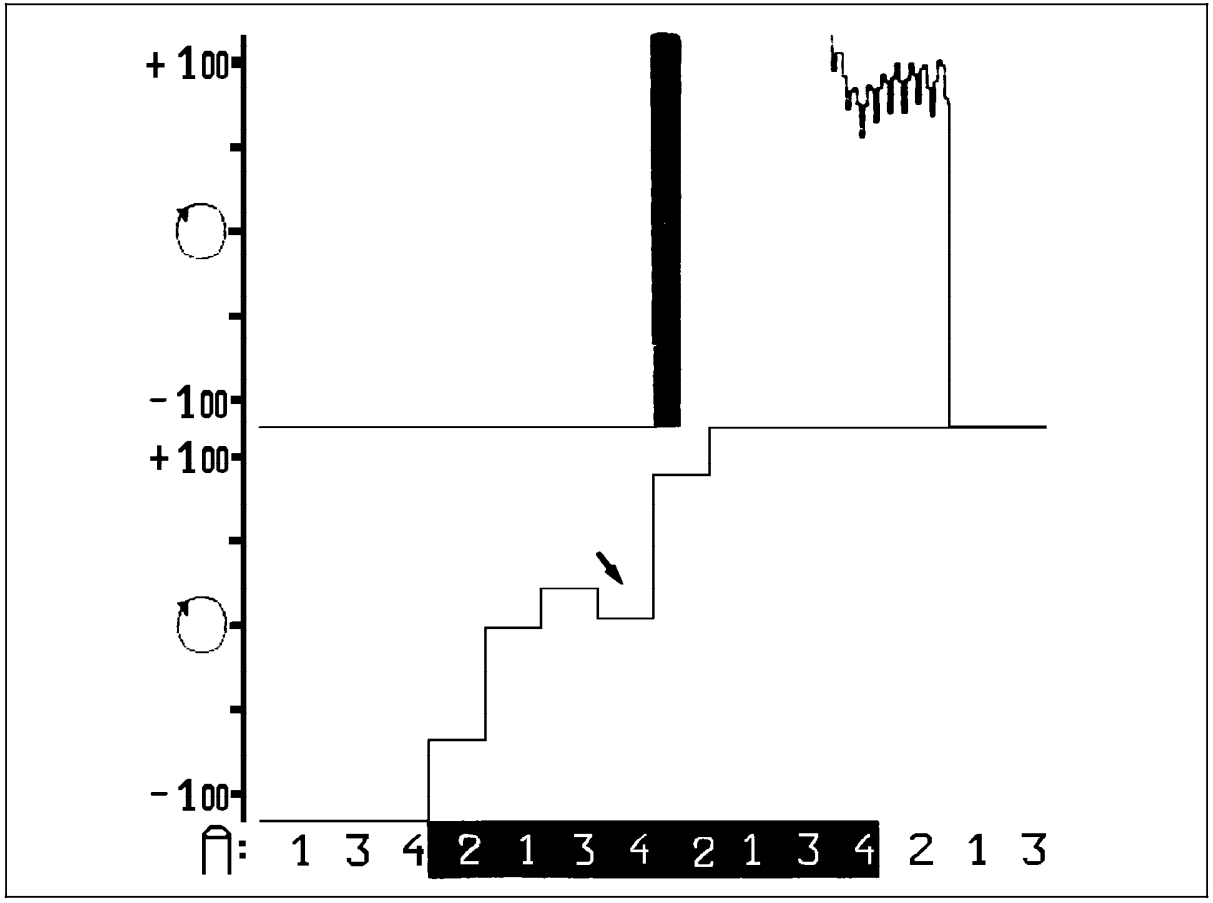
Cylinder	Average engine speed	Average engine speed change
1	1056	17
3	1051	– 5
4	1047	– 4
2	1039	– 8
Max	1056	
Min	1039	
Difference	17	

Diagnosis – Idle Quality

While Starting

a) 4-Cylinder engine, Engine 102
Malfunction at cylinder 4, arrow.
Cause: leaking injection valve.
Engine shut off for approximately 15 minutes after previous start.

