

- **DRIVEABILITY—SURGE/ROLLING IDLE—GEAR DRIVEN SYNCHRONIZERS—INCORRECT INSTALLATION—CAMSHAFT POSITION SYNCHRONIZER (CMP) INSTALLATION TOOL CORRECT APPLICATION**
- **ENGINE—GEAR DRIVEN SYNCHRONIZERS—INCORRECT INSTALLATION—CAMSHAFT POSITION SYNCHRONIZER (CMP) INSTALLATION TOOL CORRECT APPLICATION**

**Article No.
02-22-1**

FORD: 1994-1997 THUNDERBIRD
1995-2003 TAURUS
1996-2003 MUSTANG
1995-1997 AEROSTAR
1995-2003 RANGER, WINDSTAR
1996-2000 EXPLORER
1997-2003 E SERIES, F-150

MERCURY: 1994-1997 COUGAR
1995-2003 SABLE
1997-2000 MOUNTAINEER

ISSUE

Incorrectly installed gear driven camshaft position (CMP) sensor synchronizer assemblies may be hard to diagnose. Vehicle may exhibit poor fuel economy, driveability Diagnostic Trouble Codes (DTCs) P1336, P1309, P0340 with MIL light on. Loss of power, surge, hesitation and runs rough on acceleration may also be present.

ACTION

New diagnostics have been developed for WDS to diagnose incorrectly installed gear driven camshaft position (CMP) synchronizer assemblies. Refer to the following Service Procedure to diagnose a possible mis-installed synchronizer assembly and proper installation procedure.

SERVICE INFORMATION

Items Covered In This Article:

- “Hall” vs. “VRS” sensor function
- Vehicle history scrutiny for past service of the synchronizer assembly
- WDS - Power balance test
- WDS - CMP and CKP wave signal comparison
- Wave Comparison chart - CMP vs. CKP
- Correct (CMP) synchronizer installation tool application & installation procedure
- “Top Dead Center” (TDC) alignment
- Synchronizer installation tool application chart

Hall - Effect (Hall) and Variable Reluctance (VRS) CMP Sensors

CMP sensors are used on all current model year engines, regardless of fuel system or ignition system type. The CMP sensor provides the Powertrain Control Module (PCM) with cam position information to indicate # 1 cylinder, on the compression stroke

There are two different types of CMP sensors:

- The three- pin, Hall-effect sensor (Figure 1)
- The two-pin Variable Reluctance sensor (Figure 1)

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Although the Hall-effect (three-pin) and the Variable Reluctance (two-pin) CMP sensors perform the same function, their signal appearance is quite different and they are not interchangeable.

- The three-pin Hall-effect sensor uses a Hall effect device and a magnet to generate a digital square wave signal (Figure 2)
- The two-pin Variable Reluctance sensor is a magnetic transducer, which uses differential voltage across windings to generate a voltage waveform that is similar to a sine wave (Figure 2)

Both sensors provide a switching voltage as the engine rotates.

SERVICE PROCEDURE

If you suspect that a vehicle (engine) may have had the synchronizer assembly (Figure 3) installed incorrectly, check the vehicle history to see if related service has been performed. If you determine that the synchronizer could have been installed incorrectly, use the following procedure with WDS to verify correct installation (Figure 5).

NOTE

CORRECT CAMSHAFT POSITION SYNCHRONIZER ASSEMBLY INSTALLATION IS CRITICAL. AN INCORRECTLY INSTALLED SYNCHRONIZER CAN CAUSE HARD TO DIAGNOSE DRIVEABILITY CONDITIONS AND POSSIBLE SERIOUS ENGINE DAMAGE.

Reasons for incorrect installation are:

- Not setting the # 1 cylinder on Top Dead Center (TDC) of the compression stroke
- Use of the incorrect camshaft synchronizer tool for installation
- Incorrect alignment of the synchronizer tool

Power Balance Test In WDS

The WDS Power Balance Test can be used to quickly determine if the CMP synchronizer assembly is installed incorrectly. Use the following procedure.

1. Run the vehicle while viewing the power balance test in WDS to insure that no engine misses are occurring.
2. Shut the engine off and remove the # 1 cylinder injector electrical connector.
3. Start the engine and view the WDS power balance test.

4. The test should indicate a power loss in the # 1 cylinder (Figure 4).
 - If the # 1 cylinder is indicated, then the CMP synchronizer assembly IS NOT grossly mis-installed. (Figure 4) Continue to Step 5 in this procedure
 - If any other cylinder is indicated during the power balance test, then the CMP synchronizer assembly HAS BEEN INSTALLED INCORRECTLY, and must be reinstalled. (Refer to the installation procedure, tool chart and TDC reference described in this TSB, or refer to the appropriate model year Workshop Manual Section 303-14, Synchronizer-Camshaft).
5. If power loss is indicated in the # 1 cylinder (Figure 4), connect a 104 pin break-out box between the PCM and the PCM electrical connector.
6. Insert the red WDS probe into pin # 21 and the black WDS probe into pin # 85 of the break-out Box.
7. Select oscilloscope from the WDS Toolbox.
8. Select "Channel one Auto Mode", then select the Crankshaft Position (CKP) sensor.
9. Select "Channel two Auto Mode", then select the CMP sensor based on whether it is a VRS (2-pin) or Hall-effect (3 pin) CMP sensor.
10. Press the start button and view both the CKP sensor as well as the CMP sensor signals. Figure 6, 7 and 8).
11. Compare the wave forms of both sensors.
 - The missing tooth of the CKP sensor trigger wheel will be shown on the screen as an extra space between the wave forms. This position is 60° Before Top Dead Center (BTDC)
 - The upper peaks of the wave form are each spaced 10° of crankshaft rotation apart
 - The CMP timing setting on all current 6-cylinder engines should be between 10 and 40° After Top Dead Center (ATDC)

On all Hall-effect sensors, the CMP wave form rising edge should occur between the 7th and the 10th peak past the missing tooth. (Figure 6)

On the VRS sensors (except 5.0L engines), the falling edge of the CMP waveform should cross the zero reference line between the 7th and 10th peak past the missing tooth waveform. (Figure 7).

