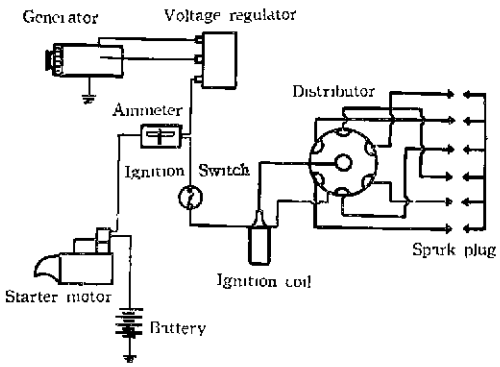
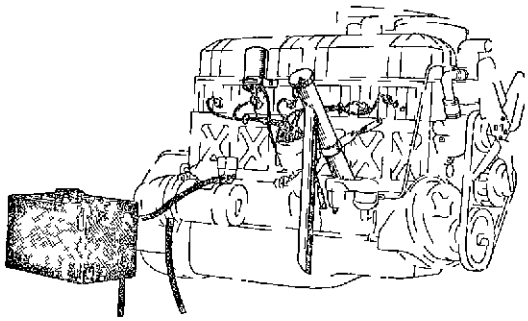
TOYOTA
REPAIR MANUAL

MODEL FJ

IGNITION SYSTEM
CHECKING AND REPAIRING ELECTRICAL UNITS
INSTRUMENTS
LIGHTING SYSTEM

IGNITION SYSTEM





Ignition Diagram

The ignition system serves to ignite the mixture drawn into the combustion chamber of the engine and is a specially important part of the gasoline engine. If it functions improperly, it immediately will affect the engine performance and fuel consumption so that special care should be taken in the maintenance of this system

The wiring diagram of the ignition system is shown in the illustration This is of the so-called battery ignition system in which the battery and generator are used as sources of electrical power. Its principal components are as follows.

1. Electrical Source

   Battery and generator

2. Ignition Coil

   A unit which converts low voltage current from battery or generator into high voltage pulsating current of over 10,000 volts required for ignition sparking

3 Interrupter

   A form of a periodical switch located inside the distributor which cuts off the current flowing through the primary coil of ignition coil at time of ignition to form high voltage current in secondary coil of ignition coil

4. Distributor

   A unit which distributes the high tension current induced in the secondary coil of ignition coil in specified order (1-5-3-6-2-4) to the spark plugs at the correct time.

. Condenser

   An important unit which serves to absorb the self induced current produced in primary winding of ignition coil when this current is cut off bythe inter-

rupter and increase the induced voltage in secondary coil In addition it extinguishes the sparks formed at contact points and prevents burning out of this main part of the ignition system

6. Spark Plug

These serve to ignite the compressed mixture inside the combustion chamber by means of a high tension spark jumping across its gap.

7. Ignition Switch

A key switch which opens or closes the primary circuit of the ignition system

8. Ignition Cord

These consist of two kinds, one for the low voltage current flowing from the battery or generator through the primary circuit, and the other for the high voltage current flowing through the secondary circuit The cord for the secondary circuit is provided with specially high resistance insulation.

OPERATION OF IGNITION SYSTEM

The wiring diagram of the ignition system for the "Toyota" engine is shown in illustration.

The interrupter cam has 6 angles corresponding to the number of cylinders It rotates together with the distributer rotor on the same upright shaft at half the engine speed and cuts off the primary current 6 times for every 2 revolutions of the crankshaft. The distributor cap is placed on top of the interrupter, the center terminal being connected to the secondary terminal of the ignition coil and the terminals around the center being connected, in the order of rotation of distributor, to each spark plug in accordance with the firing order.

When the engine is running and the interrupter closes the contact points, the current flows from the (+) terminal of the battery, through the ammeter, ignition switch, primary windings of the ignition coil, and enter the interrupter where it passes through the contact arm spring, contact arm, contact points and returns to the (—) terminal of the battery by way of the ground, thus completing the circuit

When the ignition is to take place, the contact points are opened by the cam and the primary current is cut off. The current induced in the primary windings is instantly absorbed by the action of the condenser placed on the interrupter, and the rapid collapse of the magnetic field induces a high voltage in the secondary windings. This high voltage current flows out from the secondary terminal of the coil through a high tension wire into the center terminal of the distributor, then across to the distributor cap and through the high tension cord to the center electrode of the spark plug. In overcoming the resistance of the highly compressed gas around the spark gap, the current jumps across with a strong spark, igniting the mixed gas, and returns to the (—) terminal of the battery by way of the ground, completing

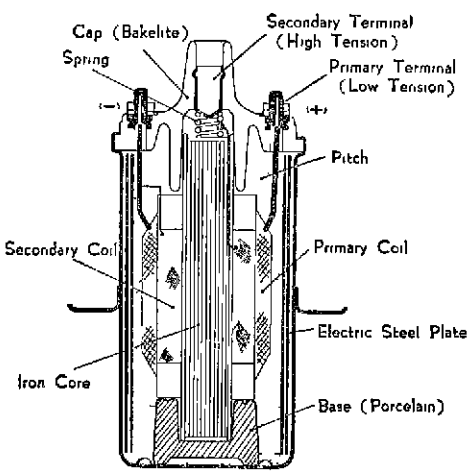
the circuit This action is repeated over and over again and at the same time maintaining a correct relationship with the engine movement

That is, on the "Toyota" Model F six-cylinder engine, the explosions takes place in the 1—5—3—6—2—4 order for every 1/3 revolution of the crankshaft The interrupter revolving at one-half the engine speed opens the contact points at every 1/6 turn, cuts off the primary current and induces high voltage current The distributor rotor for every 1/6 turn distributes high voltage current in the correct order to the spark plugs

CONSTRUCTION AND OPERATION OF MAIN UNITS IN IGNITION SYSTEM AND PROCEDURES FOR THEIR REPAIRS AND ADJUSTMENTS.

1. Iguition Coil

Location At right center side of engine
Primary Coil 0 75 mm 250 turns 1 2 ohms
Secondary Coil 0 08 mm 20,000 turns
Primary Current 4 5+0 5 amperes
(Engine stopped and key switch closed)



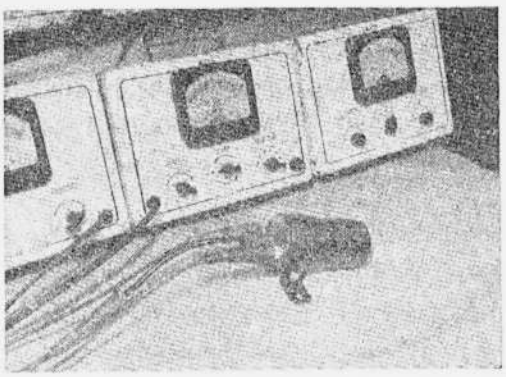
Iguition Coil

The ignition coil is installed on top of the engine cylinder head and is connected from the key switch to the source of power through a wire inside a sealed cable.

The construction of the coil is as shown in the illustration, and consists of a soft iron core having a high inductive rate, that is, it has the characteristic of being readily magnetized and demagnetized. Around this 20,000 turns of enamel insulated 0 08 mm copper wire is wound to form the secondary coil Over this is wound 250 turns of enamel insulated high grade 0.75 mm copper wire to form the primary coil. The spaces between the coils are filled with pitch for insulation and prevention of moisture entering

As shown in the illustration, one end of the secondary coil connects to the secondary terminal plug in on the cap and the other end to the primary terminal on the cap together with one end of the primary coil The other end of the primary coil connects to the primary terminal on the cap from where it leads to the key switch and source of power

Checking for Trouble in Ignition Coil



Spark test coil

Troubles arising in the primary and secondary coils are shorting, grounding, and breaks in the windings. In any of these cases, the coil will not be able to function at full capacity so that the sparks will miss or be too weak to start the engine or will cause erratic running. Any faulty ignition coil should be repaired immediately.