Closed throttle engine speed
after starting . . . . . 938 rpm
Engine oil temperature . . . . . 80 °C



P15-0362-57

Figure 23

Diagnosis – Idle Quality

While Starting

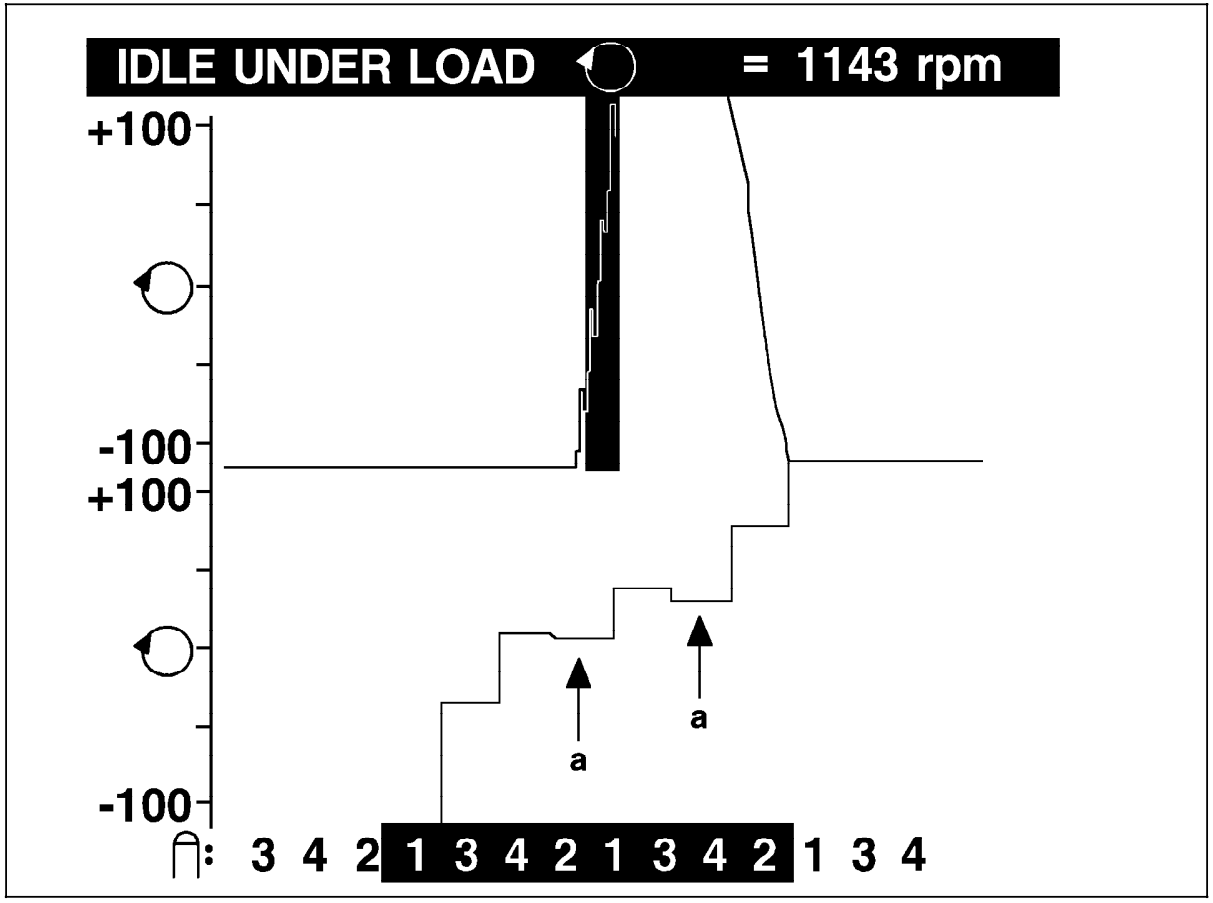
b) 4-Cylinder engine, Engine 111 HFM-SFI

Cylinders 2 and 3 do not work correctly.

Cause: for example, ignition coil.

- Turn off engine.
- Select illustration “Idle Quality During Starting Process”.
- Engine: at Idle.
- Accelerate briefly one or several times.
- Stop display.

