음과 같이 表示 될 수 있다.

$$T \fallingdotseq \frac{0.804B}{\sqrt{GM}} \quad \cdots\cdots (15)$$

式 (15)를 그림-9에 圖示하였다.

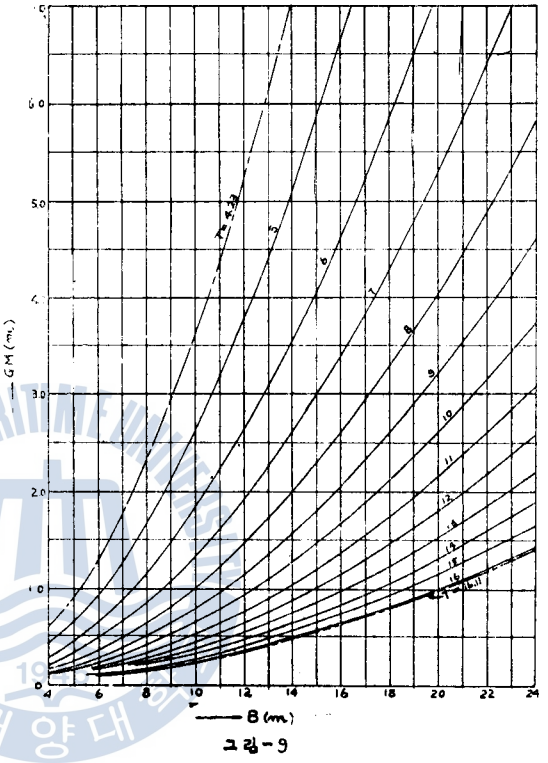

그림-9

7. 基準(Ⅱ)의 判定法

(1) 既存船： 復原力曲線이 있는 船舶에 對해서는 그 復原力曲線上에 그림-1의 鎖線으로 부터 얻은 $1.5D_w$를 GZ 軸上에 取하고, 그림-6에서와 같이 水平線 DBG를 긋는다. 다음 $1.5D_w$의 2/3가 되는 點 F를 求하고. 그림-7, 8, 9로 부터 θ를 求하여, 垂直線 DE를 긋는다. 이때의 面積 a, b를 求하고, $a>b$이면 基準(Ⅱ)를 滿足하는 것이 된다.

(2) 計劃初期의 船舶： 計劃初期의 船舶或은 復原力曲線이 없는 既存船은 直立時와 90°傾斜時의 浮心位置를 推定하는 것만으로 渡邊, 今井法⑦으로 比較的 正確하게 復原力曲線을 얻을 수 있다.

8. 結　　論

安全上 매우 重要한 要素인 復原性에 關한 規程이 法的으로 規制되고 있음으로 海務官廳에서는 船舶의 轉覆事故 防止策上의 이 規制를 强力히 推進해야 할 것이다. 海難事故의 船舶에는 復原性關係의 諸計算 資料가 全혀 없든가 或은 있다 해도 不完全한 것이 實情이며, 現在 就航하고 있는 船舶들도 어느 程度의 復原性 資料를 具備하고 있을지 疑心스럽다. 또한 運航者들이 復原性 規則에 關한 知識도 完全하지는 못할 것이다.

完全한 復原性 資料를 所有하지는 못하드라도 大畧的인 復原性을 計算 檢討는 하여야 할것이다.

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STUDY ON TROUBLE SHOOTING FOR AUTOMOTIVE IGNITION SYSTEM

By Juwa Hyong Cho

자동차 점화계통의 고장진단에 관한 연구

조 좌 형

주 림

기관의 올바른 고장진단은 차주 정비사 운전사, 교육자 및 훈련생에게 시간과 노력 및 경제적 절약을 갖어 온다. 본고는 기관고장진단의 제2차 시도로서 점화계통의 고장원인과 이의 진단에 필요한 관계지식을 체계화하여 고장 진단표를 만드는데 노력하였다. 이것의 올바른 이해와 사용은 연중 무사고 운전과 차의 수명을 길이 유지하는데 많은 도움이 될 것이 틀림 없다고 믿는다.

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1. Introduction

The principal units in the ignition system are the battery, ammeter, ignition switch, ignition coil, distributor, spark plugs and necessary wires which connect these parts. The purpose of the ignition system is only to ignite the combustible mixture in the cylinders. However, it is very important to be familialized with the trouble shooting in ignition system, since one of the most frequent troubles is in the ignition system. Passenger cars that had been seviced several times in the tune-up shops were investigated and tested, and their results were as follows as long as the ignition system troubles were concerned.

1. The plug troubles 18%
2. The distributor troubles 16%
3. The battery troubles 12%
4. The coil troubles 10%
5. The ignition wiring troubles 5%

This figures show that the ignition system troubles are in common and should be paid attention

to assure a year round trouble free operation.

Therefore, the writer attempted to make a complete trouble shooting chart on ignition system as the second trial on the engine. The first trial was the valve gear trouble shooting chart and that was already reported on The YEON-GU WEOLBO, Vol. 6, No. 9, Sept., 1969, published by the Educational Research Institute, Cholla Puk Do.

It is not easy to pin the troubles down and allocate the troubles when an engine is operating in malfunction or found to be failure in operation. Even the well-trained experts often fail to localize the troubles and stick around the wrong parts or systems and may do them harm and cause them to fail sooner than they otherwise would.

