

A. General

When complaints are received about engine performance, e. g. inadequate output, unsatisfactory starting, high oil consumption, excessive smoke formation, irregular running, etc., checking operations should always include a compression test. Whenever the deviation as between individual cylinders exceeds 1.5 atm. in gasoline engines or 3.0 atm. in diesel

engines a CLT should be used for an additional leakage test.

Both compression and cylinder leakage test should only be performed with the engine warm; when the engine is cold the measurements are unreliable since they do not reflect engine performance under operating conditions.

B. Compression Test

1 Check the tappet clearance and adjust if necessary (see Job No. 00-3).

2 Bring the engine up to normal working temperature (cooling water temperature 70-80°C).

3 Remove the spark plugs or glow plugs. On a diesel engine also unscrew the injection pipes and cover up the injection pump and injection nozzle unions.

4 Turn the engine a few times with the starter to eliminate any oil carbon deposits or soot. This procedure is recommended to prevent soot from clogging the compression recorder.

5 On gasoline engines press the rubber cone of the compression recorder into the spark plug bore of the cylinder to be tested.

On diesel engines screw the connector (1) into the glow plug bore of the cylinder to be tested (Fig. 00-5/1). Tighten well to provide a leak-proof seal. For testing cylinders 2 and 3 attach the angular connector (2) to the connector (1) by means of the cap nut. Then attach the hose (3) of the compression recorder (4) to either the connector (1) or the angular connector (2).

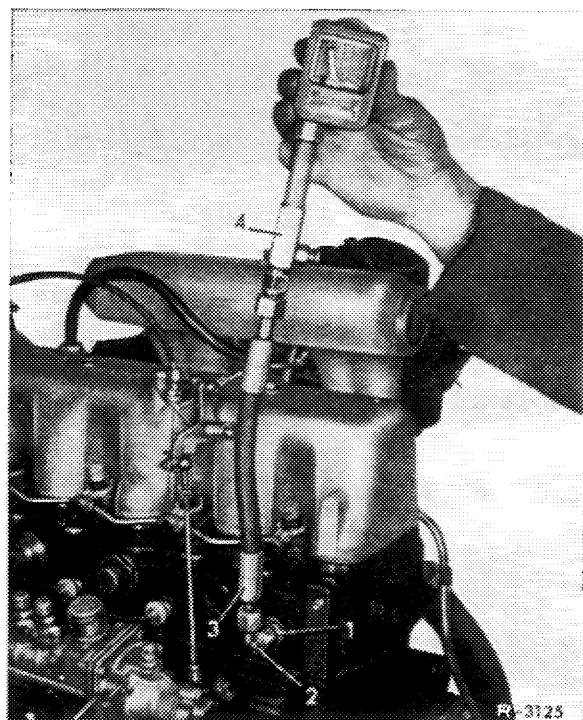


Fig. 00-5/1

1 Connector
2 Angular connector
000 589 00 90 00

3 Movable hose
4 Compression recorder
000 589 69 21 00

6 To measure the compression, turn the engine 8 times by means of the starter, with the throttle valve wide open (gas pedal fully depressed) to ensure a satisfactory cylinder charge.

7 Test all cylinders the same way; remember to turn the chart in the compression recorder before starting on the next cylinder.

Make sure that there is as little difference as possible in the number of times the engine is turned for individual cylinder measurements. (For measuring values see Job No. 00-0). Whenever the deviation as between individual cylinders exceeds 1.5 atm. in gasoline engines or 3.0 atm. in diesel engines, a CLT should be used for an additional leakage test (see Section C).

C. Cylinder Leakage Test

1 With the engine at normal working temperature, remove all spark plugs or glow plugs.

2 Hold the throttle valve or control valve wide open and remove the air cleaner (for escape noise check on intake pipe see para 8).

3 Remove the filler cap from the oil filler neck to check on escape noise from crankcase.

4 Remove the radiator cap; fill up if cooling water is too low for a proper check on air bubbles in the cooling water.

5 Now attach the hose (1) of the cylinder leakage tester (CLT) to the compressed-air supply and calibrate the tester (see operating instructions for tester). Then screw the appropriate connector (6) into the spark plug or glow plug thread of cylinder no. 1 and attach the pressure hose (4) to the free opening of the connector (6).

