

TM 9-4910-477-10

DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR'S MANUAL

**TESTER,
INTERNAL COMBUSTION ENGINE,
VACUUM AND PUMP PRESSURE,
0 TO 8 LBS PRESSURE
AND 0 TO 27 INCHES VACUUM
(CENTURY TOOL COMPANY MODEL 27-12)
(4910-55-8673)**

This copy is a reprint which includes current
pages from Changes 1.



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30 DECEMBER 1966

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DEPARTMENT OF THE ARMY
WASHINGTON, D.C., 30 December 1966

TM 9-4910-477-10 is published for the use of all concerned.

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CML Arctic Test Actv,	Regt/Gp/BG (2)
Ft Greely (1)	Bn (2)
CML Tropical Test Actv,	Co/Btry (1)
Canal Z (1)	

NG: State AG (3); TOE Units 9-7, 9-9, 9-12, 9-57, 9-76, 9-127, 9-197 (1).

USAR: None.

For explanation of abbreviations used, see AR 320-50.

CHANGE

No. 1

HEADQUARTERS
DEPARTMENT OF THE ARMY
WASHINGTON, DC, 7 May 1973

Operator's Manual

**TESTER,
INTERNAL COMBUSTION ENGINE:
VACUUM AND PUMP PRESSURE,
0 TO 8 LBS PRESSURE
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(CENTURY TOOL COMPANY, MODEL 27-12)
(4910-255-8673)**

TM 9-4910-477-10, 30 December 1966 is changed as follows:

Page before APPENDIX. Add the following paragraphs:

Reporting of Equipment Publication Improvements

The reporting of errors, omissions, and recommendations for improving this publication by the individual user is encouraged. Reports should be submitted on DA Form 2028 (Recommended Changes to Publications) and forwarded direct to: Commander, US Army Weapons Command, ATTN: AMSWE-MAS-SP, Rock Island, IL 61201.

Components of the End Item

Parts included with the end item and considered as components of the end item configuration are listed in Table 1.

Table 1. Components of the End Item

<i>Components</i>	<i>Part No. (FSCM)</i>
ADAPTER, MANIFOLD: female, inverted flare, 1/4-24NF-2 thd	830-1/2 (99463)
ADAPTER, MANIFOLD: female, inverted flare, 1/16-24NF-2 thd	830-7/16 (99463)
ADAPTER, MANIFOLD: female, inverted flare, 1/4-20NF-2 thd	830-1/2 (99463)
ADAPTER, MANIFOLD: male, flared, 1/16-24NF-2 thd	834-5/16 (99463)
ADAPTER, MANIFOLD: male, bared, 1/2-20NF-2 thd	834-1/2 (99463)
ADAPTER, MANIFOLD: male, plain, 1/4-27NPT thd	827-1/4 (99463)
ADAPTER, MANIFOLD: male, plain, 1/4-18NPT thd	827-1/4 (99463)
ADAPTER, MANIFOLD: male, plain, 1/2-18NPT thd	827-1/2 (99463)
CASE, CARRYING: S, 4 w, 7 lg, 2 h, hinged, w/snap latch	27-12C (99463)
GAGE: DIAL: vacuum and pressure, 2 1/2 dia face, w/27 in. vacuum increments and 8 pressure increments	27-12G (99463)
HOSE, AIR: rubberized fabric, 50 in. lg, 1/4 id	27-12H (99463)

The Appendix (BASIC ISSUE ITEMS LIST) is superseded as follows:

**APPENDIX
BASIC ISSUE ITEMS LIST
AND
ITEMS TROOP INSTALLED OR AUTHORIZED LIST**

Section i. INTRODUCTION

1. Scope.

This appendix lists basic issue items and items troop installed or authorized required by the crew/operator for operation of the tester, internal combustion engine.

2. General

This Basic Issue Items List and Items Troop Installed or Authorized List is divided into the following sections:

a. Basic Issue Items List. Not applicable.

b. Items Troop Installed or Authorized List. Not applicable.