This is mainly due to their guess work since the experts do not know about what to do with, or haw to test some units or systems which they are not in familiar with. In present days, the trouble shooting in the operation of an engine is simply no more than a scientfic proeedure, if they have only the knowledge of how and guess work should be strictly restricted.

The purpose of this paper is to help instructors, trainees and diagnosticians, in this field, as a completely systematized trouble shooting chart on the units of ignition system. This chart will make trainees understand the units better than the conventional methods that have been used hitherto, which only enumerate the complaints and their causes having no relation to the systems. Instructors could make some troubles on engine units artificially or purposely and make the trainees find them in a definite and quick manner. This method will help the instructors as well as the trainees in saving their labor, time and money.

However, the conventional method might be practical and convenient to detect over-all troubles on the road.

And this unit trouble shooting chart may be very usefull to the preventive maintenance work, since the periodical check up and an analysis of an engine will show up worn units, parts, or improper adjustments that soon might cause real trouble, and correction can then be made immediately before serious trouble develope.

2. Trouble Shooting Basic Apparatuses

To detect the troubles for the units of ignition system, the following instrumets and testers are used. Handling these apparatuses, consult the maker's instruction books.

a. For Battery
   1. Anti-freeze tester
   2. Battery starter tester
   3. Fast charger
   4. Hydrometer
   5. Low reading voltmeter

b. For Ignition Coil

1. Circuit cotinuity tester
2. Coil tester
3. Lamp and testing points

c. For distributor

1. Dial indicator
2. Distributor tester
3. Dwell-angle tachometer tester
4. Spring tension tester
5. Stroboscopic timing light

d. For Condenser

1. Circuit continuity tester
2. Condenser tester
3. Testing lamp

e. For Spark Plug

1. Spark plug tster
2. Spark plug gap gauge
3. Cylinder ballance tester
4. Tachometer
5. Vaccum gauge

f. For Connecting Wires

1. Circuit continuity tester
2. Volt-ampere tester
3. Wire gauge

g. For Over All Test

1. Motor-scope

3. Battery Troubles

The troubles are not listed in the order of frequency of occurrence in the following charts.

Complaint; Engine won't start

Troubles in;

1. Run down battery
   a. Faulty generator or regurater
   b. Faulty wiring circuit
   c. Excessive load demand
   d. High-self discharge
   e. Defective or old battery

Clue to find troubles;

a. Slow cranking or failure

b. Hydrometer reading low
c. Voltage reading low

Defective or old-battery

d. Gravity readings in the individual cells differ by more than 40 to 50 points
e. Open circuit voltage readings differ by more than 0. 04 to 0. 05 volt.
f. Individual cell voltage uneven by 0. 1 volt or more on three minute test.
g. The battery voltage rises above 7. 75 volts, but the cell voltage remains even on three minute test
h. Voltage below about 1. 5 volts per cell or difference of more than 0. 2 volt in cell readings on high discharge test
i. The electrolyte discolored by brownish sediments.
j. Inside negative plates flecked with white spots and outside negative plates loose active material and washed out
k. The final and completely accurate check on a battery is to give a full charge and see if it will hold the charge for a reasonable length of time. Batteries in good condition and well charged standing unused will hold the gravity at the losing rate of 0. 001 per day over a 30 days period.

Low cell shorted

l. The battery cell voltage readings are not uniform within 0. 1 or 0. 2 volt or one is considerably lower than others on a quick charge test.
m. Voltage varies 0. 2 volt between the cells on a high discharge test
n. Hydrometer readings more than 25 points apart between cells.
o. Bridge over or treeing by the material accumlation in the bottom of the cell or by floating material in the electrolyte…… when battery is opened
p. Orange colored spots either on plates or on the separators. The spots usually quite small but easily seen because of their brilliant color…… when the battery is opened
q. Defectve separators or buckled plates

Leaking electrolyte

r. Voltage varies within 0. 2 volt between cells but 25 points gravity reading apart on a high discharge test, the trouble is due to loss of electrolyte. The causes of the cracked battery; 1. Battery loose in holder 2. Battery hold down clamps too tight 3. Battery frozen 4. Battery hit by flying stone.
s. Battery uses excessive water

Sulphated battery

t. The negative plate grayish white while the positive plate milky white
u. The plate swelled and the grids broken
v. Positive plate material soft, mudy and brownish color
w. Material accumulates in the bottom of cell

Over Charged batterh

x. Require excessive amount of water
y. The positive side of the cell pushed up
z. Gasing heavily and spray electrolyte, battery top wet with electrolyte and surrounding metal plates acid corroded
aa. Negative plate very hard and dense
bb. The separator, if of wood, crumbly and brittle
cc. Battery will not take a charge
dd. Excessive battery temperature

2. Terminal loose or badly corroded
3. Improperly grounded
4. Defective battery

Complaint; Hard starting when engine is cold
Trouble in; Weak battery due to extremely low temperature
Complaint; Hard starting after long storage
Troubles in; a. Low or run down battery
b. Sulphated battery
Complaint; Engine misfire at all speeds
Tronble in; Low voltage

Related Information

Must know

1. An approximate guide to the condition of a standard battery charge (Based on gravity reading taken at 80 degrees F.)
   1. 265 to 1. 290 Fully charged
   1. 235 to 1. 260 Three fourth charged
   1. 205 to 1. 230 One half charged
   1. 170 to 1. 200 One fourth charged
   1. 140 to 1. 165 Battery operative
   1. 110 to 1. 135 Completely discharged
   Batteries used in the hot climates have a different specific gravity of a charge
2. The gravity of electrolyte changes about 0. 004 for every 10 degrees F. As the table based

on 80 degrees, must add 0. 004 to the gravity reading for every 10 degrees above 80 degrees or subtract 0. 004 for every 10 degrees below 80 degrees.