On 5.0L engines with a VRS CMP sensor, the falling edge waveform should cross the zero reference line between the 6th and the 9th peak past the CKP missing tooth (Figure 8).

On 5.0L engines with a Hall-effect VRS CMP sensor, the rising edge of the wave form should occur between the 6th and 9th peak past the CKP missing tooth wave form.

(CMP) SYNCHRONIZER INSTALLATION PROCEDURE

1. Set the # 1 cylinder on Top Dead Center (TDC) of the compression stroke.

NOTE

THE # 1 CYLINDER MUST BE SET ON TOP DEAD CENTER (TDC) OF THE COMPRESSION STROKE OR THE SYNCHRONIZER ASSEMBLY WILL NOT BE INSTALLED CORRECTLY.

2. Disconnect the battery ground cable.
3. Remove the CMP sensor from the synchronizer assembly.
4. Remove the synchronizer clamp (hold down bolt) and remove the synchronizer assembly.

NOTE

IN SOME CASES THE OIL PUMP INTERMEDIATE SHAFT MAY NOT COME OUT WITH THE SYNCHRONIZER ASSEMBLY. IF SO, RETRIEVE THE INTERMEDIATE SHAFT BEFORE PROCEEDING.

5. After performing the required service and before beginning the installation of the synchronizer assembly, ALWAYS COAT THE SYNCHRONIZER DRIVE GEAR WITH CLEAN ENGINE OIL PRIOR TO INSTALLATION.
6. Install the correct engine and model year synchronizer alignment installation tool. Install the tool to the synchronizer assembly by rotating the tool until it engages the notches in the camshaft synchronizer housing and the armature (Figure 10).

CAUTION

SOME OF THE TOOLS WILL FIT ACROSS ENGINE LINES AND COULD BE PERCEIVED AS

BEING THE CORRECT TOOL. ALTHOUGH THE TOOLS MAY APPEAR SIMILAR, THERE ARE SUBTLE DIFFERENCES BETWEEN THEM, ALWAYS CHECK THE TOOL APPLICATION CHART PROVIDED IN THIS TSB (FIGURE 9).

7. During the installation of the synchronizer assembly (with the tool attached) into the engine, the arrow on the tool will rotate until the intermediate shaft and the camshaft gear fully engage.

NOTE

THE ARROW WILL ROTATE CLOCKWISE OR COUNTER CLOCKWISE DEPENDING ON THE ENGINE TYPE AND ENGINE ROTATION.

8. Install the camshaft synchronizer assembly so the arrow on the installation tool (Figure 3) is in the correct position as specified in the appropriate model year vehicle and engine. (Refer to Workshop Manual Section 303-14, Synchronizer-Camshaft).
9. Install the synchronizer clamp (bolt) before removing the installation tool. Tighten to 18 Lb-ft (25 N•m).
10. Remove the installation tool.
11. Install the CMP sensor. Tighten to 27 Lb-in (3 N•m).
12. Install battery ground cable.

CAUTION

DO NOT LOOSEN THE SYNCHRONIZER BOLT AND ROTATE THE SYNCHRONIZER ASSEMBLY. THE SYNCHRONIZER ASSEMBLY IS NOT ADJUSTABLE; DO NOT LOOSEN THE SYNCHRONIZER BOLT AFTER THE ALIGNMENT TOOL HAS BEEN REMOVED IN ORDER TO ALIGN THE CMP ELECTRICAL CONNECTOR FOR ANY REASON. IF THE ELECTRICAL CONNECTOR IS NOT IN THE CORRECT POSITION, THE SYNCHRONIZER ASSEMBLY HAS TO BE REMOVED, THE ALIGNMENT TOOL REINSTALLED AND THE ASSEMBLY REINSTALLED ASSUMING THE ENGINE HAS NOT BEEN ROTATED FROM TDC OF THE COMPRESSION STROKE ON # 1 CYLINDER.

Article No. 02-22-1 Cont'd.

OTHER APPLICABLE ARTICLES: NONE

WARRANTY STATUS: INFORMATION ONLY

OASIS CODES: 404000, 490000, 499000, 608000,
608500, 610000, 610500, 611000,
611500, 612000, 612500, 614000,
614500, 622000, 698298