A very simple method of checking the ignition coil is to remove the cap and rotor from the distributor and crank the engine by hand until the contacts close. Turn on the ignition switch and pull out the high tension cord coming out of center terminal of ignition coil from the distributor cap. Then while holding the end of this cord about 1/4 inch from any metallic part of the engine, open and close the contact points by moving the contact arm with the finger. If a strong bluish spark jumps across the end of the cord to the metallic part, the coil can be assumed to be satisfactory.

If a new coil is available, replace and compare to make a sure check. But if not available, connect the battery, primary terminal of the ignition coil, and about a 30-ampere ammeter in series. By the amount of current flowing through the circuit, the condition of the ignition coil can be determined correctly. If the coil is in good condition, the ampere will register about 4.5 amperes when the switch is closed but will fall down to about 3.5 amperes in about a minute and remain at about this value. If the amount of current flowing is very large, the coil is shorted and if current fails to flow, there is a break in the coil windings. For ground test, use a test lamp and test between primary coil terminal and any unpainted surface of the ignition coil. If the coil tested in this manner is found to be defective replace with new part.

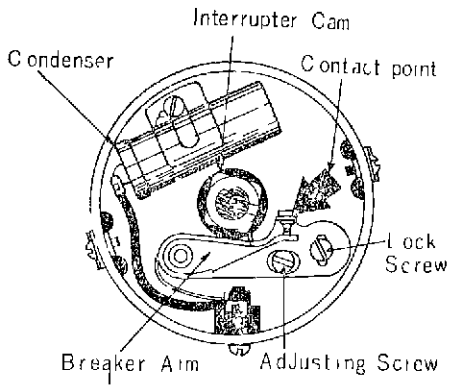
Ignition and Starting Switch

The ignition and starting switch is located on the instrument panel and serves to open and close the primary circuit of the ignition system. This operation is made through a different key switch provided in each vehicle so that the engine cannot be started without inserting the key into the switch.

This switch also serves as switch for activating the fuel gauge so that the amount of fuel in the tank cannot be known unless this switch is turned on.

2. Distributor

The distributor is driven by the camshaft and its principal components consist of the driven shaft with its interrupter cam, the contact arm and distributor rotor actuated by this cam, and the distributor cap which receives the high tension secondary current distributed by the high tension secondary current distributed by the rotor and leads it to the spark plugs In addition, there is the governor control which automatically adjusts the ignition timing, the octane selector, and the condenser which promotes the action of the ignition coil



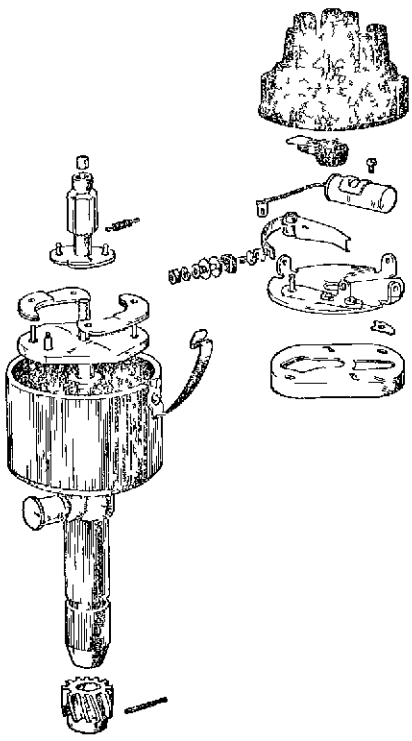
Construction of Contact Point Part

The operation of the interrupter cam and contact arm is as shown in the illustration With the rotation of the distributor shaft, the contact points on the end of the contact arm opens and closes the primaly circuit

The contact point gap must be accurately adjusted to 0 018 in (0.46 mm). This gap is a part that requires extreme accuracy for if it is too narrow, the self induced current will flow across the gap when the points are opened causing the voltage in the secondary coil to be low Consequently the spark will be weak so that there will be difficulty in starting the engine, while driving the engine will miss at all speeds and the power will be noticeably lessened Also it will cause the points to be damaged so that they will not function properly

On the other hand, if the gap is too wide the moving distance of the contact point is increased so that when the engine is running at high speed, the points are opened by the cam before they are fully closed, that is, before the current can flow fully into the primary windings of the ignition coil This causes the engine to miss so that it cannot be accelerated to the desired high speeds

Thus, the contact points should be checked and adjusted if necessary, and should



Distributor

always be kept clean and maintained in proper working condition

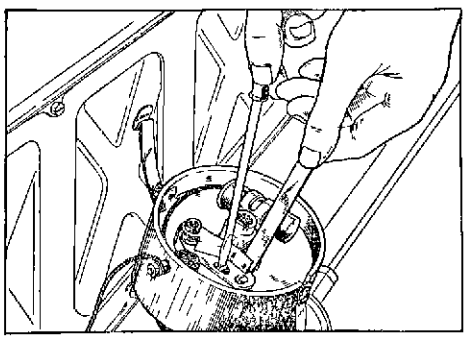
Troubles Arising in Contact Arm and Adjusting Contact Points

a Points fail to open fully

This is due to the bakelite part contacting the cam being worn To prevent this, lightly grease the cam part occasionally

b. Point faces burned

When the point faces become dirty or pitted so that they contact poorly, the electrical resistance of this part increases. Consequently, the current flowing through the primary current becomes less so that the high voltage induced in the secondary coil becomes low. When this occurs, clean and dress down the point faces with a fine file (SST-1001) or remove contact arm and dress down points with oil stone After points are dressed down, adjust gap in following manner.



Adjusting Contact Point

1. Crank slowly by hand until points are fully open
2. Check gap with 0.018 inch (0.5 mm) thickness gauge (SST-1001)
3. If this gap is too wide, loosen lock screw and adjust by turning adjusting screw in counterclockwise direction with screwdriver If too narrow, turn in opposite direction
4. After adjustment is completed, tighten lock screw, and to make sure recheck with thickness gauge

c. Checking insulation on contact arm and contact arm spring

Fiber insulations are provided where the contact arm pivots on the base plate pin and where the contact arm spring attaches to the interrupter housing Check to see that these insulation are not loose or dirty causing faulty insulation and allowing the primary current to ground and resulting in misfiring.

Distributor Cap and Rotor

The distributor cap consists of the cap and the distributor rotor Both are made of bakelite and withstands over 20,000 volts, are highly heat-proof and water-proof, and are made mechanically strong and durable

Be careful that there are no cracks in the distributor cap and rotor. If cracked, there is no other way than to replace with new parts It is also necessary to see that on the distributor rotor, the spring is contacting the carbon properly. The clearance

between the contact face of the distributor rotor and the terminal face of the cap should be from 0.010 to 0.012 in. (0.254 to 0.305 mm.)