3. As a battery becomes older, it gradually looses gravity. A battery that start with 1. 295 gravity, for example, may drop to a top gravity, when fully charged, of not more than 1. 250 to 1. 257 after 18 to 24 month of service.
4. The higher the temperature and the gravity, the faster the self-discharge. For example, battery kept at 100 degrees F. will drop from 1. 290 to 1. 230 (half discharged) in 30 days. Old batteries or battries that have impurities in them, self-discharge more rapidly.
5. Self-discharged battry without recharged in time may be completely ruinded. The discharged battery should be recharged within 24 hours.
6. The higher the gravity, the lower the temperature required to freeze the electrolyte. Freezing usually ruin the battery.
7. A run down battery must never be left out in the cold.
8. The hydrometer readings show only the chemical condition of the battery and do not report the electical conditions of the battery. That are, how much active material are still available to furnish current or how the separators are holding out.
9. Measuring cell voltage while the battery is being discharged will give a good indication of thess factors.
10. The battery gravity should be above 1. 225 and the the battery temperature somewhere around 60 to 90 degrees F. for the high discharge test, otherwise the results will not count for very much.
11. Drawing 150 to 250 amperes from a battery, check each battery cells very quickly with a low reading voltmetter. All cells should be tested within 10 to 15 seconds.
12. Battey life definitely shortened, if the battery is excessively over loaded during high discharge test.
13. The high temperature in the battery cell as the overcharge continues may cause the plates to buckle and produce direct internal short and completely ruin the battery.
14. Strong electrolyte gives the high gravity readings even though the battery were almost discharged. To check this condition the battery puts on charge, if the gravity reading now goes up above the fully charged value, it shows the electrolyte is too strong. Readjust the electrolyte.
15. Constant-current charge; One ampere per positive plate per cell for most makes of batteries and the charging should be continued until no further rise in specific gravity of the electrolyte for two hours.
16. The voltmeter should never be used to test batteries that have just been charged since the gases on the plate surfaces will cause an abnormally high readings. To be allowed to stand for several hours after it has been charged or the gases can also be eliminated by high-discharging the battery for a few moment.
17. Keep the electrolyte level at the correct height of 3/8″ above the plate by adding water

when necessary.

18. If water is added, do not take the hydrometer reading until the battery has been charged for at least one hour. Otherwise the water will not be mixed with electrolyte and the reading will not be correct.
19. Water must be added periodically, the plates and separators are exposed to the air will be ruined.
20. A coating of petroleum jelly on the clamps and terminals will help to retard the formation of corrosion. And also keeping the vent plug tight will help to prevent the escape of the electrolyte, which promote corrosion.
21. The hold-down clamps shoulb be kept sufficiently tight so that the battery will not bounce around or move in its carrier. On the other hand, excessive tightening of the clamps should be avoided since this will cause the battery case to warp, bulge or break.
22. Some of the oxygen gathering at the positive plate due to over-charging, attack the grid structures of the plates causing them to oxydized or turn into lead oxide. This is not only weaken the plate grids, but also causes the plate to swell. This swelling pushes the positive sides of the cell cover up. Consequent a direct short and causes battery failure.
23. A battery operated for long periods in patially discharged condition may be permanently damaged.
24. After the new battery is in, operation of the generator regulator system should be checked to make sure it is normal. If not the new battery will soon run down.
25. Removing the battery, note carefully the location of the positive and negative terminals. The negative terminal post is smaller than the positive one.
26. Use the battery carrier strap to lift the battery.
27. Usng torch to melt connector from the terminal, the battery should be blown out the gases from the top of the cells, before bringing a flame near them.
28. Never pour water into concentrated acid, it will cause an explosion. Carefully pour the acid inot the water, then stir the mixture throughly with a wooden paddle and allow it cool before taking a hydrometer reading. The solution should be between 60 degrees and 90 degrees F. when it is used.
29. Constant potential charging; the battery will come to badly over charged unless the operator removes the battery in time from the charging line.
30. If the color of the electrolyte discolored with brownish sediments, the battery should not be quick charged, as it will cause internal short. In this case slow charge only.
31. If the gravity readings are not uniform, the battery should not be quick charged. It may cause considerable heat to develope so that the battery would be ruined.
32. A battery which has been badly overcharged or sulphated should never be quick charged.
33. After the battery on quick charge for a minutes, check the electrolyte in each cell for discoloration, if any, the quick charge should be stopped as it produce internal short.
34. A battery must never be allowed to exceed 125 degrees F during quick charge. If the

temperature increases above this value, the battery will be probably ruined.