Closed throttle engine speed
after starting . . . . . 1143 rpm
Engine oil temperature . . . . . 80 °C



U07-6579-57

Figure 24
a Defective cylinder

Diagnosis – Idle Quality

While Starting

c) 6-Cylinder engine, Engine 103, 104 CFI/LH-SFI
Malfunction at cylinder 6, arrow.
Cause: leaking injector.
Engine shut off for approximately 15 minutes after previous start.

Closed throttle engine speed
after starting . . . . . 1251 rpm
Engine oil temperature . . . . . 80 °C

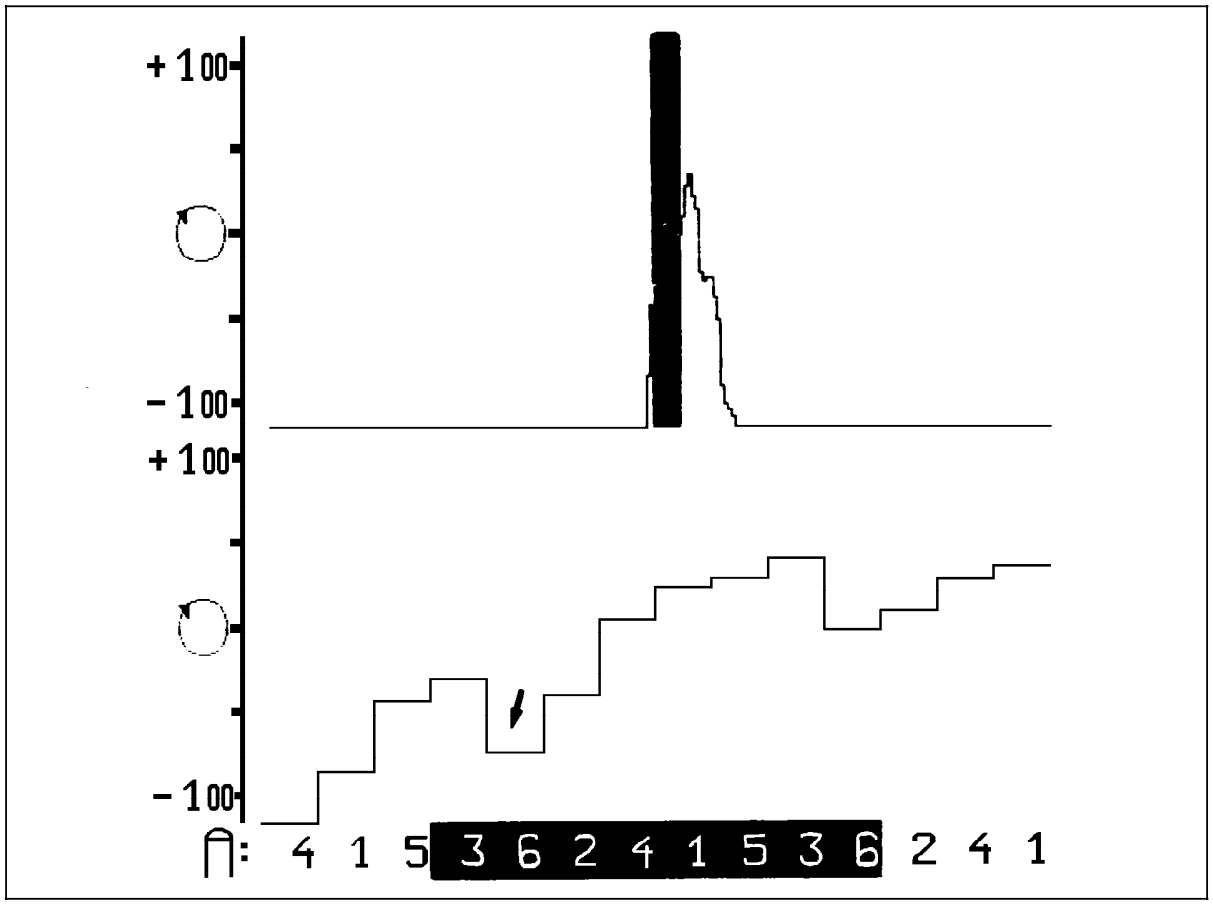


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Figure 25

Diagnosis – Idle Quality

While Starting

d) 6-Cylinder engine, Engine 104 HFM-SFI

Cylinders 2 and 5 do not work correctly.