3. Explanation of Columns

The following provides an explanation of columns found in the tabular listings:

a. Federal Stock Number. Indicates the Federal stock number assigned to the item and will be used for requisitioning purposes.

b. Description. Indicates the Federal item name and a minimum description required to identify the item. The last line indicates the reference number followed by the applicable Federal Supply Code for Manufacturer (FSCM) in parentheses. The FSCM is used as an element in item identification to designate manufacturer or distributor or Government agency, etc., and is identified in SB 70842. Items that are included in kits and sets and listed below the name of the kit or set with quantity of each item in the kit or set indicated in front of the item name.

c. Unit of Measure (U/M). Indicates the standard or basic quantity by which the listed item is used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation, e.g., ea, in., pr, etc., and is the basis used to indicate quantities. When the unit of measure differs from the unit of issue, the lowest unit of issue that will satisfy the required units of measure will be requisitioned.

d. Quantity Furnished with Equipment (Basic Issue Items Only). Indicates the quantity of the item furnished with the equipment.

e. Quantity Authorized (Items Troop Installed or Authorized Only). Indicates the quantity authorized to be used with the equipment.

f. Illustration (Basic Issue Items Only). This column is divided M follows:

(1) *Figure Number.* Indicates the figure number of the illustration in which the item is shown.

(2) *Item Number.* Indicates the item number used to identify each item called out in the illustration.

By Order of the Secretary of the Army:

CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:

VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution :

Active Army:

DCSLOG (3)	Bn (2)
CNGB (1)	Co/Btry (1)
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COE (2)	USACMLCS (1)
Dir of Trans (2)	USAOC&S (3)
ACSC-E (1)	USAARMS (3)
USA Arty Ed (1)	USATSCH (3)
CONARC (3)	AD (3)
ARADCOM (2)	Arsenals (2)
ARADCOM Rgn (2)	PG (1)
AMC (2)	ATS (1)
WECOM (10)	MAAG : Greece (2)
AVSCOM (3)	Vietnam (3)
USACDCEC (10)	BAMC (1)
OS Maj Comd (3)	USATTC (1)
USASETAF (1)	USACOMZEUR (3)
LOGCOMD (3)	Ft Knox FLDMS (10)
MDW (1)	Cml Arctic Test Actv
Armies (3) except	Ft Greeley (1)
seventh (5)	Cml Desert Test Actv
Eighth (5)	Yuma (1)
Div (2)	Cml Tropical Test
Bde (2)	Actv, CZ (1)
Regt/Gp/BG (2)	

ARNG: State AG (3).

USAR: None.

For explanation of abbreviations used, see AR 810-60.

APPENDIX

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

1. General

This appendix is a list of basic issue items. It is composed of those items which make up the major end item of equipment and the operator's tools and equipment that are issued with the equipment and are required for stockage.

2. Requisitioning a part to which FSN has not been assigned

When requisitioning a C source (local procurement) item identified only by a manufacturer's part number, it is mandatory that the following information be furnished the supply officer:

a. Manufacturer's code number (5 digit number preceding the colon in the descriptive column).

b. Manufacturer's part number (the number, and sometimes letters, following the colon, ((a) above). Dashes, commas, or other marks must be included exactly as listed.

c. Nomenclature exactly as listed herein, including dimensions if necessary.

d. Name of manufacturer of end item (from cover of TM or manufacturer's name plate).

e. Federal stock number of end item (from TM).

f. Manufacturer's model number (from TM or name/data plate, preferably name/data plate).

g. Manufacturer's serial number (from name/data plate).

h. Any other information such as type, frame number, and electrical characteristic, if applicable.

i. If DD Form 1348 is used, fill in all blocks except 4, 5, 6, and Remarks field, in accordance with AR 725-50. Complete form as follows:

- (1) In blocks 4, 5, and 6, list manufacturer's code and manufacturer's part number (as listed in description column) .

- (2) In Remarks field, list noun name (repair part), end item application (FSN of end item), manufacturer, model number (end item), serial number (end item), and any other pertinent information such as frame number, type, etc.

3. Explanation of Columns

a. **Source, Maintenance, and Recoverability Code (Col. 1).**

- (1) **Materiel numerical codes (col. 1a).** This column is not required.
- (2) **Source (col. 1b).** This column indicates the selection status and source for the listed item. Source code used in this list is:

<i>Code</i>	<i>Explanation</i>
C	Obtain through local procurement. If not obtainable from local procurement, requisition through normal supply channels with a supporting statement of nonavailability from local procurement.

- (3) **Maintenance level (col. 1c).** This column indicates the category of maintenance authorized to install the listed item. Maintenance level code used in this list is:

<i>Code</i>	<i>Explanation</i>
C	Operator or crew maintenance.