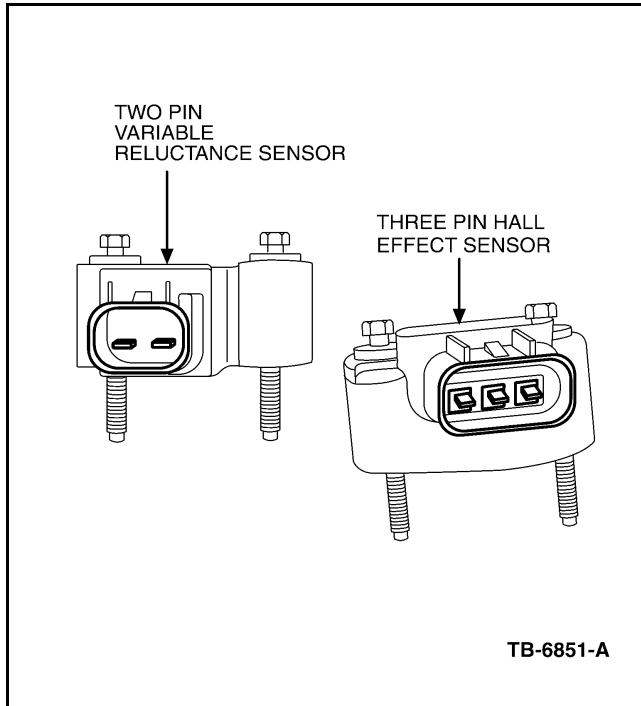
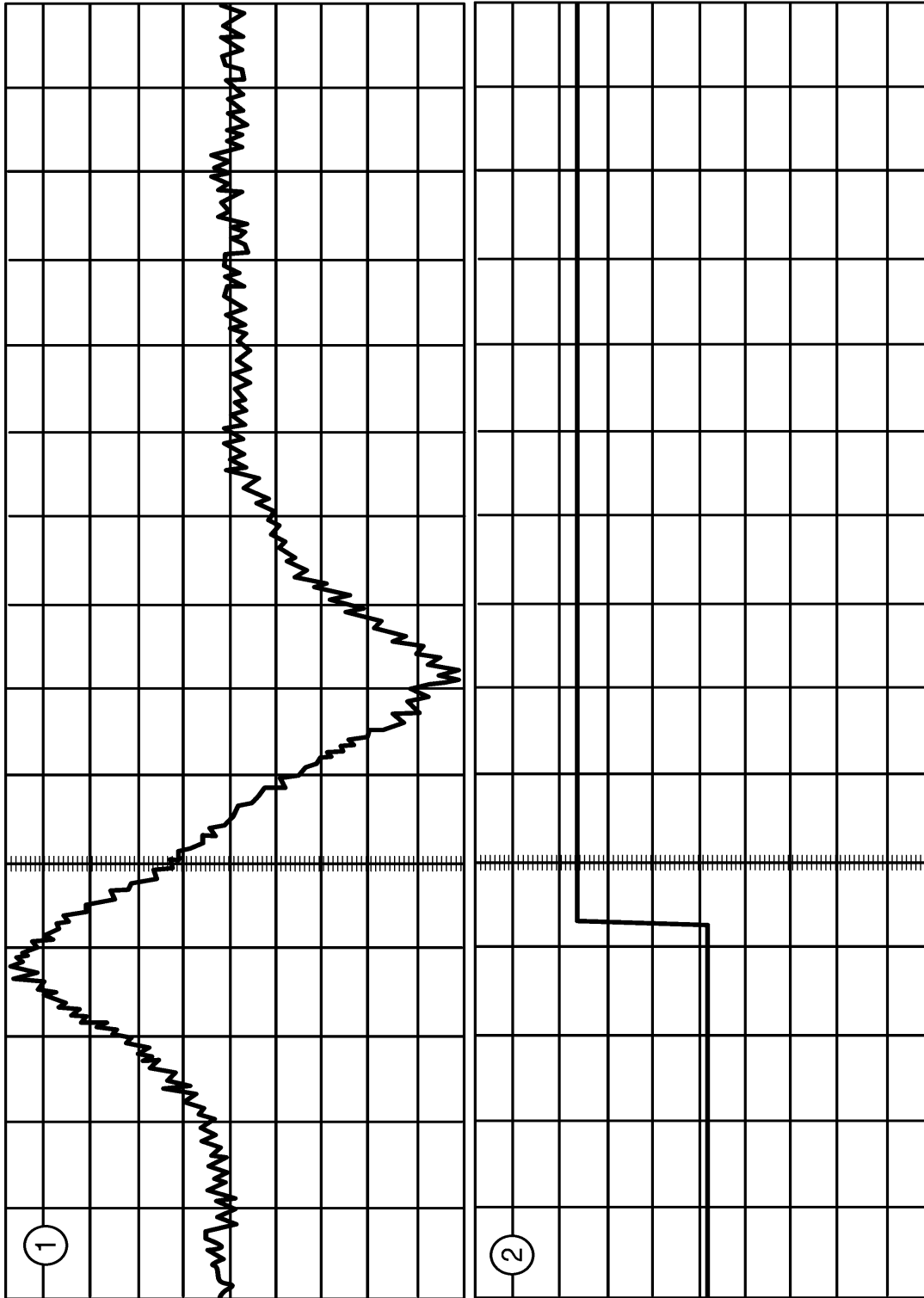