The cap should be removed frequently and the moisture and dirt wiped off from the inside

Lubricating Distributor

a Distributor Cam

Apply 2 to 3 drops of engine oil to the felt part inside the cam after every 2,000 kms

b Distributor Shaft

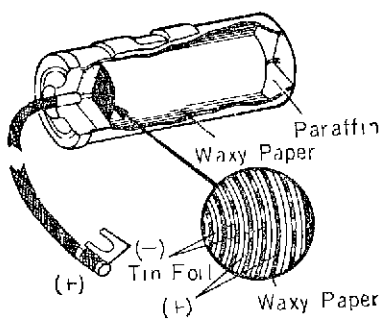
After every 2,000 kms, lubricate by turning grease cup and after every 6,000 kms, replenish grease cup.

c. Contact Arm (Preaker Arm)

Lightly grease bakelite part every 2,000 kms.

3. Condenser

The condenser is located inside the distributor housing and is connected in parallel with the primary circuit from primary coil through contact point to ground. Its construction as shown in the illustration consists of a larged surfaced conductor (tin foil) rolled together with insulating material (parafined paper).



Construction of Condenser

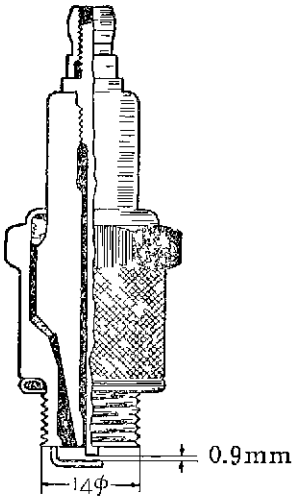
If no condenser is provided and the switch is opened, the primary current flowing in the primary coil through self induction will tend to keep on flowing for a short period of time, sparking across any small air resistance and not only making the cutting off of the primary current bad but burning up the contact points. By providing a condenser, this momentary current is absorbed and stored by the condenser to be released when the points contact again, improving the cutting off of the primary current, raising the secondary voltage, and at the same time prevents the points from burning.

Condenser Specifications

Capacitance	0.22 Mfd ±10 % at normal temperature
Insulation Resistance	Over 10 megohm when tested with 500 volts resistance tester at 80°C
Dielectric Strength	Withstand over 1 minute under 700 volts AC at 80°C
Capacitance Variation due to Temperature	+5 %
Heat Resistance	80° C

4. Spark Plug

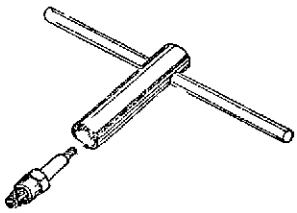
The spark is the unit which directly sets fire to the compressed mixture inside the cylinder combustion chamber of the engine by producing a strong spark Special care should be taken in its maintenance as its performance will immediately have a large effect on the engine output and fuel consumption When removing or installing spark plugs use the recommended plug wrench shown in the illustration. Check frequently and after every 1,000 kms, be sure to clean electrodes with spark plug cleaner or wire brush. After 10,000 kms, it is necessary that they be replaced with new plugs



Spark Plug

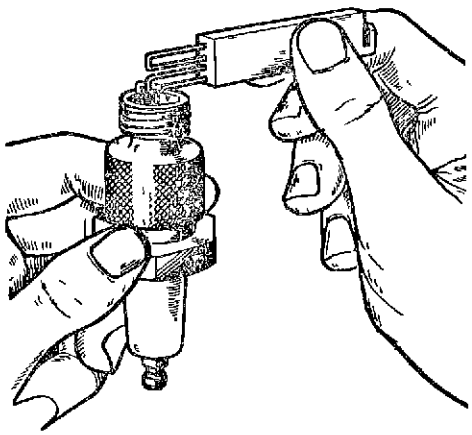
Spark Plug Specifications

Name	14 mm Spark Plugs
Gap Distance	0 8 to 0 9 mm
Type Threads	Metric
Thread Outer Diameter	14 mm
Thread Length	9.5 mm
Hexagon Part Distance across Flats	20 6 mm
Overall Length	67 6 mm

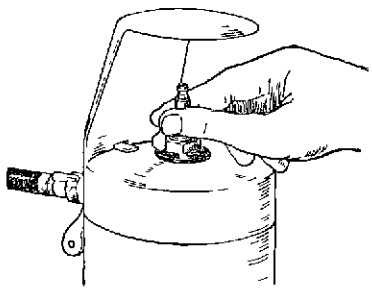

Spark Plug and Plug Wrench

Adjusting Spark Plug Gap

The spark plug gap is adjusted to the specified 0.036 inch (0 9 mm) using wire gauge (SST-1001) as shown in the illustration. Before making adjustments, always make sure to clean the spark plugs thoroughly using spark plug cleaner or wire brush


Adjusting Spark Plug Gap

In adjusting, use reverse end of wire gauge and always bend the side electrode. Never bend the center electrode


Spark Plug Cleaner

Determining Condition Inside Combustion Chamber by Spark Plugs.

1. If the inside part of the spark plug is dry, the white porcelain part lightly browned, and practically no carbon sticking on, then it can be assumed that there is perfect combustion within this cylinder

(b) If the inside of the spark plug is full of carbon, then it can be assumed that there is incomplete combustion due to too rich a mixture

c If the inside is wet with gasoline, then the spark plug is misfiring.

d. If the inside full of carbon resembling powdered coal or the inside is wet with oil, then oil is being pumped up.

5 Ignition Timing

For the internal combustion engine to display its maximum performance it is necessary to subject the maximum explosive force on the piston just at the moment it is about to go down from the compression top dead center The following problems are on what takes place from the time the contact points on the distributor open, until the high tension current passes to the spark plugs, sparks and ignites the compressed mixture and produce a most effective explosive force

1. Mechanical lag

No matter how precisely the mechanism may be made, it will take a certain amount of time for the contact points to open from the closed position to the maximum opening where there is sufficient air gap to resist the self induced voltage. This retardation is called mechanical lag

2 Electrical lag

It will also require a little time after the primary current is cut off from the ignition coil for the current to be induced in the secondary coil and flow out to the secondary circuit, reach the spark plug, overcome the resistance of the highly compressed mixture and spark across the gap, that is, ignite the mixed gas This retardation is called electrical lag

3. Flame Propagation Lag

It will also require a little time after the highly compressed mixture inside the cylinder is ignited at one point for the flame to spread and produce a most effective explosive force. This time lag is called flame propagation and depends on the shape of the combustion chamber, location of spark plug, location and shape of valves, and compression ratio. These are design problems Also, the kind of fuel used and the mixture ratio affect the speed of flame propagation.

Flame Propagation in Gasoline Engine

It is still not clearly known how the combustion of the highly compressed gasoline-air mixture takes place inside the combustion chamber From past researches, it can be thought of as taking place in the following stages. In the first stage, the

slow moving mixture close to the spark plug is ignited to start the combustion and raise the temperature of the surrounding mixture to ignition temperature

In the second stage, the combustion slowly spreads out from the point of ignition in a circle and accompanied by vibration gradually begins to pick up speed Next should be the third stage, but this is instantaneous as upon completion of the second stage, the flame spreads extremely rapid and the whole mixture ignites to form what is called explosive combustion. The three stages cannot be easily defined since the time consumed for this action to take place is only several hundredths of a second.

Taking the above subjects into consideration, it should be possible to determine the ideal time for the ignition to take place. Subjects (1) and (2) are not much of a problem since at high speeds, it only amounts to about 0 5° crankshaft angle However, on subject (3) flame propagation lag, the time variation differs considerably with engine speed as shown by the following calculations

For example, assuming the lag due to combustion rate to be 1/600 second, then when the engine speed is 450 R P.M.