- (4) **Recoverability (col 1d).** This column indicates whether unserviceable items should be returned for recovery or salvage. When no code is indicated, the item will be considered expendable. Recoverability code used in this list is:

<i>Code</i>	<i>Explanation</i>
R	Items which are economically repairable at direct and general support maintenance activities and are normally furnished by supply on an exchange basis.

b. **Federal Stock Number (Col. 2).** Self explanatory.

c. **Description (Col. 3).** This column indicates the Federal item name (shown in capital letters) and any additional description required for supply operations. The manufacturer's code and part number are also included for reference.

<i>Code</i>	<i>Explanation</i>
82078:	Century Tool Company

d. **Unit of Issue (Col. 4), Quantity Authorized (Col. 5), and Illustrations (Col. 6).** Self explanatory.

VACUUM GAUGE 6 PUMP TESTER MODEL NO. 27-12

Connect the vacuum gauge hose to the intake manifold. On many engines there is a plug in the intake manifold which can be removed. If this is the case, remove the plug, screw the proper fitting in its place and connect the hose to it. On engines which do not have plugs, remove the windshield wiper hose, and connect the vacuum gauge hose in its place. However, if there is a vacuum booster pump on the engine, disconnect the pump and connect the vacuum gauge hose to the intake manifold where the booster pump was disconnected from it.

The Vacuum Gauge is an accurate means of adjusting ignition timing. With the motor at a fast idle, advance the ignition timing so as to get the highest possible steady reading on the Vacuum Gauge. Now retard so that the needle on the gauge just begins to drop. Now the question of detonation or "ping" enters the picture. If the cooling system is functioning properly, the spark plugs are not too hot, the combustion chamber is not insulated by a carbon mixture, the carburetor mixture is right, and the mixture from the carburetor has the proper turbulence in the combustion chamber, this is the proper timing position. Unfortunately, in many instances, one or more of the above mentioned conditions exist, and we must set the ignition timing to compensate for them. To do this, short out the cylinders by clipping the differential leads to the spark plugs until the motor is working on two cylinders. We are now able to duplicate a load tendency of the motor to detonate or "ping". Retard the timing till the motor does not "ping", and the timing is now set to eliminate detonation.

CYLINDER BALANCE TEST

Pairs of cylinders can be placed under load by shorting out the plugs of the other cylinders after opening the throttle valve and locking it in place. If two cylinders are able to run the engine against the compression of the others, it indicates that the ignition is not missing, that the carburetor high speed and power circuits are working and that compression must be at least in fair condition. Compare the vacuum readings while running on different pairs of cylinders.

On 4 cylinder engines, set the throttle so the engine will run about 900 rpm with all cylinders operating. Then run on the following pairs with the other cylinders grounded out.

Run on cyl. 1 and 4. Run on cyl. 2 and 3

On 6 cylinder engines fix the throttle at about 1000 rpm with all cylinders operating. Then run on the following pairs with the remaining cylinders grounded out.

Run on cyl. 1 and 6 Run on cyl. 2 and 5
Run on cyl. 3 and 4

On 8 cylinder engines fix the throttle at about 1500 rpm running on all cylinders. Then run on the following pairs with the other cylinders grounded out.

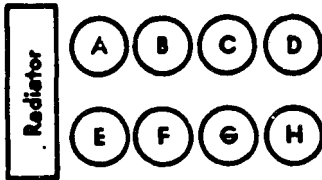
Run on cyl. 1 and 8 Run on cyl. 3 and 6
Run on cyl. 2 and 7 Run on cyl. 4 and 5

The manufacturers of V-8 Engines use several different methods of numbering the cylinders. To decrease the confusion we have used a lettering system (see illustration)

which applies to all V-8 engines regardless of which cylinder the manufacturer has designated as number one. On V-8 engines, ground out all the other cylinders and run on the following pairs.

Run on cyl. A and F Run on cyl. D and G

Run on cyl. B and H Run on cyl. C and E



1. When the pointer is low but steady, the trouble is something which affects all cylinders alike. This could be late ignition timing, late valve timing, or loose tappets. Such troubles can be responsible for the reading being anywhere from $\frac{1}{4}$ to 2 inches low. Intake system leaks (warped intake manifold, leaky manifold gasket, leaky carburetor flange gasket, poorly seating intake valves and leaky intake guides) can be responsible for the reading being anywhere from $\frac{1}{4}$ to 16 inches low depending on the size of the leak.