Figure 1 - Article 02-22-1

CMP SIGNALS AS DISPLAYED IN THE WDS OSCILLOSCOPE MODE



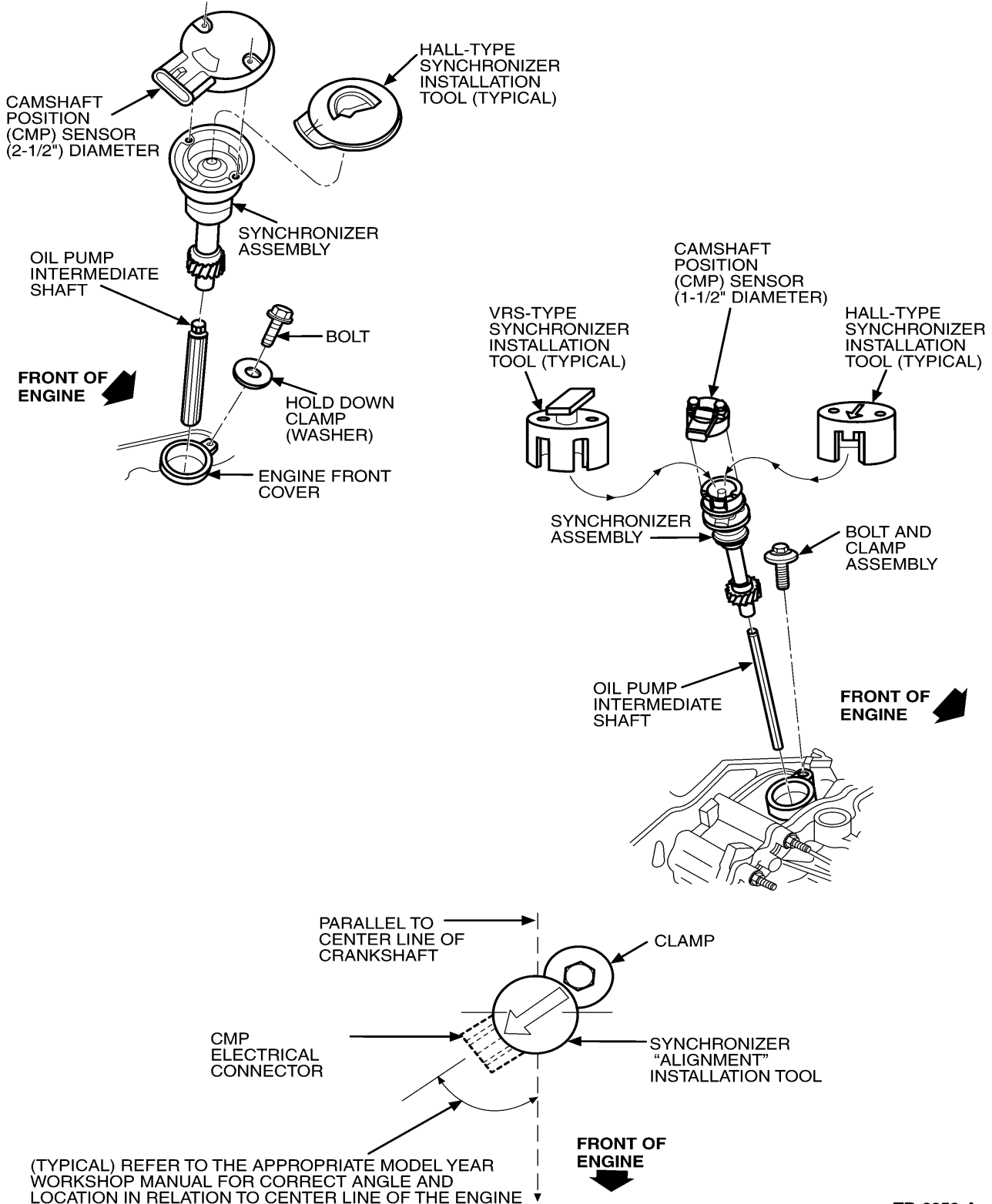
ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	SINE WAVE-TYPE (VARIABLE RELUCTANCE) SIGNAL	2	SQUARE WAVE (HALL-EFFECT) SIGNAL