35. Charging a sulphated battery, it should be put on charge at the half the normal charging rate for 60 to 100 hours, to see whether the sulphation can be broken down so that the battery will take a charge. A badly sulphated battery may be returned to useable condition, but it can never come back all the way; part of its life has been lost.
36. Battery engineers agree that the "water cure" method has little advantage over the slow-charge method on the sulphated battery.
37. Do not left the batteries in the charging line for over three hours after reaching a constant specific gravity.
38. Most batteries can be fully charged at the six ampere rate in 12 to 16 hours, but some batteries will take more than 24 hours.
39. Never stack batteries, one on top of another without providing some means of supporing the weight of the upper batteries. The weight of the upper one through the terminal post may collapse the plate assemblies of the bottom batteries and cause short circuit.
40. Moisture collected on the top of the battery to be cleaned off periodically, as this collect dust and grime and cause slow discharge across the battery top.
41. To clean the battery top use baking-soda solution.
42. To loose the cable clamp nuts, use an open-end or box wrench. Never use pliers or adjustable wrenches.
43. To pull out the stuck clamp from the battery terminal post, use a clamp puller. Never try to pry out the stuck clamp with a driver. This would cause internal short and also damage the cell cover and case.
44. Use the special wire bruch or steel wool to clean the clamps and terminal posts to bright metal.

Better to know

1. The specific gravity of water is 1.000 and the sulphuric acid is 1.835.
2. The electrolyte of a fully charged battery is about 39% of acid and 61% of water by weight, when discharged 15% of acid and 85% of water.
3. Batteries operating in hot climates are often readjusted, so that their gravity is reduced, for example, electrolyte may be redued to as low as 1.230 for a fully charged battery, which prolongs the battery life and the amount of self-discharge.
4. Each 0.01 volt is equal to a difference of 0.010 specific gravity. The difference between a fully charged and discharged battery cell would be only about 0.15 volt.
5. Check the battery at regular intervals, and keep a record of findings.
6. As a rule, a cracked or broken battery case cannot be repaired.
7. The expansion of freezing electrolyte may break plates and separators and ruin the battery besides breaking the case.
8. Paint battery holder with a acid proof paint.

4. Ignition Coil Troubles

Complaint; Engine won't start
Troubles in;
1. Opened primary or secondary windings
2. Grounded primary or secondary windings
3. Shorted secondary windings
4. Moisture on ignition coil terminals
5. Wrong porality
6. Weak or inoperative ignition coil

Complaint; Hard starting while the engine is hot
Trouble in;
1. Coil lost its effieiency while hot

Complain; Engine runs but misses in different cylinders
Trouble in;
1. Defective (weak) coil

Complaint; Miss on acceleration and hard pull
Trouble in;
1. Defective coil

Complaint; Engine misfire at all speeds
Troubles in;
1. Primary circuit restricted or open intermittently
2. Primary and secondary circuit detoured by short internally

Complaint; Muffler explosion
Trouble in;
1. Shorted circuit in coil or in secondary wire from coil to distributor

Related Information

1. Weak or defective coil cannot be repaired, it should be replaced.
2. High frequency coil tester detects:
   a. Hig voltage break down in the secondary winding
   b. High primary resistance
   c. Open circuit, grounded circuit, and shorted turns in the primary and secondary windings.
3. Coil secondary circuit resistance test, should read less than 20.000 ohms
4. On secondary efficency test, it should read 15.000 to 20.000 volts in the secondary circuit
5. If the coil secondary circuit should be opened, as when a spark plug cable is disconnected, and not grounded, the voltage may get up as high as 20.000 volts, which greatly increases the electrical strain on the coil. If this condition should be continued for more than a

few minutes, it may cause a coil failure by excessively high electrical pressure pircing the insulation at some points on the coil.

6. Ignition coil must not be subjected to steam cleaning unless it is of the hermitically sealed type.
7. Rubber nipples on the high voltage terminals are valuable
8. To clean the ignition coll tower socket use terminal cleaner
9. Wrong polarity of the coil will cause the loss of 15% or more the efficiency of the coil.

How to check the polarity:

1. Most coil testers have a provision to check the polarity.
2. Another method is to hold the ignition wire about 1/4" away from the spark plug termianl while the engine is running, then insert the point of a wooden pencil between the plug and wire. If the spark flares or feathers and has a slight orange tinge on the spark plug side of the pencil, polarity is correct. If the spark flares on the wire side, coil connection should be reversed.
3. A useful rule can be used where coil termianls are marked plus or minus; in a negative ground battery system the minus terminal should be connected to the distributor. In a positive ground battery system the plus terminal should be connected to the distributor.
10. When polarity is reversed, voltage required to fire a spark plug may increase as much as 35 to 45%. This occurs under all operating conditions and can encourage hard starting, rough idle and misfiring during acceleration and at high speed.
11. The consecutively firing spark plug cables should be separated as widely as possible to prevent cross-firing.
12. A quick check to see if the coil is worth further testing can be made with a lamp and test points.
    a. Put one test point on high tension terminal with the other at one of the primary terminals The lamp will not light but tiny spark noted as the test point rubbed over the terminals……the secondary windings not open.
    b. One test point on a clean part of the metal container and touching the other point to the pimary or high tension terminals respectively. If lamp lights or tiny spark appears at the point of the contact, the coil is grounded. Replace the coil.
    c. Put the test points on the two primary terminals, if the lamp does not light, the primary circuit is open. Replace the coil.