2. When the pointer pulses regularly, the trouble is something which affects one particular cylinder consistently; for instance, one exhaust valve which does not seat, one exhaust tappet which is too tight, or one sticky valve, or one dead spark plug. The pulses of the pointer are much greater if they are caused by some form of leakage such as exhaust valve not seating, rather than something which only slows the pistons such as a dead spark plug.

3. An unsteady pointer may be caused by defects occurring irregularly and in several or all of the cylinders. Other defects which are responsible for an unsteady pointer are loose distributor governor springs, rich carburetor mixture, extremely advanced or retarded spark, wide spark plug gaps, ignition points not synchronized, or intake valves shifting on their seats.

4. If the pointer is unsteady and if the sweeps of the pointer increase with increases in speed, the trouble is weak or broken valve springs. If the sweeps get smaller but more rapid on increasing the speed, the trouble is in intake system leaks. If the pointer steadies on increasing speed, the trouble is ignition, faulty distributor weights, or carburetion.

5. This is a normal reaction when the throttle valve is opened and closed. If the pointer does not respond with wide sweeps, it is an indication that leakage exists. If the possibilities of leakage through poorly seating valves, manifolds, gaskets, etc. have been exhausted, then the piston rings are not sealing properly.

6. (1) When the distributor is advanced to the highest steady reading and then retarded so the pointer is $\frac{1}{4}$ to $\frac{1}{2}$ inch below the highest steady reading, and (2) if the pointer is within specifications and holding steady after making this adjustment and (3) if the ignition is in time after checking with a timing light after making this adjustment, the engine can be considered to be in time. Allow one inch less for each 1000 feet of elevation.

NORMAL REACTIONS

18 to 22 inches is usually referred to as the normal range for a warmed up engine at idle speed, but with greater and greater degrees of valve overlap, this range is becoming meaningless. Some car manufacturers are now specifying 15 inches as a normal vacuum reading during engine idle. The specifications for the car under test should be checked. If with proper tune-up a particular engine could be adjusted to 21 inches of vacuum, it would be considerably out of tune if the vacuum were adjusted to only 19 inches; despite the fact that 19 is within the so called normal range.

To adjust ignition timing with a vacuum gauge, loosen the distributor set screw and advance to the highest STEADY reading. Then retard

enough so the reading is $\frac{1}{4}$ to $\frac{1}{2}$ inch below the highest steady reading. An intake system leak will also lower the reading but it may be so small that the pointer may still be within the so called normal range. More will be said about intake system leaks and timing later, but at the moment, we wish to emphasize (1) that the higher the vacuum gauge reading, the better; provided the ignition is not so far advanced that the engine "pings" under normal acceleration and (2) that an engine is not necessarily in perfect working order just because the vacuum reading is within the so called normal range on the gauge.

Normal steadiness of the gauge pointer varies according to the number of cylinders in the engine. On four cylinder engines, the intake strokes do not overlap. The vacuum gauge responds to this with an even rippling motion of the pointer. On six cylinder engines, there is only a faint trace of this rippling and on 8 cylinder engines, it is almost non-existent, except on engines which have overlapping valve timing. The best way to become familiar with a normal steady reading is to connect the gauge to engines known to be in good operating condition and then to study the readings.

Responses of the gauge to movements of the throttle valve are much more exaggerated in a driving test than in a floor test, but in either case, the vacuum will fall off when the throttle is suddenly opened and it will rise when the throttle is suddenly closed. In a floor test, it is normal for the pointer to oscillate between approximately 3 and 25 inches as the throttle is suddenly opened and closed. If the vacuum gauge does not respond in this way, it is an indication that leakage exists either in the form of poorly seating valves or in the form of poorly sealing piston rings.

REACTION TO SPEED CHANGES

A low reading on the gauge may indicate late ignition timing. A high unsteady reading may indicate advanced timing.

Just as a vacuum gauge may be used to adjust ignition timing, it may also be used, in much the same manner, to adjust the idle screw in a carburetor by richening the mixture to the highest steady reading. Thus, a faulty carburetor adjustment will affect the vacuum reading.

Valve timing too, affects vacuum gauge readings. Valve timing can be late because of improper installation of timing gears but more common than this, tappets are set too loose causing the valves to open late (and close too early). This condition would reduce power considerably. Consequently, the speed of the pistons would be slowed and this would be still another reason why the vacuum gauge reading might be low.