Cause: failure in ignition circuit T1/1, cyl. 2 and 5.

- Turn off engine.
- Select illustration “Idle Quality During Starting Process”.
- Engine: at Idle.
- Accelerate briefly one or several times.
- Stop display.

Closed throttle engine speed
after starting . . . . . 3622 rpm
Engine oil temperature . . . . . 80 °C

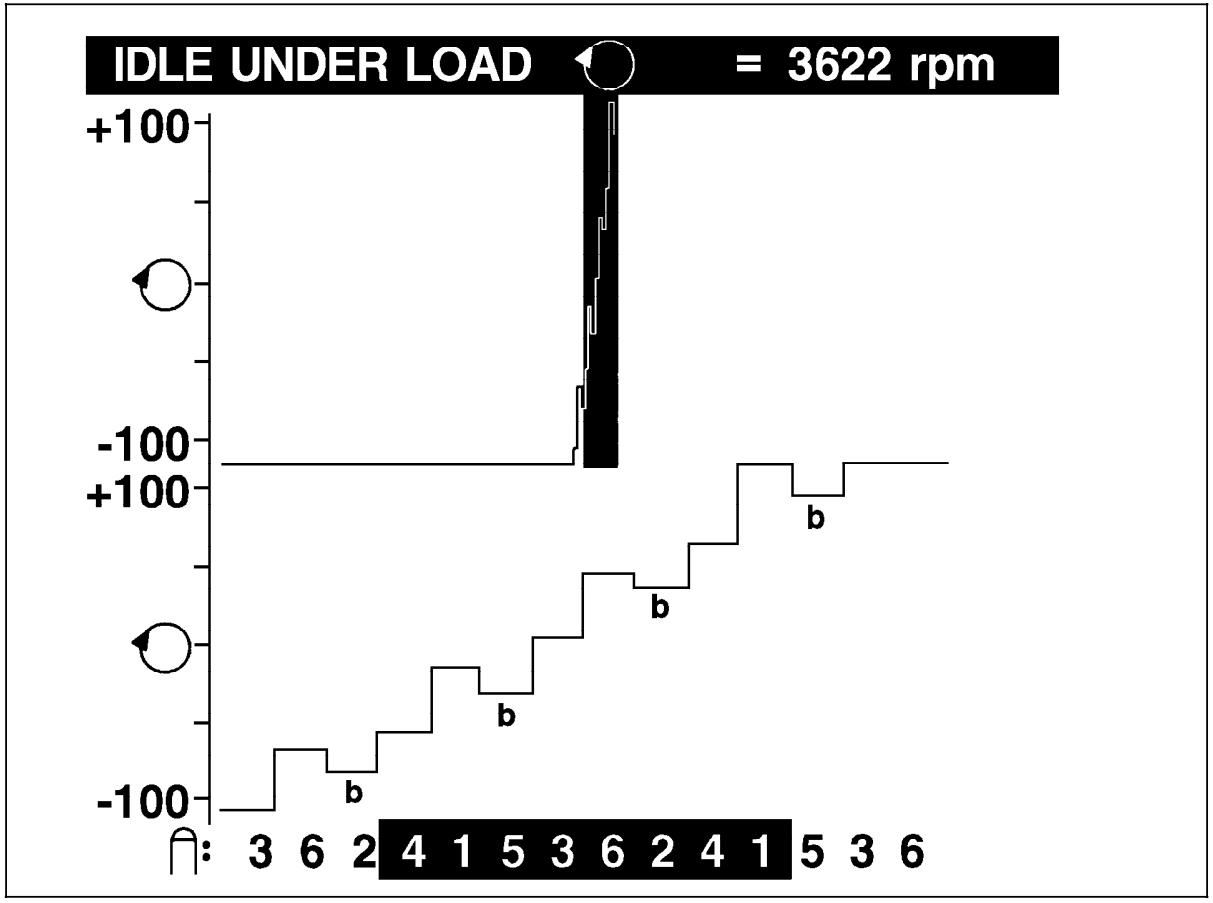

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Figure 26
b Defective cylinder

Diagnosis – Idle Quality

While Starting

e) 8-Cylinder engine, Engine 116, 117 CFI
Malfunctions at cylinders 4 and 5, arrows.
Cause: leaking injectors.
Engine shut off for approximately 15 minutes after previous start.