450—60=7 5	No. of crankshaft revolutions per second.
7 5×360=2,700	No of crankshaft angular revolutions per second.
2,700×1/600=4 5	Angular amount the crankshaft travels in 1/600 second

When the engine speed is 3,000 R P.M.

3,000—60=50	No. of crankshaft revolutions per second.
50×360=18,000	No of crankshaft angular R P.S.
18,000×1/600=30	Angular amount the crankshaft travels in 1/600 second.

Taking the mechanical and electrical lag of 0.5 degree and adding to above

At 450 R.P M.	4.5—0 5=5 degrees lag
At 3,000 R. P. M.	30—0.5=30.5 degrees lag

It can be seen from above that if the position of the contact points are set together with the engine speed so that for any speed, the contact points will open when the piston is just at the proper position before the top dead center, then the maximum explosive power will be obtained when the piston is just abut to go down from the upper dead point.

Taking all the above factors into consideration, the ignition point on the Toyota Model F engine is specified to be set 7° before piston combustion top dead center with reference to crankshaft rotation when the engine is revolving at 500 r.p m

The engine speed is not constant as it is always changing to low and high speeds to meet various demands Consequently, the ignition timing must be constantly adjusted to conform to engine speed. After basically determining the ignition timing, the advancing or retarding of the timing to conform to engine speed is made through mechanisms called spark control.

Effects of Faulty Ignition Timing

a. Ignition timing too slow

If the ignition timing is too retarded, the combustion will take place after the piston has passed the first dead point. In this case, the cylinder volume will be enlarged so that the combustion of the mixed gas will be dull and incomplete. Consequently, the explosive power will be weak and the cylinder will be subjected to the flame for a longer period of time. This will result in.

1 Engine losing power.
2. Increased consumption of fuel.
3 Engine overheating.
4. Lubricating oil on cylinder walls being burned and wasted, causing excessive wear and damage to cylinder walls and piston sides.
(5) Large deposit of carbon on cylinder and exhaust passages due to incomplete combustion

If this condition is continued, the engine will overheat, the various engine parts will be badly worn out or damaged, and the life of the engine will be shortened.

b. Ignition timing too fast

On the other hand, if the ignition timing is too advanced, the explosion will take place before the piston reaches the compression upper dead point so that the piston moving upwards will receive a strong counter pressure. The explosive pressure and the crankshaft torque acting against each other will exert a tremendous force on all the frictional parts from the piston to the crankshaft and causing the engine to knock violently. This will result in

1. Extreme loss of engine power.
2. Piston head being damaged if counter pressure is too high.
3 Excessive wear and damage to piston and cylinder
4. Connecting rod and crankshaft being bent and in extreme case, the bearings will be damaged

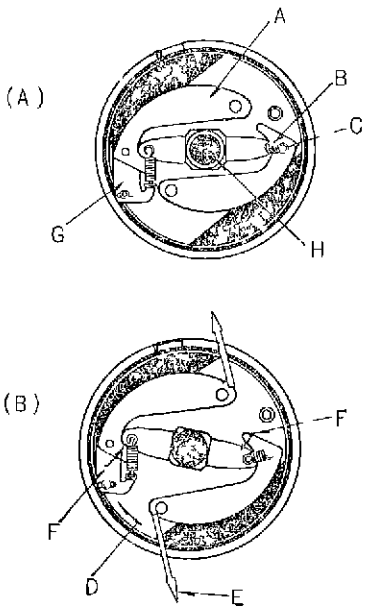
From above it can be seen that faulty ignition timing has exceedingly bad effects. Thus, it is of great importance that special attention be given to its adjustment to insure accurate operation.

6 Spark Control Mechanism

A Mechanical Advance Governor

This mechanism is located on the lower part of the distributor contact plate, and consists of governor weights and springs placed between distributor shaft driven by camshaft, and subshaft with interrupter cam which fits into the distributor shaft The centrifugal force of the weights is made to match the tensile pull of the springs so that in accordance with the speed of the distributor shaft, the lag between the two shafts will be properly adjusted.

The governor plate is rigidly attached to the distributor shaft inside the lower part of the distributor housing The part that extends above the plate fits loosely into the subshaft. On the governor plate are 2 pins which serves as pivots for governor weights and 2 holders for governor weight stop cover The plate surface is provided with 2 narrow protudions to facilitate sliding of governor weights



A *Governor Weight*
B *Governor Spring*
C *Hinge*
D *Rotation of Governor Plate*
E *Centrigual Force of Governor Weight*
F *Advances in Direction of Cam Rotation*
G *Governor Spring Suspension*
H *Cam*

Advance Governor

An oval shaped arm is rigidly fixed to the lower part of the subshaft and this arm fits into the bent part of the governor weights so that the rotation of the governor plate is transmitted to the subshaft. 2 coil springs are fixed between the pins on the subshaft arm and governor weight pivot pins on the plate so that the subshaft arm is pulled by the springs against the pivot pins on the plate.

When the engine is running at slow speed, the spring tension overcomes the centrigufal force of the weights and prevents the weights from spreading out As the speed increases, the centrifugal force of the governor weight increases and overcomes the spring tension so that the heavier ends of the weights opens out This causes the subshaft arm to move in the direction of rotation.

Consequently, the interrupter cam on the subshaft moves in the direction of rotation and advances the opening of the contacts by that amount. This advance angle will be twice that when expressed as crankshaft angle. When the engine speed decreases, the spring tension overcomes the centrifugal force of the weights to move the subshaft back and in accordance with the engine speed, the timing is adjusted correspondingly.

The relationship between the advance angle of the interrupter cam and the speed

of the Toyota Model F engine is as follows:

Distributor Speed	Cam Advance Angle	Engine Speed
200 R P.M	0	400 R P M.
500	3°	1000
800	6 5°	1600
1000	8 6°	2000
1200	11 2°	2400
1400	14.3°	2800
1600	15°	3200

To check the action of the governor weights, turn the cam fully to the right and if on releasing, the springs pull the cam back quickly to the former position, then it is all right

Lubricate the distributor shaft every 800 km by screwing in the grease cup.

Apply light oil to the felt in the center part of the interrupter cam every 2,000 km. so that the cam will operate easily.

B. Vacuum Spark Control

To obtain the best operating conditions, the ignition timing should not only be adjusted for engine speeds alone but also for the amount of load The weights operated by centrifugal force as explained before only adjusts the timing by engine speed alone so that this is not sufficient.

With light loads (such as running on level road at a fixed medium speed) it is more economical to advance the timing more then when running at the same speed with a heavy load With this purpose, the vacuum spark control is used.

This mechanism utilizes the fact that at light loads the vacuum inside the carburetor becomes high.

This vacuum spark control is installed on the distributor and is of the diaphram type. When the vacuum inside the carburetor becomes high, it overcomes the tension of the spring inside the control and pulls the lever. This moves the distributor body in the opposite direction to the rotation of the distributor rotor so that the timing is advanced.

Under light load and high speed, this vacuum spark control works together with the centrifugal control inside the distributor and advances the ignition timing more than that by centrifugal control alone.

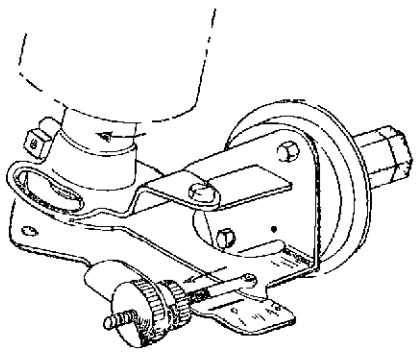
Under heavy load with the throttle fully open, the vacuum control will retard the ignition timing to the full retard position but the centrifugal control operating on engine speed will adjust this to the proper timing. In this manner, a nearly perfect timing can be had for any load and any speed.