Speed of the pistons will be slowed by anything that reduces power, such as shorted spark plugs, leaky ignition wires, or any of a number of ignition difficulties which may ground out a cylinder. To learn the effect of a dead cylinder, connect the vacuum gauge to an engine and short out first one, then two spark plugs, etc. and study the effect. You may be surprised by the small reduction in speed and vacuum at idle speed by shorting out only one cylinder, especially on an 8 cylinder engine. The reduction is greater on a 6 cylinder engine and quite noticeable on a 4 cylinder engine.

REACTIONS TO LEAKAGE

It should be understandable that a leak in any of the passageways between the carburetor and the cylinders will interfere with the flow of air and fuel from the carburetor to the cylinders. Defects of this nature affect the speed of the pistons too; but much more directly they interfere with the actual creation of the vacuum. A leak in the manifold gasket (depending on its size) can be responsible for a reading anywhere from slightly above zero to slightly below normal. Leakage into the manifold has much more effect on the gauge reading than defects that affect speed only. A very tiny leak will lower the vacuum reading considerably.

(Leakage leans the mixture. When it is excessive, it burns the valves and spark plugs prematurely. Even in its mildest form, it causes an engine to ping. It should be noted that compensation can be made in mild cases of leakage by retarding the spark. When this is done, the engine will not develop quite as much power or have quite as good mileage as when the leakage is corrected and the timing advanced to where it should be. When adjusting the ignition timing with a vacuum gauge as explained previously, leakage is automatically compensated for. Or looking at it another way, if the vacuum gauge setting is later than the timing light setting, it usually indicates that intake system leakage exists. There are other reasons, however, why it is sometimes necessary to retard the spark from the timing light setting to prevent a "ping". Sometimes it is because of low octane gasoline or because of compression being too high).

Intake system leakage is not only found in the form of a leaky manifold gasket. It might be in the form of a warped or loose intake manifold, leaky carburetor flange gasket, worn throttle shaft, one or more poorly seating intake valves (for any reason including a tight tappet), one or more worn intake valve guides, or leaks in any of the lines or fittings to any vacuum operated units such as windshield wipers, etc. All of these defects affect all cylinders equally so all of them cause the vacuum gauge to give a low but steady reading. How low the reading depends on the size of the leak.

There are other types of leakage which DO NOT affect all cylinders alike and therefore DO NOT give a steady reading on the vacuum gauge. A poorly seating exhaust valve, for instance, would affect the intake only for one cylinder. Every time the intake valve for that cylinder would open (on the intake stroke of the piston) exhaust gas would be drawn into that cylinder. This momentary reduction in vacuum would react on the gauge as a large pulse of 2 to 4 inches and much larger than the pulses caused by shorting out a cylinder. Of course, the size of the pulse depends on the size of the leak and where more than one cylinder is concerned, the pulses change to an erratic wandering of the pointer in

fairly wide sweeps. Other defects which DO NOT affect all cylinders equally are a worn exhaust valve guide, a piston ring that does not seal, a leaky spark plug gasket, etc.

UNSTEADY POINTER

If the pointer moves in wide sweeps of 3 or 4 inches, the trouble could be a blown head gasket between two cylinders or ignition cross firing because of insulation breaking down either in the distributor or in the spark plug cables. The trouble could also be weak valve springs. To determine whether or not the trouble is due to cross firing, one plug at a time may be shorted out to determine which is firing its cylinder at the wrong time. The sweeping action will stop when the offending plug is shorted out.

Distributor governor weight movements are sometimes very critical at low engine speeds because there is no spring tension on them; and often they cause a continual but very slight change in engine speed by moving in and out. This action causes a continual advance and retard of the spark, in turn, causing the pointer on the gauge to be unsteady. The pointer may react much the same way if the spark is advanced beyond the highest steady reading.

An unsteady action of the pointer may also be caused by unevenly or widely spaced spark plug gaps or by spark plugs that are carbonized from a rich mixture or from oil; or just because they are too "cold" for the engine. An unsteady pointer may also be the result of small inconsistent intake system leaks, such as intake valves shifting on their seats because of worn guides or such as a worn throttle shaft in a carburetor. Ignition points that are not synchronized, insufficient tappet clearance, weak valve springs and sticky valves also cause the pointer of the gauge to be unsteady.