5. Distributor Troubles

Complaint; Engine won't start
Troubles in;

1. Burnt or oxidized points

2. Improper point gap adjustment
3. Breaker arm distorted, bent, or binding on its pivot pin
4. Dirty ignition points
5. Worn rubbing block
6. Faulty insulation in breaker arm bushing
7. Cracked or faulty insulator at distributor primary terminal
8. Moisture on or in the distributor cover
9. Craked cap
10. Burnt carbon track from distributor cap center terminal to distributor housing
11. Rotor contact point bent or broken
12. Rotor grounded
13. Cap inner center terminal broken or missing
14. Broken or burnt out Radio Suppressor in cap

Complaint; Rough engine idling
Troubles in;

1. Ignition points too narrow or too wide
2. Uneven worn distributor cam

Complaint; Engine misfires at low or idle speed
Troubles in;

1. Cracked or faulty cap
2. Burnt or worn radial contacts in cap
3. Point gap too narrow
4. Worn bearing at movable breaker plate assembly

Complaint; Engine misfires at high speed
Troubles in;

1. Breaker arm binding on its pivot pin
2. Breaker point gap too wide
3. Dirty or oxidized breaker points
4. Worn bearing at movable breaker plate assembly
5. Low point pressure
6. Excessive cotact point pressure

Complaint; Engine misses on acceleration and hard pull
Troubles in;

1. Break down insultation at distributor cap, rotor or coil tower due to a crack or carbon streak
2. Burnt or too wide gap between distributor cap and rotor segment
3. High tension current jumping from rotor to primary wire in the distridutor

Complaint; Engine misfires at all speeds
Troubles in;

1. Burnt or pitted ignitino points

2. Incorrect ignition point gap
3. Faulty gap or rotor

Complaint; Engine stalls

Trouble in;

1. Ignition point need attention

Complaint; Eratic engine operation

Trouble in;

1. Worn balls or ball races on three ball supported breaker plate.

Complaint; Engine runs but misses in one cylinder

Trouble in;

1. Defective distributor cap or lead(cracked or burnt)

Complaint; Engine runs but misses in different cylinders ……miss jump around

Troubles in;

1. Worn distributor or improperly adjusted points
2. Advance mechamism erratic in action
3. Worn balls or ball track or dirty balls in the distributor with breaker plate supported by balls
4. High tension leakage through distributor cap or rotor(detected by a etched vissible path)
5. All causes in the item of Engine Lacks Power

Complaint; Lack of power or high speed performance

Troubles in;

1. Incorrect ignition timing
2. Improperly operating centrifugal governor advance
3. Improperly operating vacuum advance
4. Burnt, pitted, sticking or bouncing points

Complaint; Enging kick back

Trouble in;

1. Ignition set too far advance

Complaint; Engine backfire

Troubles in;

1. Leakage of current across the distributor cap
2. Ignition timing off

Complaint; Flat spot

Trouble in;

1. Late ignition timing

Complanint; Spark knock, pinging and detonation at low or moderate speed on open throttle

Troubles in;

1. Excessively advanced timing
2. Faulty advance mechanism

3. Points out of adjustment
4. Bent distributor shaft or worn distributor bearing

Complaint; Engine over heat

Troubles in;

1. Late ignition timing
2. Sticky centrifugal advance mechanism

Related Information

Must know

1. To correct misalignment of the contact points, bend the stationaly contact, never bend the breaker arm between the rubbing block and the contack.
2. Clean the dirty contact points with carbon tetrachloride on tintless tape.
3. To correct the misalignment of the rubbing block, bend by arm between the hinge pin and the rubbing block. Never be filed or sandpapered.
4. To correct crator on the positive contact point
   a. Reduce condenser capacity
   b. Lengthen the condenser lead
   c. The distributor-to-coil lead closer together
   d. Lead away from the ground
5. To correct crator on the negative contact point
   a. Increase condenser capacity
   b. Short condenser lead
   c. Separate distributor-to-coil low and high tension lead
   d. Remount the coil directly to ground
6. To make a quick check on the operation of automatic advance mechanism by holding the shaft and turn the cam by moving the rotor in the direction of distributor rotation as far as it will go and release it. It should return to the original position with no drag or restriction. Otherwise it should be overhauld.
7. To make a quick check on the mechanical operation of the vacuum advance unit, move the breaker plate if it is movable or the distributor if it is rotating type against the direction of distributor shaft rotation and release it. It should freely return to the original position without drag or hesitation, if not, it should be checked.
8. Worn distributor shaft bearing; the side play over 0.005 inch with 5 pounds side pull applied, the bearing is sufficiently worn to require replacement.
9. Burnt points cleaned with a thin fine-cut contact file or stone. Never be sandpapered
10. Lubrication of the distributor should be refered to the specification.
11. Dwell angle ranges from 34 to 38 degrees for six cylinder cam and from 26 to 30 for eight cylinder cam in general. Refer to the specification.
12. Burnt or oxidized contact points were caused from any of the following conditions.