The vacuum spark control advances the timing up to 7 degrees advance angle (14 degrees crank angle).

C. Octane Selector.

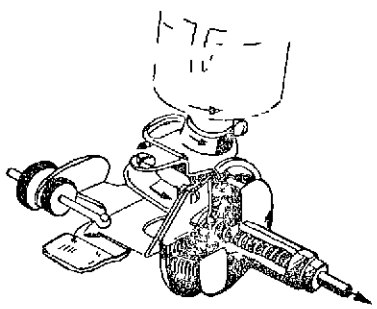
In order to increase the engine power and economize on fuel it is desirable to use gasoline having a high octane count, that is, one that has high anti-knock properties.

There are so many different kinds of gasoline sold on the market today that it is necessary to have some device installed on the engine in order that any gasoline can be used without knocking This device is the so-called octane selector and is fixed on the previously mentioned vacuum spark control



Octane Selector

To adjust the octane selector. First loosen the adjusting nut and move the pointer toward the "RET" side for low octane count gasoline and toward the "ADV" side for high octane count gasoline In moving the pointer always move one graduation at a time (1 graduation is equivalent to 2 degree change in ignition timing) and after every movement, tighten the nut and operate the car Run at about 15 to 30 km/h on a level road and step on the accelerator suddenly. If there is a slight knocking but at other speeds, there is no knocking, the adjustment is correct.



CHECKING AND REPAIRING ELECTRICAL UNITS

A. Starting Motor fails to Start Engine

(a) Check for defective starter motor connection

(b) Check headlamp switch and also check to see that headlamps light properly If faulty, there may be a defect in the battery so that it should be checked for following.

(1) Battery charge is low or completely discharged
In this case check specific gravity of battery electrolyte with hydrometer.

(2) Terminal connections on battery posts are loose or corroded.
Loosen clamp post and remove terminal from post Then clean inside of terminal and outside of post by scraping with knife Finish by applying a thin coat of vaseline (or grease), and inserting terminal and tightening clamp bolt securely.

(3) Check to see that both ends of the ground cable from the battery to frame are on secure.

B. Lamps Brighten Up when Engine is Started

This indicates a loose connection in the charging circuit from the battery to the generator In this case, check each of the following connections.

1. Ammeter terminal
2. Generator terminal
3 Starting motor terminal
4. Terminals at each end of battery

C. After Ignition Switch is turned on, and engine cranked with starting motor, engine fails to shart

Remove high tension wire from one spark plug and while turning engine with starting motor, hold terminal end of wire about 1/4 inch from metal base of spark plug. The spark should easily jump across this gap but from the condition of the spark, the following can be determined.

(a) If it fails to spark over or if the spark is very weak, the following troubles are possible

(1) Breaker point is hollowed or is not adjusted.

(2) Condenser is defective

(3) Ignition coil is defective.

(b) Sparking is satisfactory but the engine fails to start

(1) Remove spark plug and check to see that they are clean. If found dirty, use spark plug cleaner and clean thoroughly

(2) Check ignition timing and correct

(c) Engine runs unevenly.

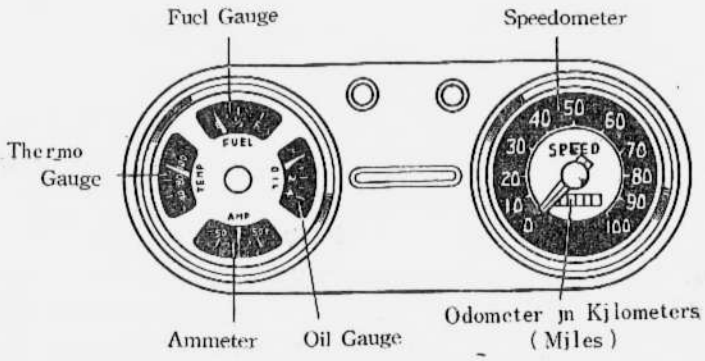
(1) Clean spark plug with plug cleaner and inspect

(2) Clean breaker points and adjust clearance to specified value.

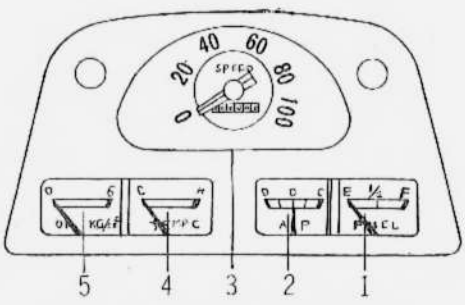
INSTRUMENTS

The Toyota Model FA 60 Truck and the Toyota Land Cruiser are equipped with the following instruments: speedometer, gasoline gauge, oil pressure gauge, water thermo gauge, and ammeter.

Among these gauges, the gasoline gauge, oil pressure gauge, and water thermo gauge on the Toyota Model FA 60 Truck and the oil pressure gauge and gasoline gauge on the Toyota Land Cruiser are of the electrical type.



Instruments on Toyota Model FA 60 Cargo Truck



① *Fuel Gauge*
② *Ammeter*
③ *Speedometer*
④ *Thermo Gauge*
⑤ *Oil Pressure Gauge*

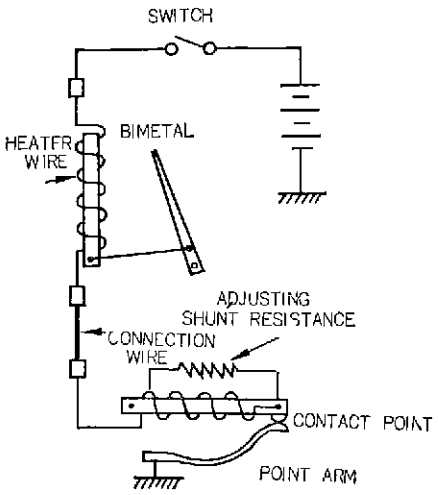
Instruments on Toyota Land Cruiser

Principles of Electrical Gauges

The gasoline gauge, oil pressure gauge, and water thermo gauge all operate on the same principle, utilizing the characteristics of bimetals. All gauges consist of the

meter unit and the operator unit, both units being connected with a single line.

Closing the key switch allows electric current to flow from the battery through the heat wire in the meter unit, through the heat wire and contacts in the operator unit, to the ground. This electric current heats up the heat wires, this heat being transferred to the respective bimetals The bimetal consists of two dissimilar metals with different heat expansion coefficients so that when heated, the metal with the higher expansion coefficient will bend toward the one with the lower expansion coefficient. The amount of bending will depend on the temperature, that is, the amount of current (current×time of flow) Since the same current flows through the meter unit and the operator unit, the amount of bending in the meter unit will be proportional to that in the operator unit.



Operating Diagram

The function of the contact points on the bimetal in the operator unit is to determine the amount of current which is to flow through the heat wires. When the contact points take only a short time to open when the key switch is closed (case when points are lightly contacting each other). the amount of current is small Consequently, the bimetal will remain practically unbent and the pointer will not deflect But when the contact points take considerable time to open (case when points are contacting each other heavily), the amount of current is large and the pointer deflection will also be large. The gauges are constructed so that time required for the contact points to open will depend on the amount of fuel, water temperature, or oil pressure, and depending on the amount of current decided, the bimetals will bend and the pointer will register the corresponding amount

Maintenance of Electrical Gauges

1. Terminals and Wiring Should Not Be Grounded.

If the meter unit or operater unit terminal is grounded, the meter unit will be directly subjected to a voltage of 6 volts and cause the heat wire to burn up. Thus, the wiring should never be removed while the switch is closed, and the meter should never be checked for deflection by grounding its terminals without connecting the operator unit. Also, when shipping the chassis, the tank unit is removed so that in this case the terminal leads from the fuel gauge unit should be completely insulated.