Often the trouble may be isolated by adjustment of the timing and the carburetor and a check of the ignition circuit including inspection of the

4. Abbreviations

<i>Abbreviations</i>	<i>Explanation</i>
h -----	high, height
NF -----	American National Fine Thread
NPT -----	American National Taper Pipe Thread
S -----	steel
w -----	wide, width
w/ -----	with

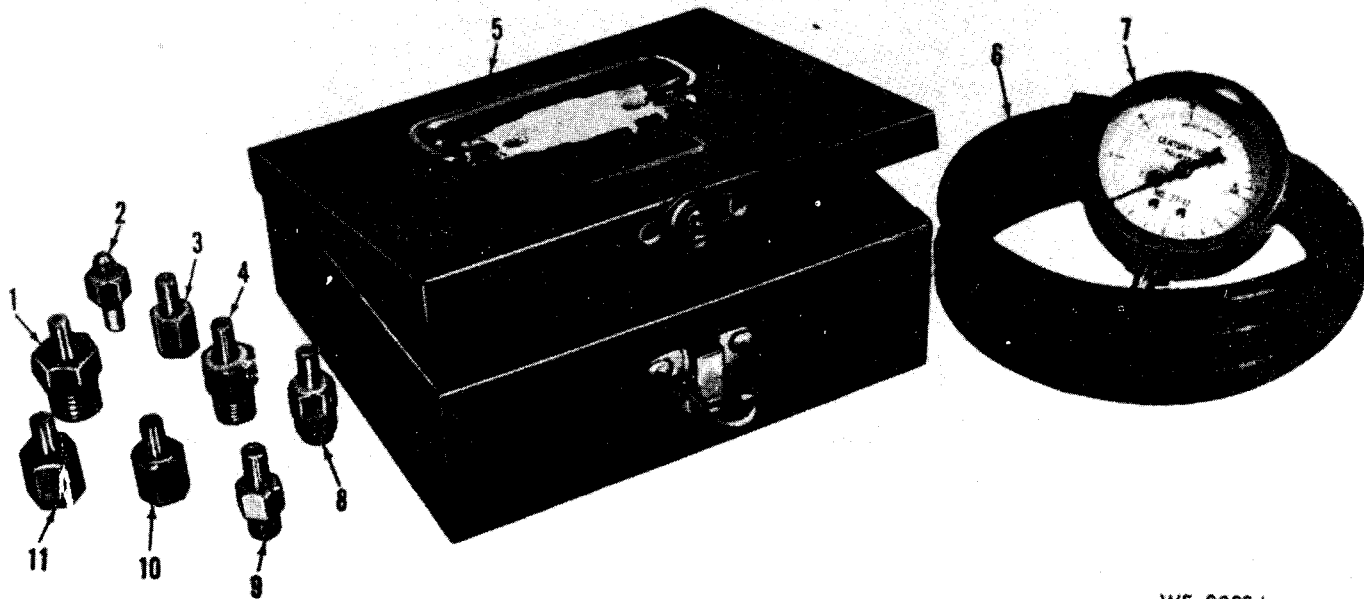
5. Errors, Comments, and/or Suggestions

Report of errors, comments, and/or suggestions are encouraged. They should resubmitted on DA Form 2028 and forwarded direct to: Commanding General, Headquarters, U.S. Army Weapons Command, ATTN: AMSWE-SMM-P, Rock Island Arsenal, Rock Island, Ill. 61201.

Section II. BASIC ISSUE ITEMS LIST

(1) Source, Maintenance, and Recoverability Code				(2) Federal stock No.	(3) Description	(4) Unit of Issue	(5) Quantity authorized	(6) Illustration	
(a) Material code	(b) Source	(c) Maintenance level	(d) Recoverability					(a) Figure number	(b) Item number
			R	4910-255-8673	<p align="center">MAJOR COMBINATION</p> <p>The following item is to be requisitioned for initial use only.</p> <p>TESTER, INTERNAL COMBUSTION ENGINE: unmounted, for testing manifold vacuum and fuel pump pressure, 0 to 8 lbs pressure and 0 to 27 in. vacuum, compression and vacuum gage scale ranges, w/carrying case (Century Tool Company Model 27-12) (4910-255-8673)</p> <p align="center">COMPONENTS OF MAJOR COMBINATION</p> <p align="center">None authorized.</p> <p align="center">SPARE PARTS</p> <p align="center">None authorized</p> <p align="center">TOOLS AND EQUIPMENT FOR:</p> <p>TESTER, INTERNAL COMBUSTION ENGINE: (82078: 27-12)</p>				