a. Misaligned contact points
b. Contact points coated with grease or oil due to over lubrication of the distributor or clogged engine breather pipe.
c. Pitted contact surfaces
d. Dirty or corroded contacts.
e. Improperly adjusted contact points
f. High series resistance in ignition condenser
g. High voltage at contact points due to
   1) improperly adjusted or inoperative voltage regulator
   2) excessively advanced third brush adjustment on the third brush generator
   3) too high resistance in contact points
   4) Corroded battery terminal
   5) generator charging rate too high
   6) battery over charged
   7) engine mountings too loose, producing imperfect ground
   8) loose ground strap on rubber mounting engine
   9) a sulphated battery or defective cells
   10) loose connections
   11) worn breaker arm pivot pin and bushing
   12) incorrect breaker point gap
   13) improper breaker arm spring tension

13. Steady and low reading on the vacuum gauge test indicate late ignition timing or valve timing.
14. More than plus, minus 3 degrees variation on the cam angle variation test means fluttering shaft or worn bushing and breaker plate.
15. Checking rubbing block alignment, hold distrbutor in front of a strong light and rotate shaft until the rubbing block is resting on a peak of one of the cam lobes. If the rubbing block properly aligned, light will not be vissible at any point between the rubbing block and cam.
16. Checking for fluttering or fanning of the timing mark at any speed (accelerate the engine slowly), use timing light. If this erratic movement covers more than 3 degrees on the index of flywheel or vibration dampener, the distributor should be replaced or overhauled as required. ····· excessive wear in the bushing or drive train.

Better to know

1. Breaker arm spring tension ranges from 17 to 23 ozs in most cases. Refer to the specification.
2. The pull required to move the breaker plate on the support plate should be between 8 and

16 ozs.

a. Low tention causes tipping and rattering of the plate and consequent irregular ignition.

b. Excessive tention prevents normal vacuum advance action. To adjust, increase or dicr-ease the tension of the spring washer by adding or removing shims.

3. Breaker point gap ranges from 0. 018″ to 0. 02 0″ in general. Refer to the specification.

4. The end of the rotor dose not actually contact the metal stud or botton which leads to spark plug wire, leaves a gap from 0. 010 to 0. 020 inch.

5. Reconditioning worn balls or ball races on three ball supported breaker arm plate, the grooved ball race regrounded and fitted with over size ball or install spark-o-liner.

6. Out of timing of the engine may be resulted from the following conditions.

a. Timing not set properly

b. Worn or bent distributor shaft or bushing

c. Defective vacuum advance mechanism

d. Defective centrifugal advance mechanism

e. Wrong heat ranged spark plugs or fouled plugs

7. Ignition timing should always be checked after new breaker points are installed or point spacing is adjusted.

8. A distributor should be checked periodically on a test fixture to assure correct automatic advace characteristics.

9. Distributor tester will give the following informations.

a. Wear in the distributor shaft and bushing

b. Wear in the distributor plate and housing

c. Leak in vacuum advance units

d. Automatic spark advance

e. Contact point dwell setting

f. Synchronization of the double breaker points

g. Contact point sprinr tention

h. Dirt circuit and contact point resistance

10. Disconnect lead from one spark plug and hold it about 3/16″ from the engine and crank the engine at normal speeds, if good spark jumps to the block, the chances are the prim-ary and secondary circuits are in good condition.

11. Remove the distributor cap and ignition switch on. The lead from the coil high tension terminal hold close to the engine block and snap the contact points open and close. If the spark does not occur, the ignition system not doing its job.

12. Remember that one degree in the distributor will produce two degrees error in spark timing.

6. Ignition Condenser Troubles

Complaints;

1. Engine won't start
2. Engine misfires at all speeds
3. Engine runs but misses in diffent cylinders
4. Muffler exprosion (just a couple of exprosion and then no more for a time or even for days).

Troubles in;

1. Shorted or grounded condenser
2. Weak condenser
3. Gradually failing condenser
4. High series resistance
5. Low capacity

Related Information

1. Condenser can not be repaired, so any defective condenser should be replaced.
2. A quick check way of the condenser: Charge the condenser from a 110 volts source, then hold the condenser clip close to the case, if spark occurs, the condenser in question may be all right.
3. Open the breaker points and block them, place the one test point on the distributor primary terminal and the other on the distributor base, if the lamp light the condenser is shorted.
4. Condenser capacity may be ranged within 0.20 to 0.25 micro F. in general, refer to the specification.
5. Condenser tester will check the following factors:
   a. Series resistance
   b. The capacity
   c. Insulation

   In addition, other valuable checking may be made with this tester as resistance test from 1 ohm to 10 megohms like on gas gauge, realays, resistance units and suppressors, etc.

7. Spark Plug Troubles

Complaint; Engine won't start

Troubles in;

6. Ignition Condenser Troubles

Complaints;

1. Engine won't start
2. Engine misfires at all speeds
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7. Spark Plug Troubles

Complaint; Engine won't start

Troubles in;

1. Moisture on porcelains
2. Improper type of spark plug
3. Spark plug damaged

a. Insulator tip fouled
b. Spark gap bridged
c. Upper part of insulation fouled

4. Dirty or wet porcelain
Fouled plugs with wet or black deposits due to excessive amount of oil getting into cylinder.
5. Cracked porcelain
6. Gaps improperly spaced

Complaint; Rough engine idle
Troubles in;
1. Plug gaps too narrow or too wide
2. Weak spark

Complaint; Ignition misses at low speed
Troubles in;
1. Improper gaps
2. Carbon deposits on plug insulation
3. Faulty plugs

Complaint; Engine misfires at all speeds
Troubles in;
1. Hot spark plug
2. Improper spark plug gap
3. Deposit on spark plug insulasion