Closed throttle engine speed
after starting . . . . . 878 rpm
Engine oil temperature . . . . . 80 °C

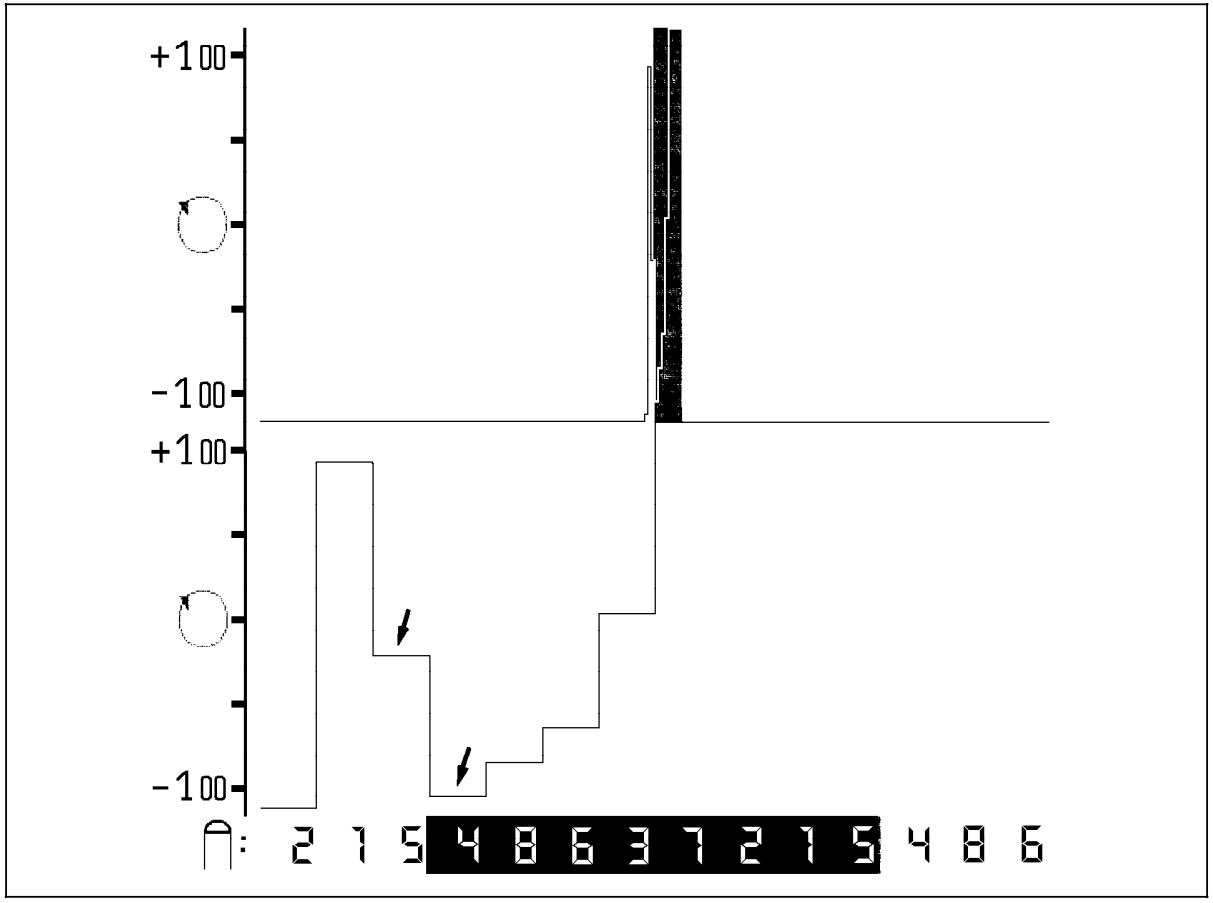

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Figure 27

Diagnosis – Idle Quality

While Starting

f) 8-Cylinder engine, Engine 119
Malfunction at cylinders 3 and 7, arrows.
Cause: leaking injection valve.