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Figure 2 - Article 02-22-1

ILLUSTRATIONS OF THE GEAR-DRIVEN CMP SYNCHRONIZER ASSEMBLY INSTALLATION

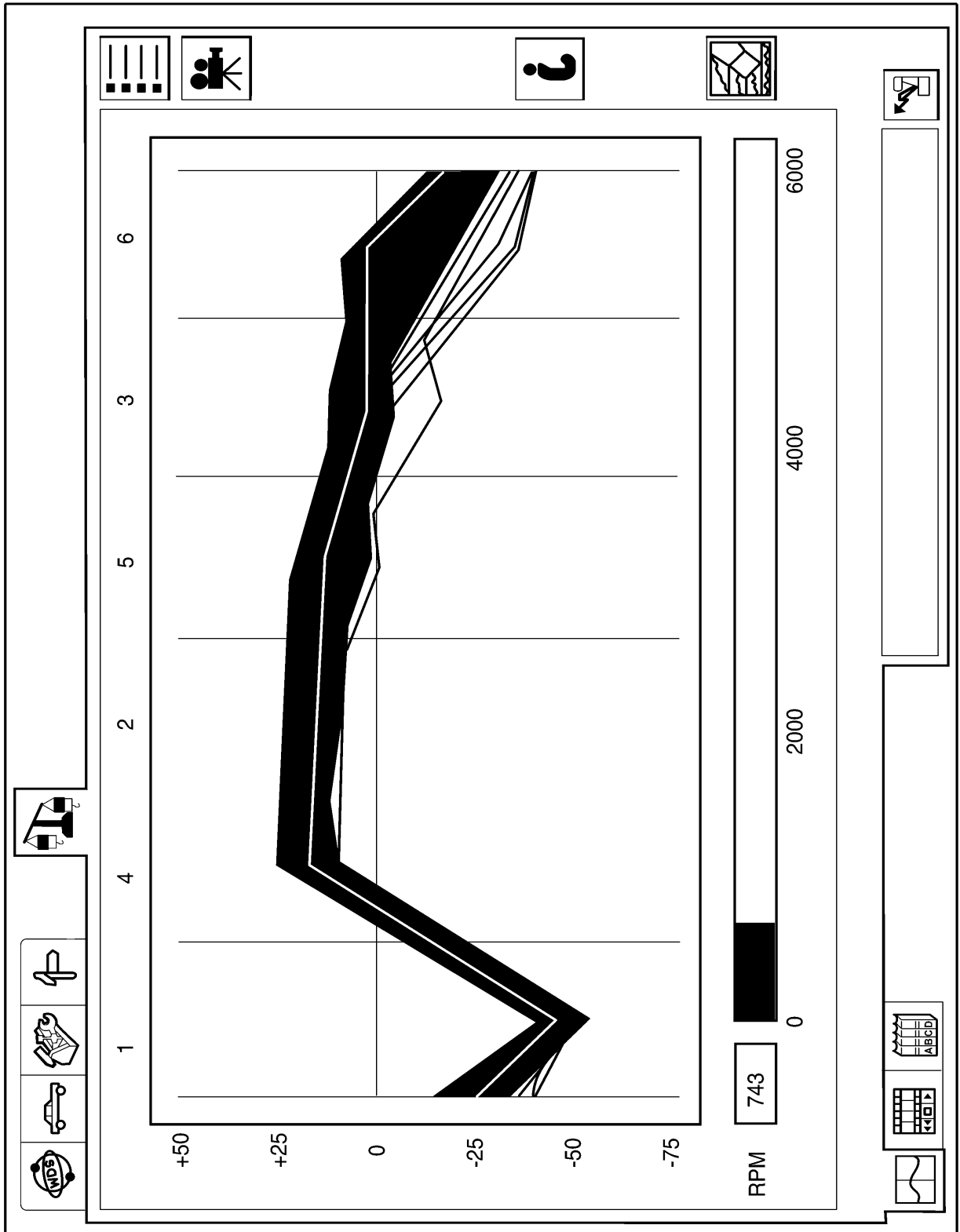
1994 3.8L MUSTANG SHOWN



TB-6853-A

Figure 3 - Article 02-22-1

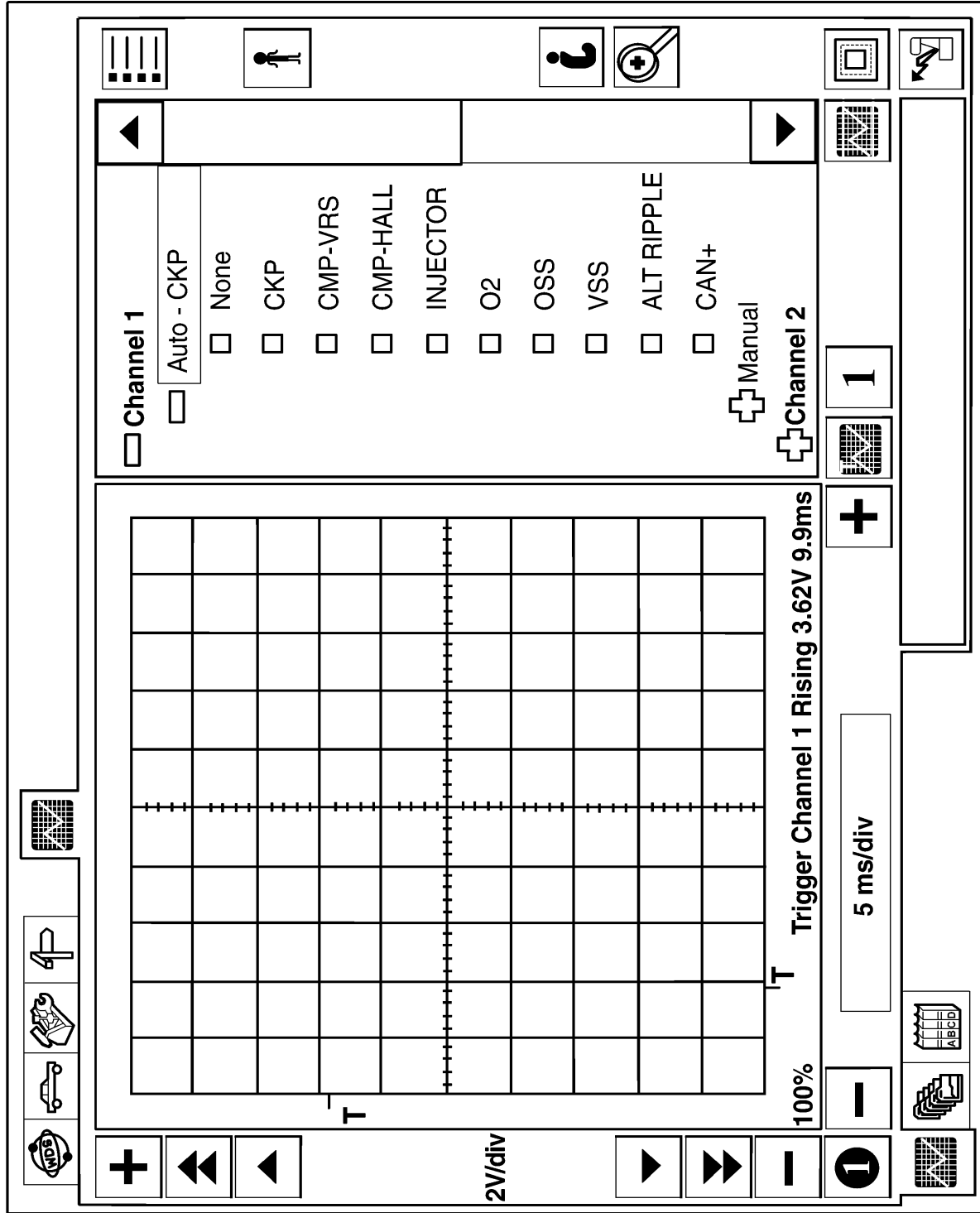
WDS SCREEN SHOWING POWER LOSS IN # 1 CYLINDER