Complaint; Engine misses at all speeds
Troubles in;
1. Fouled spark plug
a. Hard carbon deposits baked onto the insulator
b. Soft, fluffy, dry black carbon deposits
2. Weak or no spark in one or more of cylinderes

Complaint; Engine misfire on acceleration and hard pull
Troubles in;
1. Worn plug (weak spark)
2. Plug gap too wide
3. Fouled or damp plug
4. Porcelain blow par
5. Insulator cracked

Complaint; Engine lack of power or high speed performance
Trouble in;
1. Faulty spark plug

Complaint; Engine back-fire

Trouble in;

1. Hot plug……use colder plug

Complaint; Engine knocks or ping

Trouble in;

1. Wrong heat ranged spark plug

Complaint; Pre-ignition

Trouble in;

1. Over heated plug

Complaint; Blow-by

Trouble in;

1. Loose plug in its seat

Related Information

Must know

1. While making a cylinder balance test, the vacuum and tachometer reading should be compared for each pair of cylinders that working together, one inch of vacuum and 40 r. p. m. would be considered excessive in difference.
2. Short out each of the plug in turn with a driver, if no change in the operetion is noted, the cylinder is not delivering power i. e. misfire.
3. Won't stop running when the ignition switch shut off. means pre-ignition.
4. 50% or mor of over-heated plugs due to loose plugs in its seats.
5. High grade spark plug gives a minimum of 10,000 miles and may give many more thousand miles of service over this amount when properly used.
6. Spark plug shoud be re-gapped at intervals of 4.000 to 5.000 miles of operation for best results……on heavy duty more frequently.
7. Use the round gauge to check plug gap, never with a flat gauge.
8. Install a new spark plug gasket if used, everytime a new or cleaned spark plug installed for better porformance and long life.
9. Side and sometimes center electrode shows excessive worn, while the insulator shows no sign of excessive heat whatsoever. This is due to the high output ignition coil.
10. Grayish black streaks on the insulator top just above the cell, shows the sign of blow-by due to abnormally high temperature and carelessly handled or defective plugs.
11. When installing a new set of spark plugs, sometimes necessary to readjust the idling speed and the idling mixture of the carburetor.
12. Setting spark plug gap, bend the side electrode using the special electrode bending tool.
13. Spark plug manufacturer recommends, to be replaced the plugs at intervals of 10.000 miles to avoid loss of engine operating economy due to worn plugs.
14. Before removing plugs, use air jet and blow away any foreign matters.
15. Use a spark plug socket when removing and installing the plugs.

16. Install the plugs when the engine is at the normal operating temperature as far as possible.
17. Do not use any graphite or any other lublicant compounds on the thread when installing the plugs in aluminum cylinder head.
    a. Lublicant retard the heat transfer
    b. Lublicant makes the plugs go easier resulting over tightening.
18. Tight the plugs to recommended tightening torque.

Better to know

1. Built in resister plug permits a wider gap settling which helps;
    a. to eliminate occasional missing
    b. smooth running the engine
    c. longer electrode life
2. The only sure and practical guide to determine the plug heat range is gotten from the examination of the firing tips of insulators on plugs that have been run at other than idling speed for at least a few hours under normal operating condition.
    a. Light tan and insulator clean…… just right
    b. Black……too cold
    c. White ashy appearance and burnt appearance of electrode…… too hot
3. A car served for several years with high mileage, better to change for hotter plug due to a low operating temperature.
4. For slow speeds, door to door service, short trip, slow or heavy traffic, install hotter plugs due to low operating temperature.
5. On the same car above, on long trip at high speed with a substantial proportion of time, required cold plug due to high operating temperature.

8. Ignition Wiring Thoubles

Complaint; Engine won't start

Troubles in;

1. Primary circuit resistance and burnt or open (12 V system)
2. Open ignition circuit
3. Distributor to coil lead grounded
4. Corroded spark plug terminals
5. Chafed or cracked insulation on cables
6. Spark plug cables not correct for engine firing order
7. High tension cable leaks

Cemplaint; Excessive vibratinn at idle speed or uneven idling performance

Troubles in;

1. Spark plug wire leaks

2. Faulty insultation coil-to-distributor cable

Complaint; Engine turn over slowly but won't start

Trouble in;

1. Undersized battery cadle

Complaint; Engine misfires at low or idle speed

Troubles in;

1. Fractured primary lead between distributor primary terminal and breaker arm.
2. Dirty or corroded secondary circuit connection or faulty ignition cables.

Complaint; Engine misfires at all speeds

Troubles in;

1. Faulty spark plug cable
2. High tension wire shorted in metal manifold

Complaint; Ignition misses at high speed only

Trouble in;

1. Fractured primary lead between distributor primary terminal and breaker arm

Complaint; Engine misfire on acceleration and hard pull

Troubles in;

1. Secondary cable from coil to distributor, poor electric contact at terminal.
2. Spark plug cable, poor electric contact at terminal.
3. High tension cable leakage due to fractured or oil soaked cables.

Complaint; Lack of power or high speed perfromance

Trouble in;

1. Faulty ignition cable

Complaint; Normal under idling or light load but intermittent or regular misfire under heavy load

Trouble in;

1. Faulty high tension cable

Complaint; Engine back-fire

Trouble in;

1. Ignition cross-firing(two mixed up plug)

Complaint; Muffler exprosion

Troubles in;

1. Shorted circuit in secondary wire from coil to distributor.
2. Intermittent open circuit in primary (ammeter needle swings further away from the zero when generator is charging).