Closed throttle engine speed after starting	878 rpm
Engine oil temperature	80 °C

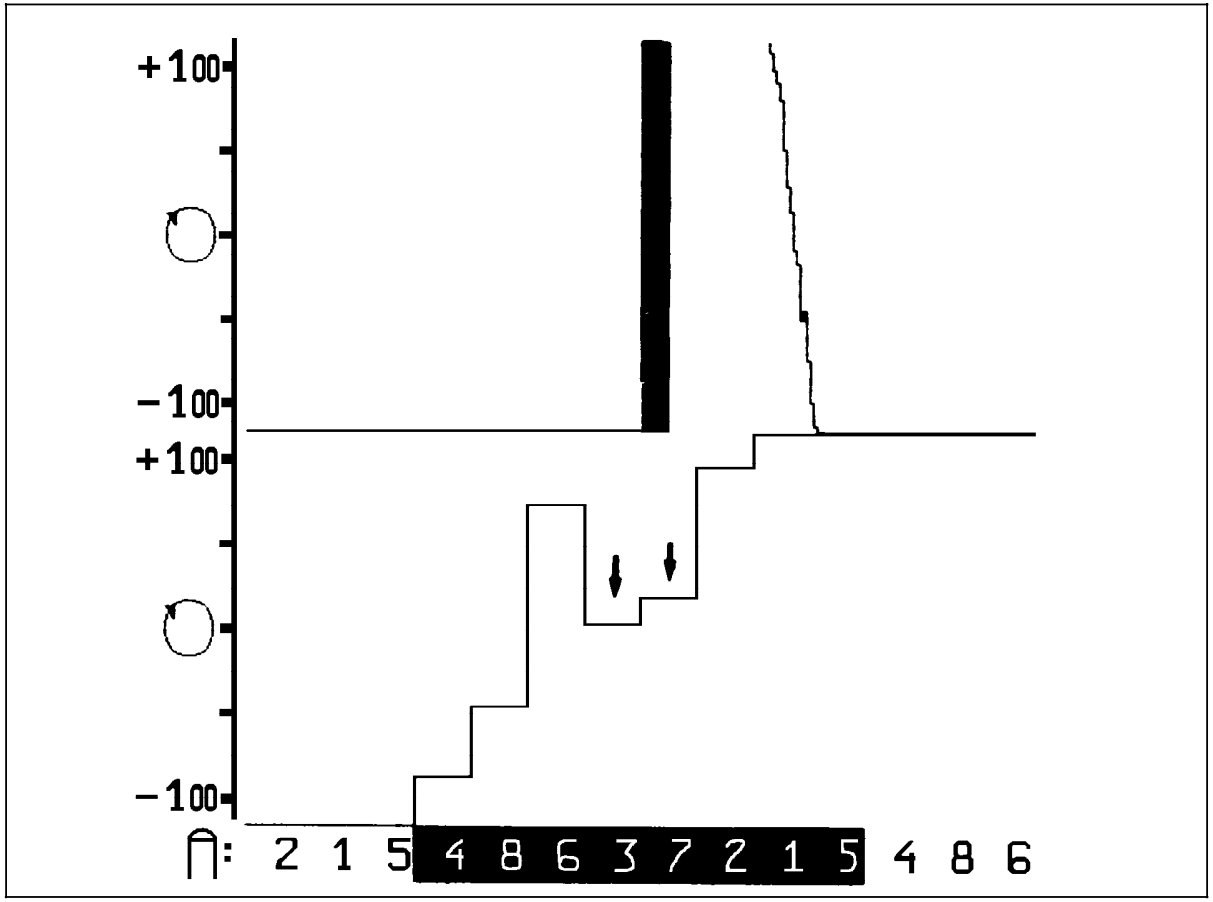

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Figure 28