C	C	-----	ADAPTER, MANIFOLD: female, inverted flare $\frac{3}{8}$ -24NF-2 thd (82078:830- $\frac{3}{8}$).	EA	1	A-1	3
C	C	-----	ADAPTER, MANIFOLD: female, inverted flare $\frac{1}{8}$ -24NF-2 thd (82078:830- $\frac{1}{8}$).	EA	1	A-1	11
C	C	-----	ADAPTER, MANIFOLD: female, inverted flare $\frac{1}{2}$ -20NF-2 thd (82078:830- $\frac{1}{2}$).	EA	1	A-1	10
C	C	-----	ADAPTER, MANIFOLD: male, flared, $\frac{3}{16}$ -24NF-2 thd (82078:834- $\frac{3}{16}$).	EA	1	A-1	8
C	C	-----	ADAPTER, MANIFOLD: male, flared, $\frac{1}{2}$ -20NF-2 thd (82078:834- $\frac{1}{2}$).	EA	1	A-1	2
C	C	-----	ADAPTER, MANIFOLD: male, plain, $\frac{1}{8}$ -27NPT thd (82078:827- $\frac{1}{8}$).	EA	1	A-1	9
C	C	-----	ADAPTER, MANIFOLD: male, plain, $\frac{1}{4}$ -18NPT thd (82078:827- $\frac{1}{4}$).	EA	1	A-1	4
C	C	-----	ADAPTER, MANIFOLD: male, plain, $\frac{3}{8}$ -18NPT thd (82078:827- $\frac{3}{8}$).	EA	1	A-1	1
C	C	-----	CASE, CARRYING: S, 4 w, 7 lg, 2 h, hinged, w/snap latch (82078:27-12C).	EA	1	A-1	5
C	C	-----	GAGE, DIAL: vacuum and pressure, 2 $\frac{1}{2}$ dia face, w/27 in. vacuum increments and 8 pressure increments (82078:27-12G).	EA	1	A-1	7
C	C	-----	HOSE, AIR: rubberized fabric, 50 in. lg, $\frac{1}{4}$ id (82078:27-12H).	EA	1	A-1	6



WE 30234

Figure A-1. Tools and Equipment.

plugs. If further isolation is necessary, the engine speed should be increased to what would be about 12 or 15 mph. The higher speed reduces the effect of a rich mixture, puts tension on the governor weights and decreases the effect of small intake system leaks. At the same time, it increases the effect of bad valve action.

(A) On this faster engine speed, if the pointer steadies, the trouble is ignition, carburetion, faulty distributor weights or advanced timing.

(B) If the sweeps get larger with further increases in speed, the trouble is definitely weak or broken valve springs.

(C) When the sweeps become shorter and more rapid on the increased engine speed, the trouble could be slight intake system leaks. Such leaks could be due to sticky valves or insufficient tappet clearance. Tappet clearances can be checked and sticking valves can be eliminated in most cases, at least temporarily, by the introduction of oil through the intake system or by applying it directly to the guides where possible.

LOW READING

A low reading can often be corrected too, by adjusting the ignition timing. If it cannot be corrected in this manner, concentrate on finding an intake system leak. Head gasket leaks to the outside atmosphere can be located by running the engine and listening for the escape of the burned gases. If the escape is suspected to be through the spark plug, the plug should be examined closely for streaks. If the head gasket is blown between two cylinders or if the exhaust valves do not seal properly, a compression gauge test will reveal the cylinders at fault.

To determine if intake system leaks are present, the ignition should be shut off and the engine cranked with the starter while the hand is held tightly over the carburetor air

horn (after removing the air cleaner). A vacuum gauge reading during cranking of at least 17 inches indicates the intake system to be fairly well sealed, but the higher the reading, the better. If the reading is low, it should be determined whether the leak is in the carburetor or in the engine. To do this, the carburetor should be removed and the test made again, but this time with the mouth of the manifold covered with the hand or with some kind of a stopper. If a higher reading is obtained by the latter test, then the leak is in the carburetor. Possibly a worn throttle shaft, a poor vacuum line, a leaky flange gasket or a cracked casting would be the source of the trouble. With the engine running, intake system leaks may be detected by squirting oil around where leaks could exist. If a leak is present, the oil disappears into the leak. A leak between the intake and exhaust manifolds in the heat riser is difficult to locate by any other method than elimination of other possibilities or by direct examination.