2. Faulty insultation coil-to-distributor cable

Complaint; Engine turn over slowly but won't start

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1. Undersized battery cadle

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1. Faulty high tension cable

Complaint; Engine back-fire

Trouble in;

1. Ignition cross-firing(two mixed up plug)

Complaint; Muffler exprosion

Troubles in;

1. Shorted circuit in secondary wire from coil to distributor.
2. Intermittent open circuit in primary (ammeter needle swings further away from the zero when generator is charging).
3. Intermittent short circuit in primary (ammeter needle swings toward zero when generator is charging.

Related Information

1. Every time the engine is overhauled, a new set of high tension cable to be installed

unless the cable comparatively new. Otherwise, the engine will develope a weakness in the ignition system after engine is overhauled.

2. Inspect high tension cables for
   a. wear
   b. faulty insulation
   c. cracks
   d. hardness and brittleness
   e. heavy coating of grease, oil and dust
3. Any of the following conditions in the ignition wires will produce weak spark.
   a. Too much resistance or leakage
   b. Terminal looseness
   c. Corrosion
   d. Breaks or cracks
   e. Oil soaked
   f. Damaged surfaces
4. Check voltage drops with a low reading voltmeter in ignition wiring for;

Check Point	**Voltmeter reading**
a. Battery ground terminal to distributor base	0 Volt
b. Battery ground terminal to car frame	0 Volt
c. Distributor base to car frame	0 Volt
d. Battery terminal to coil primary terminal (ign. switch side) (through ignition switch)	0.25 Volt max.
e. Battery terminal to starting switch terminal	0 Volt
f. Starting switch terminal to ammeter	0.05 Volt max.
g. Ammeter to ignition switch terminal	0.05 Volt max.
h. Ignition switch terminal to coil primary terminal (ign. switch side)	0.1 Volt max.
i. Coil primary terminal to distributor terminal	0.05 Volt max.
j. Distributor primary terminal to distributor base (through breaker point)	0.05 Volt max.
k. Distributor base to coil primary terminal (dist. side) (through breaker points)	0.1 Volt max.

* A resistance unit connected in the primary circuit usually between the coil and distributor, the voltage drops specified above do not apply to that portion of the circuit which incorporates such resistance.

9. Conclusions

1. All automobiles should be checked periodically at intervals of about every 10,000 miles

to assure good operating condition, since the faulty operation of an engine is deeply related to public health.

2. Any symptoms of deviation from normal condition will be a clue to find out the defective oeprating units. But guess work must never be done. Check with testers correctly.
3. All engines must be provided with following papers positively to insure 100% efficient tune-up jobs.
   a. The trouble shooting chart
   b. The job analysis chart
   c. The troubles and tune-up recording cards
   d. The scientific test report
4. For the educational purpose, the progressive chart also should be added.
5. To confirm the effiecicny of the trouble shooting chart, 100 trainees were tested and its consequence showed that the trainees trained with the chart were superior to those trained without the chart, in understanding by 34%, in accuracy by 46% and in time to locate the troubles by 51%. Therefore, the trouble shooting chart is not only recommended for the effiicient tune-up job, but also for the educational purposes.

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Automotive Repair Manuals

Testing Instrument Maker's Instruction Books

$\mu(\theta)=\log_e\left|\cot\frac{\theta}{2}\right|$와 $\lambda(\theta)=\log_e\left|\cot\frac{1}{2}\left(\frac{\pi}{2}-\theta\right)\right|$의 双曲線函數와 그 應用에 關하여

蔡 亨 鎔

On the relationship between the Hyperbolic functions of $\mu(\theta)=\log_e\left|\cot\frac{\theta}{2}\right|$, $\lambda(\theta)=\log_e\left|\cot\frac{1}{2}\left(\frac{\pi}{2}-\theta\right)\right|$ and the application.

Chai Hyung-yong

Abstract

It is stated the changing method of trigonometrical functions to Hyperbolic functions, and the result was expressed on the generaligation table.

Using this table to put in practice in spherical trigono.-solution and used this result to navigational triangle solution too。

It is easily solvable the spherical trigono. and navigational triangle-solution if drawing up a table of $\mu(\theta)=\log_e\left|\cot\frac{\theta}{2}\right|$ for the value of θ, and a table of Hyprerbolic fuctions for the value of this result.

<目 次>

1. 序 言

1-1. $\sinh x=\cot\theta\left(-\frac{\pi}{2}<\theta<\frac{\pi}{2}\right)$라 하면, $\cosh x=\operatorname{cosec}\theta$, $\tanh x=\cos\theta$ 임을 밝혀라. 라는 問題에서 $x=\log_e\cot\frac{\theta}{2}$라 놓으면 双曲線函數를 三角函數로 變換할 수 있다.

1-2. $\cos a=\cos a\cdot\cos c+\sin a\cdot\sin c\cdot\cos A$ 에서

$\cos A=\dfrac{\cot\frac{a}{2}-\tan\frac{a}{2}}{2\cot\frac{c}{2}}$ 임을 證明하라. 라는 問題에서