TB-6854-A

Figure 4 - Article 02-22-1

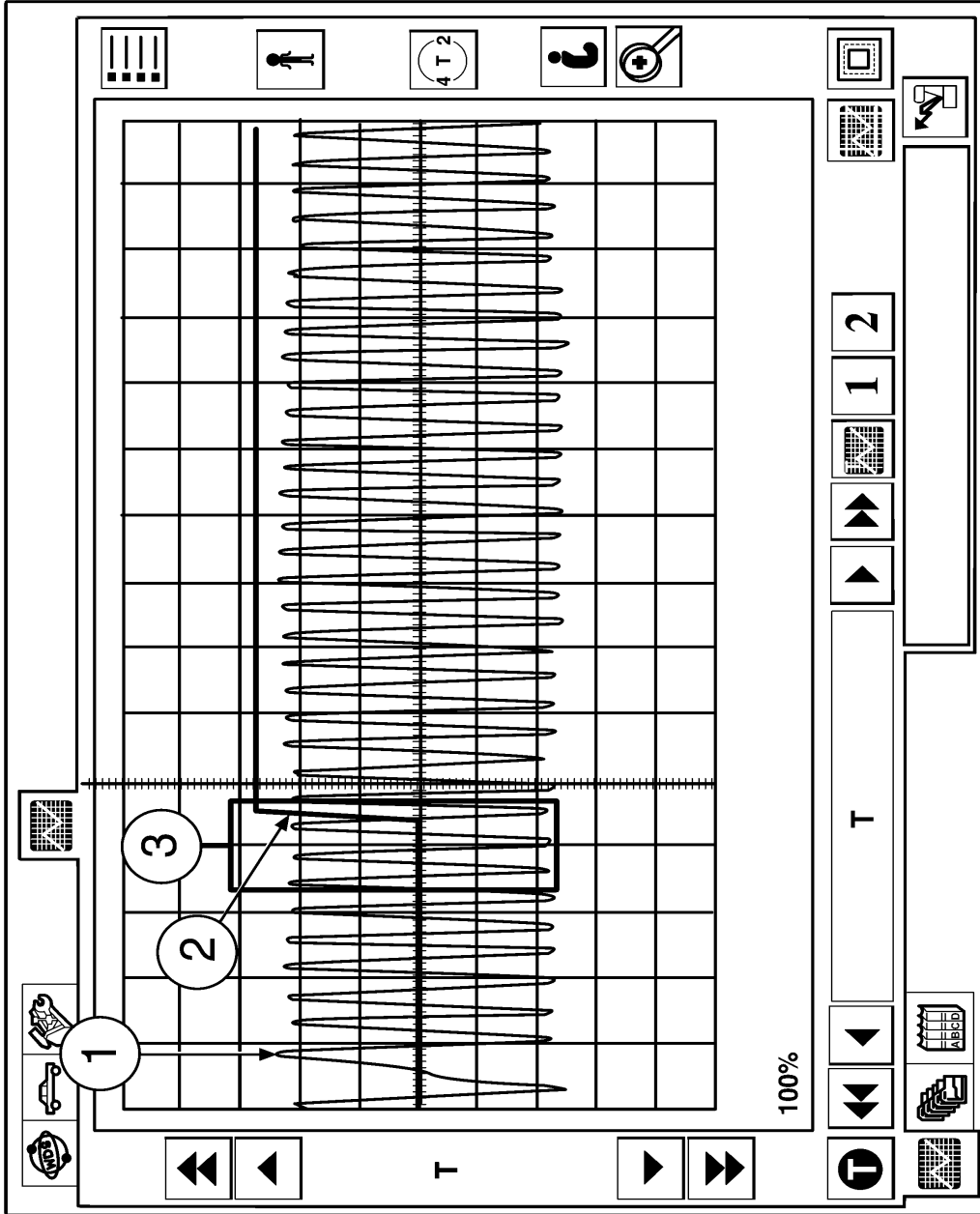
WDS SCREEN SHOWING CKP AND CMP SELECTION IN AUTO MODE



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Figure 5 - Article 02-22-1

WDS SCREEN SHOWING KNOWN GOOD CKP/CMP (3-PIN, HALL EFFECT) WAVE FORMS

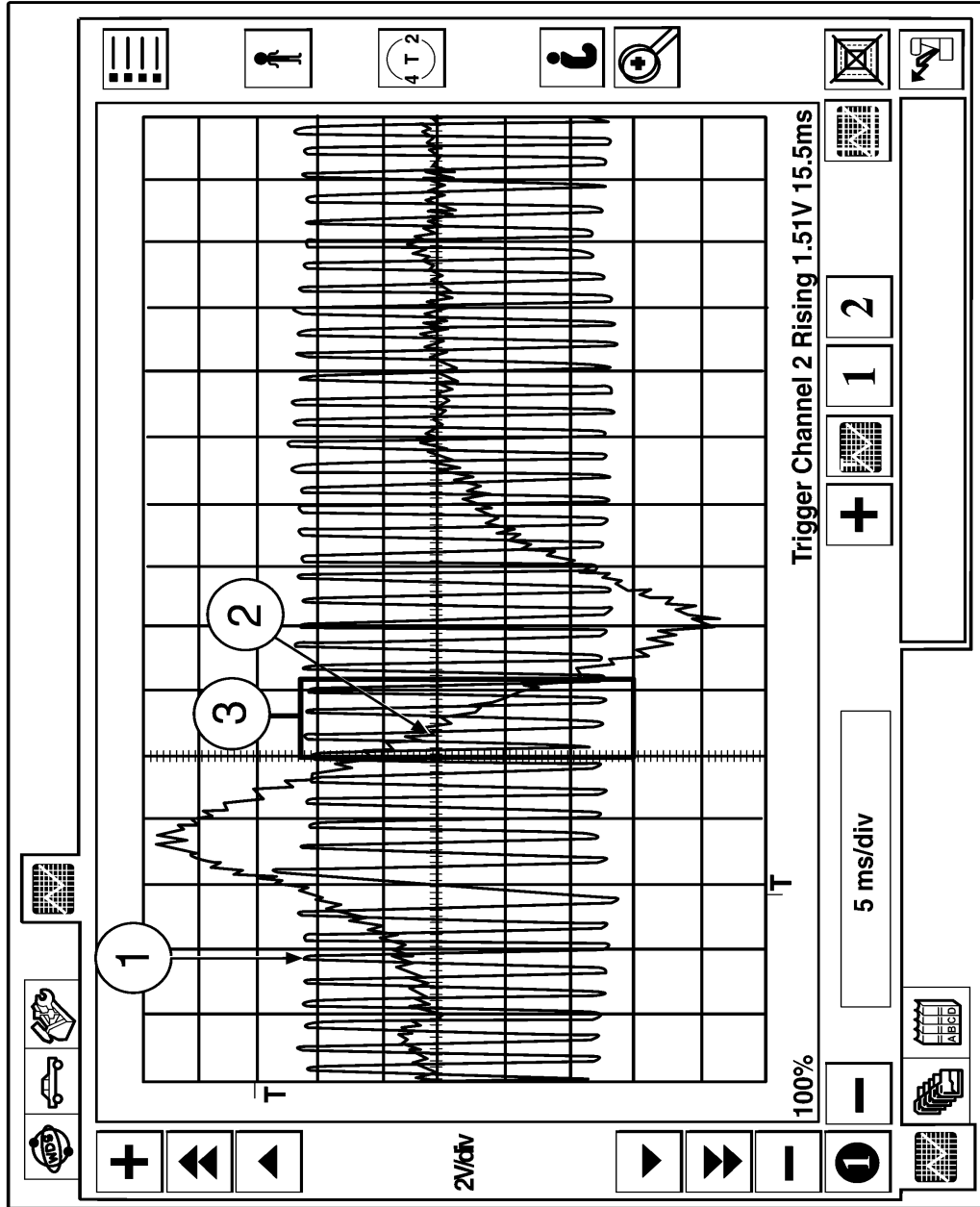


ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	CKP WAVE FORM (APPEARS IN YELLOW ON WDS SCREEN) MISSING TOOTH ON CKP TRIGGER WHEEL (60° BTDC ON THIS 6 CYLINDER APPLICATION)	3	BOX INDICATES ACCEPTABLE RANGE WHERE CMP WAVE FORM RISING EDGE SHOULD OCCUR RELATIVE TO CKP MISSING TOOTH (BETWEEN 7TH AND 10TH PEAK)
2	CMP WAVE FORM RISING EDGE (APPEARS IN RED ON WDS SCREEN)		

TB-6856-A

Figure 6 - Article 02-22-1

WDS SCREEN SHOWING KNOWN GOOD CKP/CMP 5.0L ENGINE (2-PIN, VRS) WAVE FORMS



ITEM	DESCRIPTION	ITEM	DESCRIPTION
1	CKP WAVE FORM (APPEARS IN YELLOW ON WDS SCREEN) MISSING TOOTH ON CKP TRIGGER WHEEL (50° BTDC)	3	BOX INDICATES ACCEPTABLE RANGE WHERE CMP WAVE FORM FALLING EDGE CAN CROSS THE ZERO REFERENCE LINE (BETWEEN 6TH AND 9TH PEAK)
2	CMP WAVE FORM FALLING EDGE (APPEARS IN RED ON WDS SCREEN)		