2. Fuel Tank Unit Should Not Be Interchanged with Other Makes.

The sliding resistance type of fuel tank unit is also provided with terminals but its internal construction is entirely different. If used together with the bimetal type meter unit, the meter will not only register incorrectly but the heat wire may burn out

3. All terminal connections should be in proper condition.

Care should be taken to see that the terminal connections are in proper shape. Loose connections will cause poor flow of electric current and result in incorrect readings.

4. Checking meter

Special equipment is required to adjust the deflection so that the meters should not be disassembled for adjustment. In checking heat wire for breakage, the meter unit and the operator unit must always be connected. An ammeter (1 ampere) is inserted in this circuit and if by impressing a voltage of 6 volts, the current begins to flow, the heat wire is satisfactory.

5. Position of pointer in thermo meter.

On the thermo meter alone, the pointer will register over 100° when the key switch is closed. However, the meter is not at fault if the pointer settles down to the specified temperature about 10 seconds after the key switch is closed

6. Ammeter wiring

After inserting wire into the magnetic circuit part at the back surface, clamp down the wiring with the lugs provided

7. Speedometer

The nut on the flexible shaft should be tightened down securely to the meter body

Speedometer

1. Construction

The speedometer consists of rotating shaft with rotating magnet, rotating pointer shaft on induction plate, hair spring, integrating ring, and gears

2 Operation

When the rotating magnet is turned by the flexible shaft, the induction plate above this magnet tends to turn in the same direction due to the eddy currents produced in plate by the magnet. This turning force is controlled by the hair spring connected to the pointer Since the turning force produced in the induction plate is proportional to turning speed of the rotating magnets, the pointer will register the speed of the vehicle

On the odometer, the rotation of the flexible shaft is transmitted to the ring by means of gears. Through a special pinion provided on the ring, the odometer will register 1 km for every 637 turns of the shaft

Ammeter

1. The ammeter consists of one permanent magnet and one moving core with a pointer attached There is no magnetic coil There are no terminals on the back cover but provisions are made so that the lead wires can be inserted into the magnetic circuit

2 Operation

When the charging current flows through the wire in the magnetic circuit, this current produces a new magnetic field at right angles to the existing magnetic field of the permanent magnet The pointer attached to the moving core will point in the direction of the resultant magnetic field In the case of discharge current, the magnetic field produced will be in the reverse direction so that the pointer will register on the minus side

Oil Pressure Gauge

1. Construction

The meter part consists of a U-shaped bimetal wound with heat wire, pointer and graduation dial The unit part consists of phosphor-bronze diaphragm to receive the oil pressure, point arm to transfer this pressure to the contact points, contact points to cut-off the current, and U-shaped bimetal.

2 Operation

a When there is no oil pressure.

At this condition, the lower contact point is not subjected to oil pressure so that there is no bending in the bimetals and the points contact each other very lightly. When the key switch is closed, the current flows through the heat wire But as very little heat is required to bend the bimetal, that is, the contact points open with current flowing for a very short time, the temperature of the bimetal heater part does not rise and the pointer shows practically no deflection

b When there is oil pressure

At this condition, the bimetal is bent being pushed up with a force proportional to the oil pressure. When the key switch is closed, a much higher temperature, that is, the current must flow for a longer period for the points to open than is required in the case of "a". But just before rising above this higher temperature, the points open and cuts off the current However, it is necessary for the bimetal to cool only slightly for the points to close again so that the temperature at which the bimetals open (temperature proportional to the oil pressure) will be the boundary at which the points open and close repeatedly. On the meter part, the bimetal will be heated correspondingly to a high temperature so that the larger bending will cause a larger

deflection of the pointer.

Fuel Gauge (Bimetal type)

The meter part is identical to that of the oil pressure gauge and the unit part is similar with the exception of the float

Its operation is similar to that of the oil pressure gauge in that the contact points are pushed up by the float and the temperature required for the points to open being determined by the height of the float.

Water Thermo Gauge

1. Construction

The meter part is similar to that of the oil pressure and gasoline gauges except that the location of the parts are symetrically opposite Thus, the pointer will be registering over 1000 when the key switch is open.

The bimetal on the unit part is a straight bar instead of being U shaped.

2. Operation

The contact point arm unlike that of the fuel gauge remains stationary, and the bimetal part is fixed so that it presses strongly against the arm at ordinary temperature When the water temperature is low, the current must flow for a long period before the points open so that in the meter part, the bimetal bends considerably and the pointer will register low temperature. When the water temperature rises, the bending of the bimetal due to water temperature decreases the amount of bending required by the current so that less current flows through Thus, the pointer deflection will become less and higher temperature will be registered.

Fuel Gauge (Sliding resistance type)

The Toyota Land Cruiser is equipped with an electrical type gasoline gauge consisting of the tank unit and the dash unit. This gasoline gauge does not operate with bimetals but is provided with a sliding resistance in the tank unit to vary the current, the variation being registered on the graduations in the dash unit.

1. Construction

The dash unit consists of two coils placed at right angles to each other The keeper is suspended at the intersection of the coil centerlines, and the point is rigidly attached to the keeper.

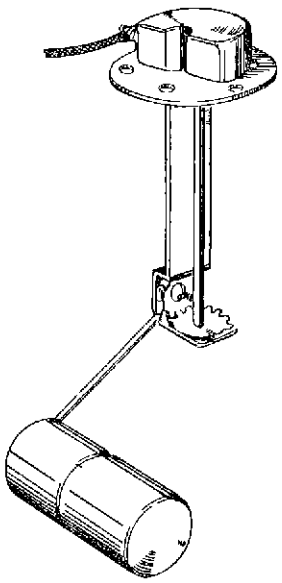
The tank unit consists of a form of variable resistance, its contact arm being operated by the up and down motion of the float inside the tank

2. Operation

When the fuel in tank is low, the contact arm will be contacting the resistance coil on the right end where there is practically no resistance. On closing the switch, the current from the battery passes through the left side coil in the dash unit,

through the contact arm resting on the right end of the resistance coil, and to ground The core on the left side becomes strongly magnetized and pulls the keeper toward the left side so that the pointer attached to the keeper deflects to the left

When the fuel in the tank increases, the contact arm moves to increase the reistance on this part. The current flowing through this part becomes less while the current flowing through the right side coil in the dash unit to the ground increases. When the float reaches the highest part, the resistance of the tank unit will be at its maximum so that current from the battery unable to flow through this resistance, flows from the left side coil directly through the right side coil to the ground.



Fuel Gauge Tank Unit

Both of these coils are so wound that the polarity at the lower ends are the same, and consequently the keeper will be attracted by both poles. When the tank is full, both coils attract the keeper with the same force to bring the keeper to vertical position and the pointer to F position.

Thus the position of the pointer will vary with the amount of resistance, that is, it will register any position from E to F to correspond with the amount of fuel in the tank

The current flowing through this fuel gauge circuit is very small being from 1/6 to 1/10 ampere.