6 Advance the 1st cylinder piston to ignition dead center by turning the crankshaft in the **direction of rotation** until the TDC mark on the crankshaft or on the balancing disk corre-

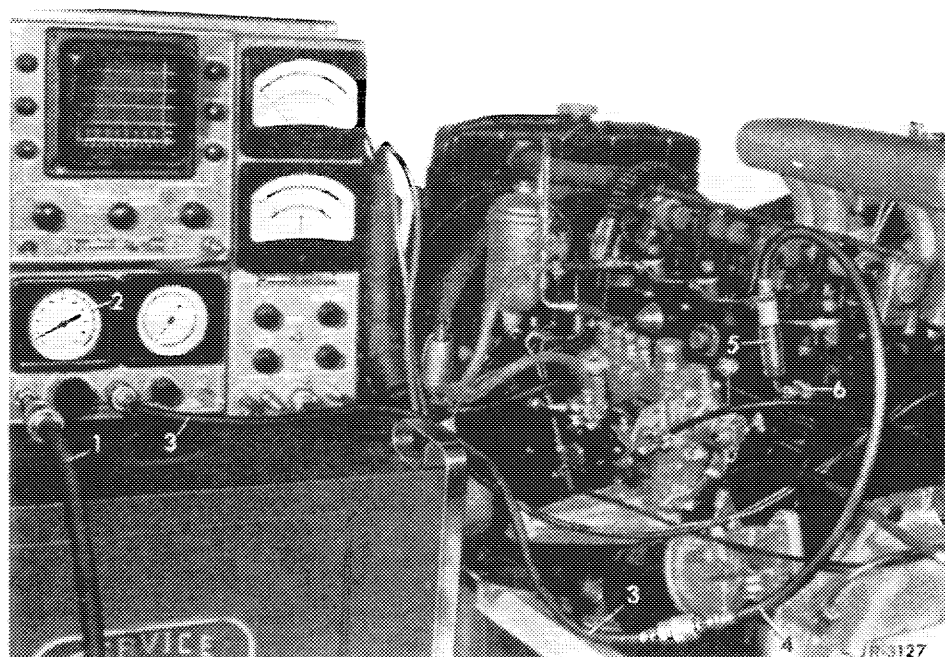


Fig. 00-5/2

- 1 Hose
- 2 Pressure gage of CLT
- 3 Hose
- 4 Hose
- 5 Angle piece
- 6 Connector

sponds with the pointer on the crankcase and both the inlet and the exhaust valve of the 1st cylinder are closed.

7 With the engine stationary couple the CLT pressure hose (4) to the pressure hose (3), making sure that the engine does not turn. Watch the fan during the process and again check the TDC mark.

Caution: If the crankshaft should have moved beyond the dead center in the **direction of rotation** it should be rotated further in the same direction by $1\frac{3}{4}$ -2 turns until the TDC mark on the balancing disk again corresponds with the pointer (see Fig. 00-9/1).

However, if the crankshaft should have moved **contrary to the direction of rotation**, it should be turned in the proper direction until the TDC mark on the balancing disk coincides with the pointer.

Now repeat the procedure described in para 7.

8 Read off "percentage of pressure loss" on the pressure gage (2). Listen carefully to determine whether air escapes through the carburetor or the intake pipe, through the exhaust pipe or the exhaust manifold, or through the crankcase. At the same time watch for air bubbles in the cooling water (for measuring values see Job No. 00-0).

9 Uncouple pressure hoses (3) and (4). Turn the crankshaft until the next piston is at ignition dead center or until the next TDC mark on the balancing disk coincides with the pointer on the crankcase.

Firing order

on 4-cylinder engines 1—3—4—2

on 6-cylinder engines 1—5—3—6—2—4.

Note: For gasoline engines with a TDC mark on the crankshaft balancing disk only for the first cylinder it is advisable to use the angle of closure measuring instrument for determining the ignition TDC of the other cylinders. Attach the angle of closure measuring instrument in the normal way, switch on the ignition, turn the crankshaft until the pointer of the angle of closure measuring instrument drops from the contact resistance position and the piston has practically reached TDC.

For diesel engines it is advisable to use the whistle that goes with the instrument. After

screwing in the connector (6) — see para 5 — add the angle piece (5), insert the hose (4) in the angle piece and attach the whistle to the free end of the hose (4). Turn the crankshaft until the whistle blows (compression stroke); go on turning the crankshaft slowly until the whistle stops (piston is at ignition TDC). Remove the whistle.

