TM 9-4910-677-14&P

TECHNICAL MANUAL

OPERATOR'S, ORGANIZATIONAL, DIRECT SUPPORT
AND GENERAL SUPPORT MAINTENANCE
MANUAL INCLUDING REPAIR PARTS LIST

FOR

TESTER, INTERNAL COMBUSTION ENGINE
MODEL 27-12
(CENTURY TOOL COMPANY, INC.)
(NSN 4910-00-255-8673)

HEADQUARTERS, DEPARTMENT OF THE ARMY

MAY 1980

Technical Manual
No. 9-4910-677-14&P

HEADQUARTERS
DEPARTMENT OF THE ARMY
Washington, DC, 9 *May* 1980

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REPORTING OF ERRORS

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NOTE

This manual is published for the purpose of identifying an authorized commercial manual for the use of the personnel to whom this tester is issued.

Manufactured by: CENTURY TOOL COMPANY, INC.
Hilton Street
Easton, PA 18042

Procured under Contract No: DAAA09-76-C-6699

This technical manual is an authentication of the manufacturers' commercial literature and does not conform with the format and content specified in AR 310-3, Military Publications. This technical manual does, however, contain available information that is essential to the operation and maintenance of the equipment.

INSTRUCTIONS FOR REQUISITIONING PARTS NOT IDENTIFIED BY NSN

When requisitioning parts not identified by **National Stock Number, it is mandatory** that the following information be furnished the supply officer:

1. Manufacturer's Federal Supply Code number. (82078)
2. Manufacturer's model number for end item. (27-12)
3. Nomenclature exactly as listed herein.
4. If DD Form 1348 is used, fill in all blocks except 4, 5, 6, and remarks field in accordance with AR 725-50.
5. Complete form as follows:
   a. In blocks 4, 5, and 6 list manufacturer's Federal Supply Code number. (82078)
   b. Complete remarks field as follows:

      Noun: (nomenclature for repair part).

      For: (NSN for end item "4910-255-8673").

      Mfr: (of end item "Century Tool Co.").

      Model: (of end item "27-12").

82078 Model No 27-12

TESTER, INTERNAL COMBUSTION ENGINE

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 chain. ber, 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 different 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

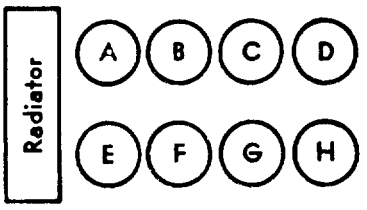
Run on cyl. 2 and 7 Run on cyl. 4 and 5

The manufacturers of V-8 engines use several different methods of numbering the cylinders. To decrease the confusion a lettering system (see illustration) has been developed

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. Band 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 from1/4 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 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 occuring 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. It 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 poor1y 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 1/4 to1/2 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 noamal 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 time 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 setscrew and advance to the highest STEADY reading. Then retard

enough so the reading is 1/4 to 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 nonexistent, except on engines which have overlapping valve timintg. 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.

REATION 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.

REACTION 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 loos e 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 ore 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 sweepingaction 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

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, car buretion, 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.

COLD 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, 3-1/4 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 s 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

PARTS LIST
MODEL NO. 27-12 VACUUM TESTER

DESCRIPTION			QTY. REQUIRED
VACUUM GAGE			1 ea.
HOSE, 50" LONG, ¼" I.D.			1 ea.
ADAPTER SET			
3/8-24	NF-2	INVERTED FLARE FEMALE	1 ea.
7/16-24	NS-2	INVERTED FLARE FEMALE	1 ea.
1/2-20	NF-2	INVERTED FLARE FEMALE	1 ea.
1/2-20	NF-2	FLARED MALE	1 ea.
5/16-24	NF-2	FLARED MALE	1 ea.
1/8-27	NPT	MALE	1 ea.
1/4-18	NPT	MALE	1 ea.
3/8-18	NPT	MALE	1 ea.
CARRYING CASE			1 ea.

GAUGE MUST BE ADJUSTED TO ZERO BEFORE USING.

By Order of the Secretary of the Army:

E. C. MEYER
General, United States Army
Chief of Staff

O f f i c i a l :

J.C. PENNINGTON
Major General, United States Army
The Adjutant General

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