LIGHTING SYSTEM

Toyota Model FA 60 Cargo Lighting System Specifications

Headlamp	45/35 watts	2 pcs	Type A
Backlamp	35	1	
Tail and Stop Lamp	25/8	1	C
Meter Pilot Lamp	3	2	D
Room Lamp	8	1	B
Parking Lamp	8	2	B
Dash Lamp	8	1	B
Winker Pilot Lamp	3	2	D
Fuse	30	5	

Toyota Land Cruiser Lighting Specifications

Headlamp	45/35 watts	2 pcs
Inspection Lamp	15	1
Dash Lamp	8	1
Winker	3	2
License Lamp	8	1
Meter Pilot Lamp	8	5
Winker Pilot Lamp	3	2
Parking Lamp	8	2
Tail and Stop Lamp	8	1
Stop Lamp	8	2

Model FA 60 Cargo Lighting Equipment

1. Headlamp

Headlamps are equipped on the left and right sides and important units for night driving Their construction consists of a 45/35 watts double filament bulb placed in the center of a special reflector The filament changeover in the light bulb for main and passing lights is made through the dimmer switch on the toeboard.

The lens is a part of the reflector and is provided with a special curvature to transfer the light beams effectively.

a. Disassembling and Reassembling Headlamp

Burned out bulbs and other parts are replaced in the following manner.

(1) Unloosen rim set screw at lower part of headlamp and remove rim by turning slightly in either direction

(2) Remove 3 screws around headlamp glass rim and the glass rim and headlamp sealed beam unit together with the light cord can be taken out.

(3) The headlamp bulb can be removed by pulling out socket carefully and turning bulb set collar.

(4) When replacing socket, it is replaced as socket and cord complete.

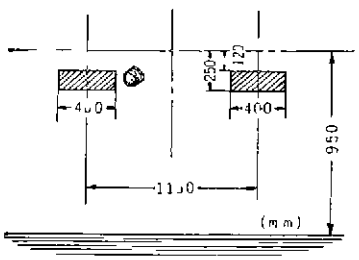
(5) When reassembling, follow the above procedure in reverse order but take care to observe the following points

(a) Bulbs replaced must be of the specified bulb.

(b) Reflector should never be touched with dirty hands, and moisture should be strictly prohibited

(c) The rubber ring at base of bulb must always be installed.

b. Adjusting Headlamp



The headlamp should be adjusted so that at a distance of 10 meters from a flat wall, the centers of the beams will fall inside the squares

The following item should be checked

a. Headlamp brightness

b Vertical deflection of beam axis

c. Lateral deflection of beam axis

Explanation of above items

a. Headlamp brightness

This is the brightness of the strongest part of the headlamp beam

The brightness necessary to distinguish a traffic obstacle at night from a distance of 50 meters is equivalent to over 130 lux measured at a distance of 10 meters

b. Vertical deflection of beam axis

The strongest part of the headlamp beam should be pointing slightly downward from the horizontal level.

At 25 meters, the beam axis should not be more than 1.2 meter above the ground. At 50 meters, the beam axis should fall within the limit between the ground and 1 meter above the ground, and should not fall above or below this limit up to 50 meters

c. Horizontal deflection of beam axis

The headlamp beam axis should not deflect more than 1 meter horizontally up to a distance of 50 meters.

A large space will be required to make actual tests to satisfy the above conditions so that ordinarily, a headlight tester is used. This type of tester

is made so that the above distances are converted to have the same effect on a smaller scale and makes it possible to carry out the tests in a smaller space.

Testing with Headlamp Tester

1. Place vehicle on smooth level surface.
2. Tire inflation, springs, and other parts are adjusted to specified values.
3. Tests are made with the vehicle unloaded and 1 person in the driver's seat.
4. The engine is at standstill.
5. The battery is fully charged
6. Distance between headlamp and tester should be made accurate to that specified in the tester
7. Move screen up and down so that the horizontal line on the screen matches the height of the headlamp centerline
8. Screen and vehicle centerline are made exactly at right angles.
9. Turn on lights and determine brightest spot on screen with luxmeter.
10. Check luxmeter reading at brightest spot see if it conforms to specifications
11. Check to see if the luxmeter position is within the specified limits

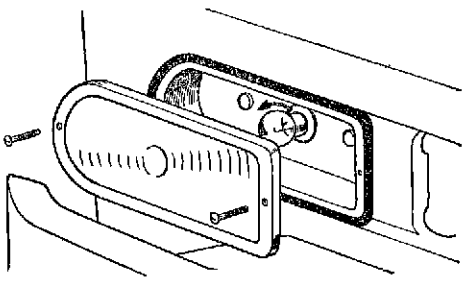
This completes the headlamp test

2 Parking Lamp

This lamp is used for night parking and is located below the headlamp

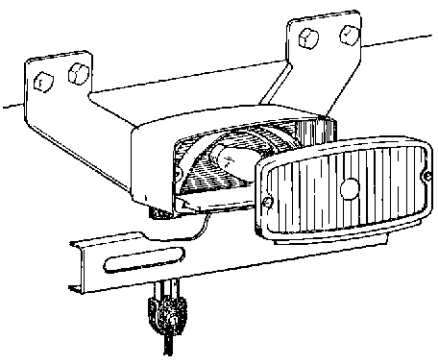
Replacing Light Bulb

a. Remove lens by unscrewing 2 screws around parking lamp lens
b. Remove bulb by pushing in and turning counterclockwise



Parking Lamp

3 Tail and License, and Stop Lamp



Tail and Stop Lamp

This is all one lamp and is installed above the license plate. The tail and license lamp will light on all positions of the headlamp switch except "off" position. The light bulb used is of the double filament type and serves all lamps.

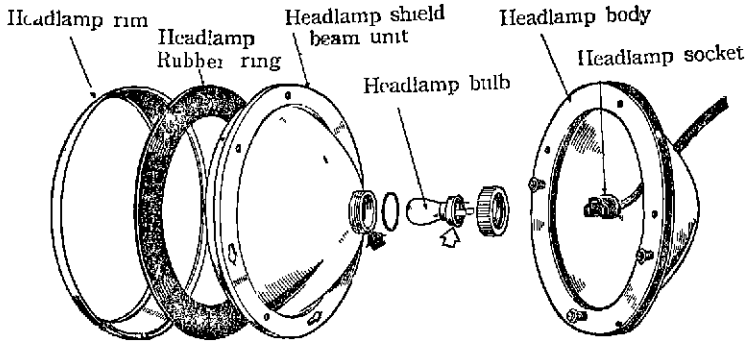
Replacing Light Bulb

a. Remove lens by unscrewing 2 screws around the lens
b. Remove bulb by pushing in and turning counterclockwise

Toyota Land Cruiser Lighting Equipement

1 Headlamp

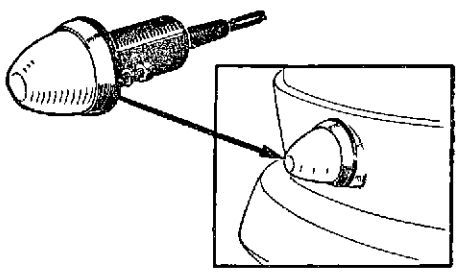
The headlamps are of the semi-scaled type being the same as that used on the Toyota Model FA 60 Cargo



Replacing of Headlamp

The headlamps are turned on at the first step of the headlamp switch and the changeover from the main to dimmer light is made through thef oot operated dimmer switch. The light bulb used is 45 watts for main light and 35 watts for dim light.

To replace lamp, unloosen screw at bottom of rim and turn rim slightly to remove Then take out sealed beam unit complete and remove nut on the back end of the reflector to remove bulb complete. When installing match mark on bulb and reflector.