10 Unscrew the connector from the tested cylinder and screw it into the cylinder next in firing order. Repeat the procedure described in paras 7, 8 and 9 until all cylinders have been tested.

11 If the recorded pressure loss exceeds the values given in Job No. 00-0, liberally wet the piston head in the cylinder concerned with oil (approx. 100 cc) to eliminate pressure loss above the piston.

Repeat the test.

If the pressure loss still exceeds 5%, the air escapes via leaking valves, defective cylinder head gaskets or cracks in the cylinder head.

Note: A leaking inlet valve can be detected by a blowing noise in the carburetor or the intake pipe.

A leaking exhaust valve can be detected by a blowing noise in the exhaust manifold.

When leaking valves are found check the tappet clearance again; in the case of valves with defective valve rotators (Rotocap) the first procedure is to replace the rotator; the rotating action reseals the valves. Success or failure of this repair should only be tested after about 3000 km. If there is no satisfactory improvement, remove the cylinder head and remachine the valve system.

A leaking cylinder head gasket or cracked cylinder head will be shown up by air bubbles in the cooling water. If the cylinder head gasket has a leak in the web between the two cylinders, there will be a clearly audible blow from the tested cylinder through the open spark plug or glow plug opening of an adjacent cylinder. If that is the case remove the cylinder head and replace the cylinder head gasket. If the gasket is undamaged check the cylinder head for cracks (pressure test with the engine warm).

12 If this reduces the excessive pressure loss from say 35% to a maximum of 5%, the fault must be with the pistons, piston rings, or cylinder working surfaces.

Since there is a chance that pressure may be lost through accidentally superimposed piston ring gaps, it is advisable to postpone larger repairs and to make another leakage test after approx. 1000 km. If the values have not improved, remove the cylinder head, check

the condition of the cylinder working surfaces, in particular check them for wear, and if necessary remove the pistons (see Section D, Evaluation of Cylinder Working Surfaces).

Note: When a cylinder inspection light is available, inspect the defective cylinder.

If scores are found on the cylinder wall, remove the cylinder head.

D. Evaluation of Cylinder Walls

Visual Inspection

Very often it is not easy for repair shops to decide whether scored or streaky cylinder walls are evidence of extensive damage requiring removal or repair of the engine, or of comparatively harmless wear. The following pictures and interpretations will help in solving this problem.

With regard to marks on the cylinder walls the first important difference is between „optical streaks“ and „seizure streaks“. As a rule „optical streaks“ are about 3 mm wide, are produced by the piston ring gaps and do not destroy the honing structure; „seizure streaks“, however, obliterate the honing structure. Figs. 00-5/3 to 6 show a variety of typical damage patterns.

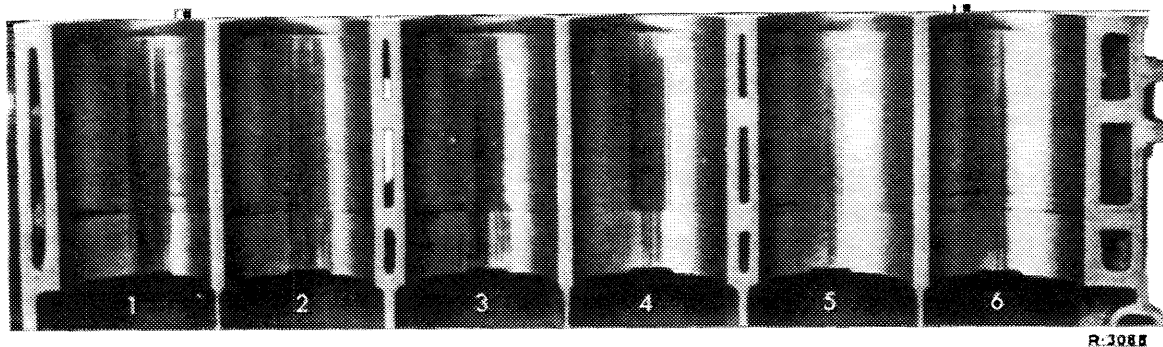


Fig. 00-5/3

- | | |
|-------------------|--|
| Cylinders 1—3 | Piston shaft has seized. Honing structure is destroyed. Engine must be removed. |
| Cylinder 4 | Oil ring and piston shaft seizure. Honing structure is destroyed. Engine must be removed. |
| Cylinders 5 and 6 | Piston shaft is scratched. Honing structure not destroyed. Engine can remain in operation. |