TB-6858-A

Figure 8 - Article 02-22-1

GEAR DRIVEN CAMSHAFT POSITION SENSOR (CMP) SYNCHRONIZER TOOL APPLICATION CHART

VEHICLES	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Mustang (3.8L)		303-358 T89P-12200-A (Hall)	303-562 T96T-12200-A (Hall)				303-630 (VRS)			
Taurus/Sable (3.0 2V)	Not Applicable (N/A)	303-453 T93P-12200-A (Hall)	303-529 T95T-12200-A (Hall)				303-589 (VRS)			
T-Bird/Cougar (3.8L)		303-358 T89P-12200-A (Hall)	303-562 T96T-12200-A (Hall)				Not Applicable (N/A)			
Windstar (3.0L 2V)	Not Applicable (N/A)	303-529 T95T-12200-A (Hall)				303-589 (VRS)				Not Applicable (N/A)
Windstar (3.8L)	Not Applicable (N/A)	303-358 T89P-12200-A (Hall)	303-562 T96T-12200-A (Hall)				303-630 (VRS)			
Aerostar (3.0 L)	Not Applicable (N/A)	303-529 T95T-12200-A (Hall)					Not Applicable (N/A)			
Aerostar (4.0 L)	Not Applicable (N/A)		303-529 T95T-12200-A (Hall)				Not Applicable (N/A)			
Ranger (3.0L 2V)	Not Applicable (N/A)	303-529 T95T-12200-A (Hall)					303-589 (VRS)			
Ranger (4.0L)	Not Applicable (N/A)		303-529 T95T-12200-A (Hall)			303-638 (VRS)				Not Applicable (N/A)
Explorer (4.0L)	Not Applicable (N/A)		303-529 T95T-12200-A (Hall)			303-638 (VRS)				Not Applicable (N/A)
Explorer (5.0L)	Not Applicable (N/A)		303-562 T96T-12200-A (Hall)			303-630 (VRS)				Not Applicable (N/A)
Mountaineer (5.0L)	Not Applicable (N/A)		303-562 T96T-12200-A (Hall)			303-630 (VRS)				Not Applicable (N/A)
F-150 (4.2L)	Not Applicable (N/A)					303-562 T96T-12200-A (Hall)	303-562 T96T-12200-A (Hall)			
E-150 (4.2L)	Not Applicable (N/A)						303-562 T96T-12200-A (Hall)			

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Figure 9 - Article 02-22-1

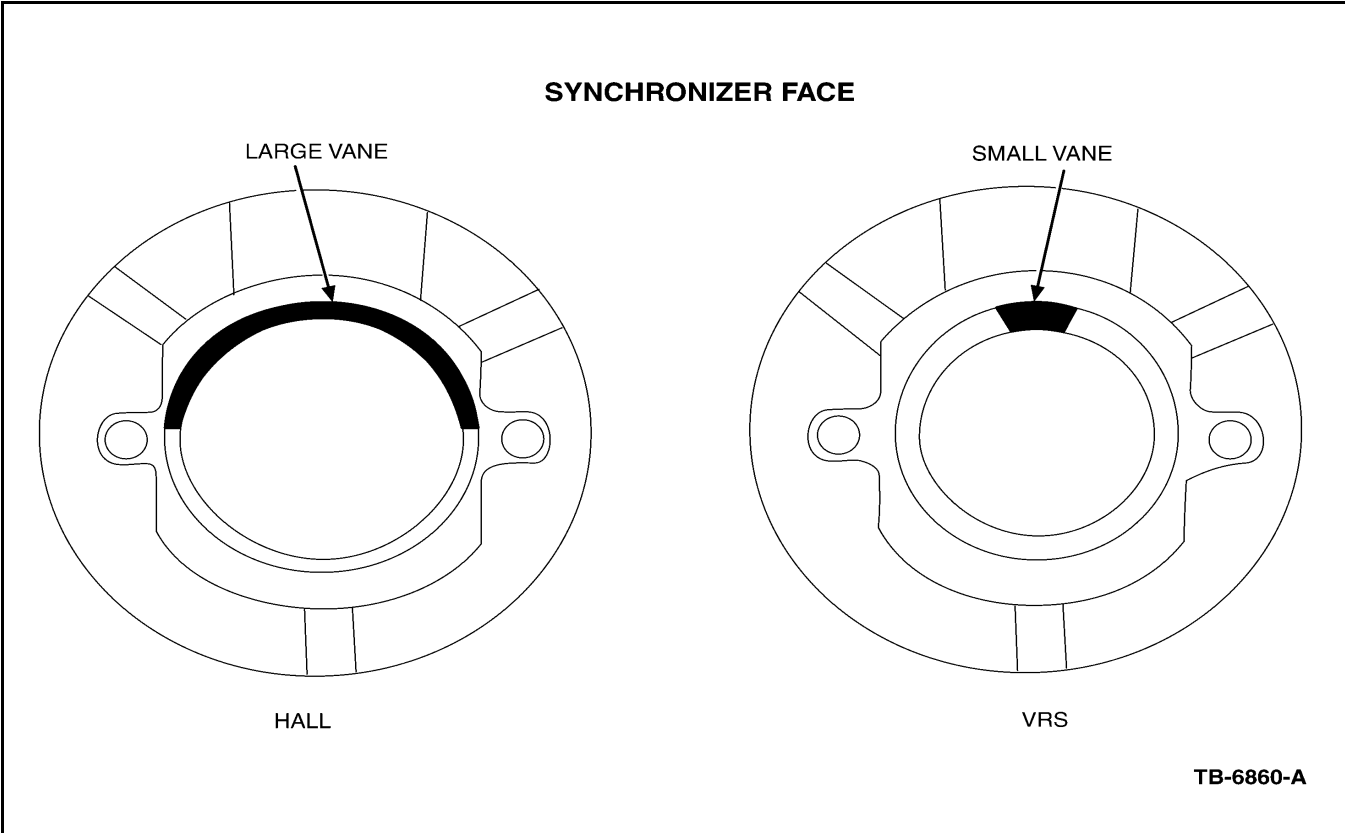


Figure 10 - Article 02-22-1

NOTE: The information in Technical Service Bulletins is intended for use by trained, professional technicians with the knowledge, tools, and equipment to do the job properly and safely. It informs these technicians of conditions that may occur on some vehicles, or provides information that could assist in proper vehicle service. The procedures should not be performed by "do-it-yourselfers". Do not assume that a condition described affects your car or truck. Contact a Ford, Lincoln, or Mercury dealership to determine whether the Bulletin applies to your vehicle.