If the trouble cannot be located with the reasoning of the previous paragraphs aided by your previous experience, make a cylinder balance test to isolate the trouble further. A cylinder balance test is also useful in determining the general condition of an engine.

C OLD ENGINE TESTING

To make a satisfactory engine analysis with a vacuum gauge, the engine must be at operating temperature because there are a great many defects present in a cold engine which correct themselves after operating temperature is reached. An engine which is cold must be capable of developing at least 7 inches of vacuum in the intake manifold while cranking to guarantee a sufficient flow of fuel into the cylinders to start the engine. Sometimes, an engine cannot develop vacuum and will not start because of lack of oil around the piston rings or because of a large intake system leak.

VACUUM BOOSTER PUMP

Disconnect both sides of the pump and connect the vacuum gauge on the wiper side. The reading should be steady between 7 and 12 inches. A ruptured diaphragm may cause high oil consumption, poor engine idle or fouling of spark plugs on one side of the engine.

CHOKED MUFFLER

Accelerate the motor quickly several times in rapid succession. With a clear muffler the indicator needle has a quick return to "normal" each time while with a clogged muffler, the indicator needle will have a tendency to be sluggish and, in severe cases, will not raise beyond 8 inches and will show excessive vibration.

LIFT TEST

With the ignition switch in the "Off" position, the throttle closed tightly, use the starting motor to turn the motor and note the indicator reading. It should read between 8 and 14 inches. Failure to do so indicates an open intake due to the butterfly not closing properly, a leaky intake manifold gasket or burnt heat risers.

CHOKE TEST

Open throttle, close the choke, and step on the starter. The gauge should read, at least, 2 inches, or as high as 6 inches depending on the type of choke. If you cannot get the desired reading, the choke valve is not closing properly which usually causes hard starting.

FUEL PUMP TESTER

PRESSURE TEST

To make a fuel pump pressure test, remove the gas line from the pump to the carburetor at the fuel pump. Remove the 1/8" pipe fitting from the pump. Insert the 1/8" pipe fitting supplied with the analyzer and fasten the hose from the pressure gauge to it. Make sure the fittings are all air tight. Operate the motor at 10 to 15 miles per hour. The reading on the gauge should be not less than 2, and not more than 3 1/2 pounds; and not less than 1/2 pound on wide open throttle. If these readings are not obtained, pump repairs are necessary. On late model Oldsmobile - 6 cylinder - specifications call for 4 1/2 pounds maximum. On the 8 cylinder, 3 1/2 pounds maximum.

VACUUM TEST

To make a fuel pump vacuum test, remove the gas line from the pump and, using the proper adapter supplied, attach the hose of the vacuum gauge. Operate the motor to 10 to 15 miles per hour. The reading on the gauge should be 8 or more inches.

If these readings are not obtained, pump repairs are necessary.

FUEL FLOW TEST

To determine if gas line or gas tank is clogged, connect T fitting between fuel pump and line to gas tank. Attach hose from gauge to remaining nipple of tee. Operate the motor at 10 to 15 miles per hour. If gas line and tank cap are clear, the gauge reading will fluctuate between 0 and 1 inch of vacuum, and steady reading above one inch of vacuum indicating partially or wholly obstructed gas line or tank cap.

MUFFLER BACK PRESSURE TEST

To make a muffler back pressure test, it is necessary to drill and tap for 1/8" pipe fitting in the exhaust manifold, as near the muffler pipe flange as possible. Insert the 1/8" pipe fitting and attach the hose leading to the pressure gauge. Start the motor. If a pressure of 3 pounds or more is shown, the muffler must be replaced. Motor speed to be approximately 50 miles per hour.

ALTITUDE COMPENSATOR FOR VACUUM GAUGE

Altitude From Sea Level	Atmospheric Pressure	Vacuum Gauge Reading - Normal Motor
Sea Level	14.7	18
1000 Feet	14.1	16
2000 Feet	13.6	14
3000 Feet	13.1	13.5
4000 Feet	12.5	13
5000 Feet	12.3	12.5