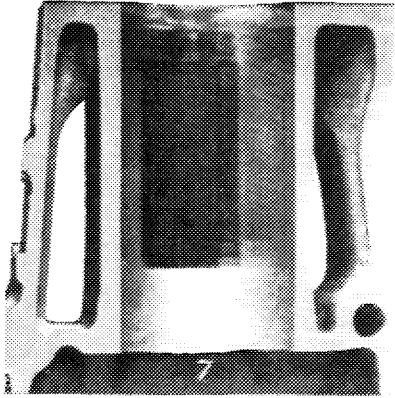


Fig. 00-5/4

Ring seizure in longitudinal direction, approx. 30 mm wide. The step produced by the oil ring can clearly be seen. Honing structure is destroyed. Engine must be removed.

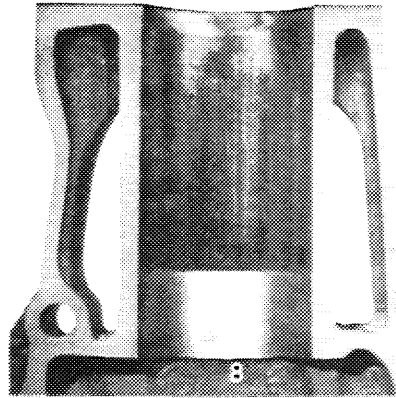


Fig. 00-5/5

Oil ring seizure extended around total half of cylinder bore. Honing structure is destroyed. Engine must be removed.

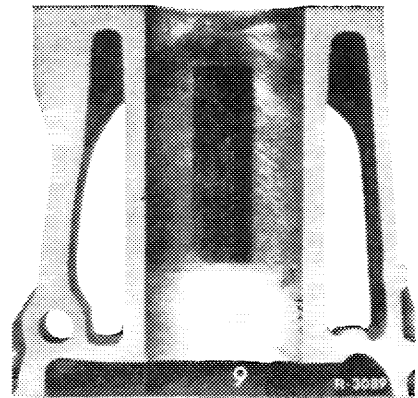


Fig. 00-5/6

Medium oil ring seizure. Honing structure still clearly visible. Engine can remain in operation.

Note: "Longitudinal streaks" (in the piston pin direction) cannot be caused by shaft scratches or seizure, since there is no contact between piston skirt and cylinder wall.

In case of complaints please enclose Examination Sheet of cylinder bores - OF 650 09 057 00a - with guarantee and goodwill claim form.

The examination sheet should contain the following details:

cylinder affected

width of streaks

height of streaks: up to first ring
up to oil ring
piston skirt

position of streaks: right front
(pressure side)
left rear
(counterpressure side)

The Examination Sheets can be obtained in the usual way under Order No. OF 650 09 057 00a.

b) Measuring of Cylinder Bores

In addition to the visual inspection, measuring of the cylinder bores is imperative, in particular when complaints are received about "high oil consumption". Use an internal micro-

meter to measure the cleaned cylinder bores at the 6 measuring points or when the pistons have not been removed and are at bottom dead center at measuring points 1, 2 and 3 (Fig. 00-5/7); measurements should be taken once in the piston pin axis direction (transverse direction A) and then in the vertical direction B. Measuring point 3 is just above the piston at BDC.

Any degree of out-of-roundness of 0.04 mm or above, any major wear in the center of the cylinder, i.e. 0.03 mm at measuring points 3 and 4 as compared with measuring point 6, or any general wear of approx. more than 0.12 mm between measuring points 1 and 6 or the original bore are bound to increase oil consumption. For high oil consumption see also Job. No. 00-50.

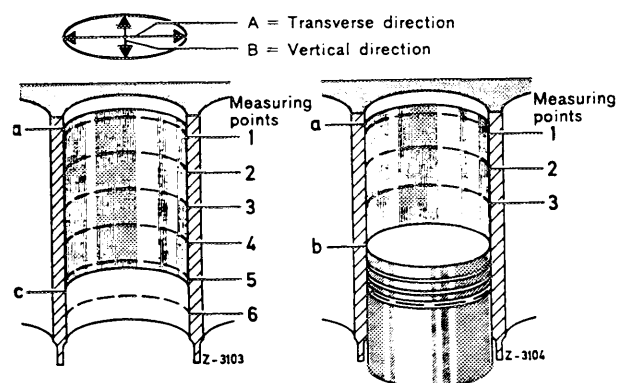


Fig. 00-5/7

a top reversal point of 1st piston ring
b bottom dead center of piston

c bottom reversal point of scraper ring

Note: 0.01 mm wear per 10 000 km can be considered normal as a comparative measurement between measuring point 1 (directly below the top reversal point (a) of the first

piston ring) and measuring point 6 (below the bottom reversal point (c) of the scraper ring).