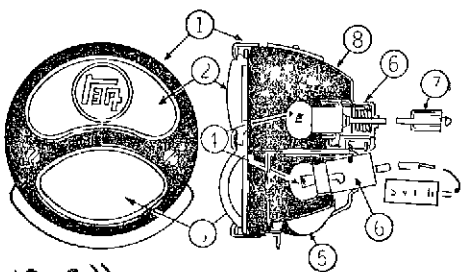


Parking Lamp

2. Parking Lamp

This lamp is located below each headlamp and the bulb used is 8 watts
The second step of the lighting switch is used to turn on this light To remove, unscrew 2 nuts on the underside of the fender and pull out.

3. Tail and License Lamp



① *Front Cover*
② *Stop Lamp Glass*
③ *Tail Lamp Glass*
④ *Light Bulb*
⑤ *Number Glass*
⑥ *Lamp Socket*
⑦ *Coupling*
⑧ *Lamp Body*

(SIMILAR TO FORD MODEL A (~1928))

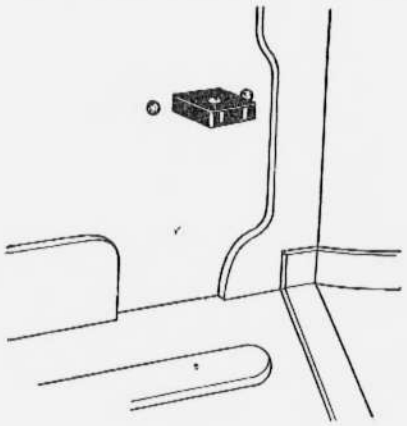
The license lamp is installed on the rear of the vehicle and lights at all steps of the lighting switch. The bulb used is 8 watts.

4. Stop Lamp

The stop lamp operates when the brake pedal is depressed, this action being transferred to the stop switch on the brake master cylinder.

5. Inspection Lamp Receptacle

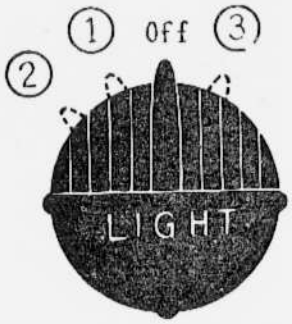
A receptacle is provided on the opposite side of the drivers seat so that if it becomes necessary to make inspection of the vehicle at night, the inspection lamp can be plugged in.



Inspection Lamp Receptacle

Lighting Switch and Fuse

A 2 stop switch is used to operate the headlamps, parking lamp, and other lamps and is as shown in the illustration.



① *Headlamp, Tail and License Lamp, Meter Pilot Lamp, Dash Lamp*
② *Parking Lamp, Tail and License Lamp, Meter Pilot Lamp, Dash Lamp*
③ *Tail and License Lamp (During parking)*

The headlamp beam changeover is made by the dimmer switch on the toeboard.

Fuses are provided on the lighting switch, each lamp circuit passing through a fuse. When a large current flows through any lamp circuit, the fuse will blow out and protect the circuit.

The current flowing through the lighting switch is 21 amperes maximum and about 17 amperes normal. The fuse used has capacity of 30 amperes direct current.

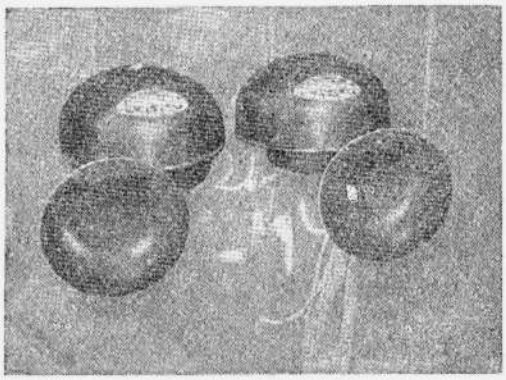
Using wires and other means as substitute when fuse blows out should absolutely be prohibited.

Dimmer Switch

The dimmer switch is located on the toeboard between the clutch and brake pedals.

Depressing this switch makes the changeover from the non glare filament to the long distance filament in the headlamp.

Horn



The horn is of the Voltex type and contains both hard and soft tones. The horn is located inside the engine room being attached with a bracket to the upper part of the cowl front stay.

A horn should normally satisfy the following conditions.

1. The volume should be large and the tone should such that it can be clearly distinguished from the surrounding noises.
2. The sound should concentrate in direction of vehicle travel and should not have much effect in other directions.
3. The tone should be musically agreeable and should be free from undesireable noises.
4. The sound should be such that persons can determine speed of vehicle.

The Voltex type horns are of two types, the hard tone and soft tone. Also, these two type can be furnished in a set so that it is possible to provide a wide range of sound.

Part Name	Part Number
Horn Assembly (Set)	D-BY 58000 or RH 58000
Hard Horn Assembly	D-BY 58000 or RH 58600
Soft Horn Assembly	D-BY 58700 or RH 58700

The horn consists of the horn proper and the horn relay. The tone, whether agreeable or not, depends largely on its adjustment. When manufactured, each horn is sound tested separately and accurately adjusted. If adjustments become faulty, correct in following manner.

1. Horn Wiring

The horn wiring is connected such that the horn can be sounded without turning on the ignition switch.

2. Method of Adjustment

a. Adjusting Horn Contacts

Check contacts and if found oxidized or burned, polish with a fine file or sandpaper. Also if the upper and lower contacts are found out of line, loosen bolt on point holder and correct.

Connect ammeter between horn and horn relay by removing horn (+) cord and connecting to ammeter (+) terminal and connecting ammeter (−) to horn (+) terminal. Then press horn button and while observing ammeter reading, adjust upper terminal by screwing in or out until the ammeter reads 9 amperes If the ammeter shows a reading while the contacts are open, it indicates a shorted coil or defective insulation and should be checked If the points are burned, the specified current may not flow so that they should be polished

If both upper and lower points are in good condition and are contacting properly but the current does not flow, it will be necessary to check for broken wire in coil or discharged battery.

If on pushing the horn button, the ammeter needle falls out, it will be necessary to check for broken breaker spring, broken moving bolt, and defective insulation.

b Defective Horn Relay

The main trouble in horn relay is burned contacts so that they should be dressed down with a fine file or sandpaper until the points contact evenly. If the horn relay does not operate when the horn button is pushed down, it is due to defective wiring or break in coil winding.

The horn relay should be adjusted so that it will operate at about 4 volts, the spring tension and point gap made to 0 45 to 0.55 mm and the air gap to 0 27 to 0 33 mm

3 Adjustment Specifications

a Horn

Nominal Voltage	6 5 volts
Nominal Current	9 amperes
Operating Voltage	5 to 7 volts
Sound Volume	105 to 115 horn
Coil Resistance	0.09 to 0.11 ohms

b. Horn Relay

Closing Voltage	3 to 4 volts
Coil Resistance	5.5 to 6.1 ohms
Air Gap	0.27 to 0 33 mm
Point Gap	0,45 to 0 55 mm

4 Operating Instructions

a To operate, there should be at least 5.5 volts on the horn terminals

b Cover and other parts should be securely tightened to prevent vibration.

c. The horn mounting part should be installed so that it has good electrical contact.

d Do not sound horn continuously but press horn button lightly and shortly as this will prolong the life of the horn and relay by preventing burning

out of the points

e. The horn should not be installed on any thin sheet metal part as this will cause vibration and tend to make the horn sound bad The horn should be securely mounted on a rigid part.

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