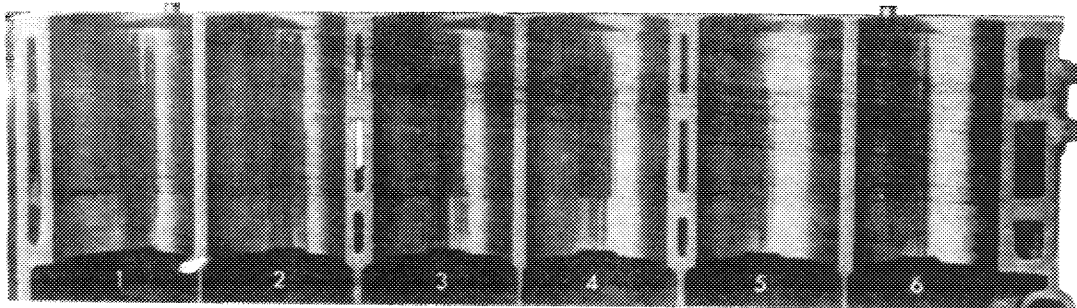
Befundblatt Zylinderbohrungen
Examination Sheet of Cylinder Bores
Bulletin d'examen des parois de cylindres
Hoja de comprobación de cilindros



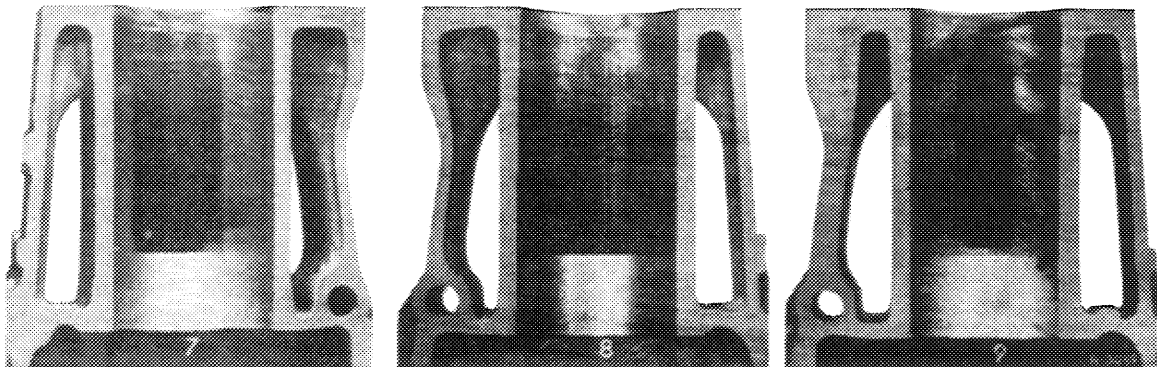
Besitzer Owner Propriétaire Proprietario

2) Niederlassung/Vertretung

3) Tag					4) Rep.-Auftrag Nr.
5) Platz	6) Pol. Kennzeichen	7) Erstzulassung	8) Typ	9) Fahrgestell-Nr.	10) Tachometerstand
11) Kopie	12) Eingebracht durch	13) Angenommen Zeit	14) Angenommen durch	15) Motor-Nr.	16) Unverbindl. Termin



- Zyl. 1-3 Kolbenschaft hat gefressen. Honbild ist zerstört. Motor muß ausgebaut werden.
 Zyl. 4 Kolbenschaftfresser und Ölringsfresser. Honbild ist zerstört. Motor muß ausgebaut werden.
 Zyl. 5-6 Kolbenschaft aufgerissen. Honbild noch durchgehend erhalten. Motor kann weiterlaufen.
 Cylinder 1-3 Piston shaft has seized. Honing structure is destroyed. Engine must be removed.
 Cylinder 4 Piston shaft and oil ring seizure. Honing structure is destroyed. Engine must be removed.
 Cylinder 5 and 6 Piston shaft is scratched. Honing structure not destroyed. Engine can remain in operation.
 Cylindres 1 à 3 Jupe de piston grippée. Glaçage endommagé. Le moteur doit être déposé.
 Cylindre 4 Jupe de piston et segment racleur grippés. Glaçage endommagé. Le moteur doit être déposé.
 Cylindres 5 et 6 Jupe de piston gratté. Glaçage encore en bon état. Le moteur peut continuer à être utilisé.
 Cilindros 1-3 El pistón se ha agarrotado. Ya no existen señales del bruñido. Hay que desmontar el motor.
 Cilindro 4 Agarrotamiento del pistón y del aro rascador de aceite. Ya no existen señales del bruñido. Hay que desmontar el motor.
 Cilindros 5-6 Pistón desgarrado. Existen señales completos del bruñido. Motor puede seguir trabajando.



- Stegseitiger Ringfresser ca. 30 mm breit. Deutlich ist der Absatz durch den Örling erkennbar. Honbild ist zerstört. Motor muß ausgebaut werden.
 Ring seizure in longitudinal direction, approx. 30 mm wide. The step produced by the oil ring can clearly be seen. Honing structure is destroyed. Engine must be removed.
 Grippage du segment du côté paroi mitoyenne sur une largeur d'env. 30 mm. On reconnaît clairement l'épaule provoqué par le segment racleur. Glaçage endommagé. Le moteur doit être déposé.
 rotamiento de los aros en el lado del alma de material entre los cilindros de aprox. 30 mm de anchura. Se puede ver claramente la interrupción que proviene del aro rascador de aceite. Ya no existen señales del bruñido. Hay que desmontar el motor.
- Ringfresser vom Örling auf die gesamte Zylinderhälfte ausgedehnt. Honbild ist zerstört. Motor muß ausgebaut werden.
 Oil ring seizure extended around total half of cylinder bore. Honing structure is destroyed. Engine must be removed.
 Le grippage du segment racleur s'est étendu sur toute la moitié du cylindre. Glaçage endommagé. Le moteur doit être déposé.
 El agarrotamiento que proviene del aro rascador de aceite se ve en todo su recorrido del cilindro. Ya no se ven las señales del bruñido. Hay que desmontar el motor.
- Mittelstarker Ölringsfresser. Honbild ist noch deutlich sichtbar. Motor kann weiterlaufen.
 Medium oil ring seizure. Honing structure still clearly visible. Engine can remain in operation.
 Grippage d'importance moyenne du segment racleur. Glaçage encore bien visible. Le moteur peut continuer à être utilisé.
 Agarrotamiento mediano que proviene del aro rascador de aceite. Se ven aún claramente las señales del bruñido. Motor puede seguir trabajando.

- | | | | | |
|---|--|---|---|--|
| 2) Brand/Agency
Succursale/Représentation
Sucursal/Representación | 3) Date
Date
Fecha | 4) Repair Order No.
No. d'ordre de réparation
No. de la orden de reparación | 5) Place
Place
Puesto | 6) License Number
No d'immatriculation
Matrícula |
| 7) Original Registration
Première immatriculation
Primera matriculación | 8) Model
Type
Tipo | 9) Chassis No.
Châssis No.
No. del chasis | 10) Speedometer Reading
Kilométrage
Kilometraje | 11) Copy
Copie
Copia |
| 12) Delivered by
Remis par
Entregado por | 13) Time of Reception
Heure de réception
Hora de recepción | 14) Received by
Réceptionné par
Recibido por | 15) Engine No.
No de moteur
Motor No. | 16) Date, not binding
Prêt le, sans engagement
Plazo, sin compromiso |

Zyl. 1

6	6
5	5
4	4
3	3
2	2
1	1

OT TDC PMH PMS

UT BDC PMB PMI

Auch hier Befund
einzeichnen
Fill in seizure
marks here too
Marquer ici aussi
le résultat d'examen
Añóte también
aquí el resultado

UT BDC PMB PMI

OT TDC PMH PMS

Es bedeuten
gefressen
aufgerissen
Streifen
blank

Identification
seized
scratched
streaks
smooth

Légende du marquage
grippé
gratté
rayé
poli

Significación
agarrado
desgarrado
rayado
pulido