# Volume 4

*January to September 1966*

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assist servicemen in Service Stations, Independent Garages and Fleets.



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## Note from the Editor

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# Shop Tips FROM FORD

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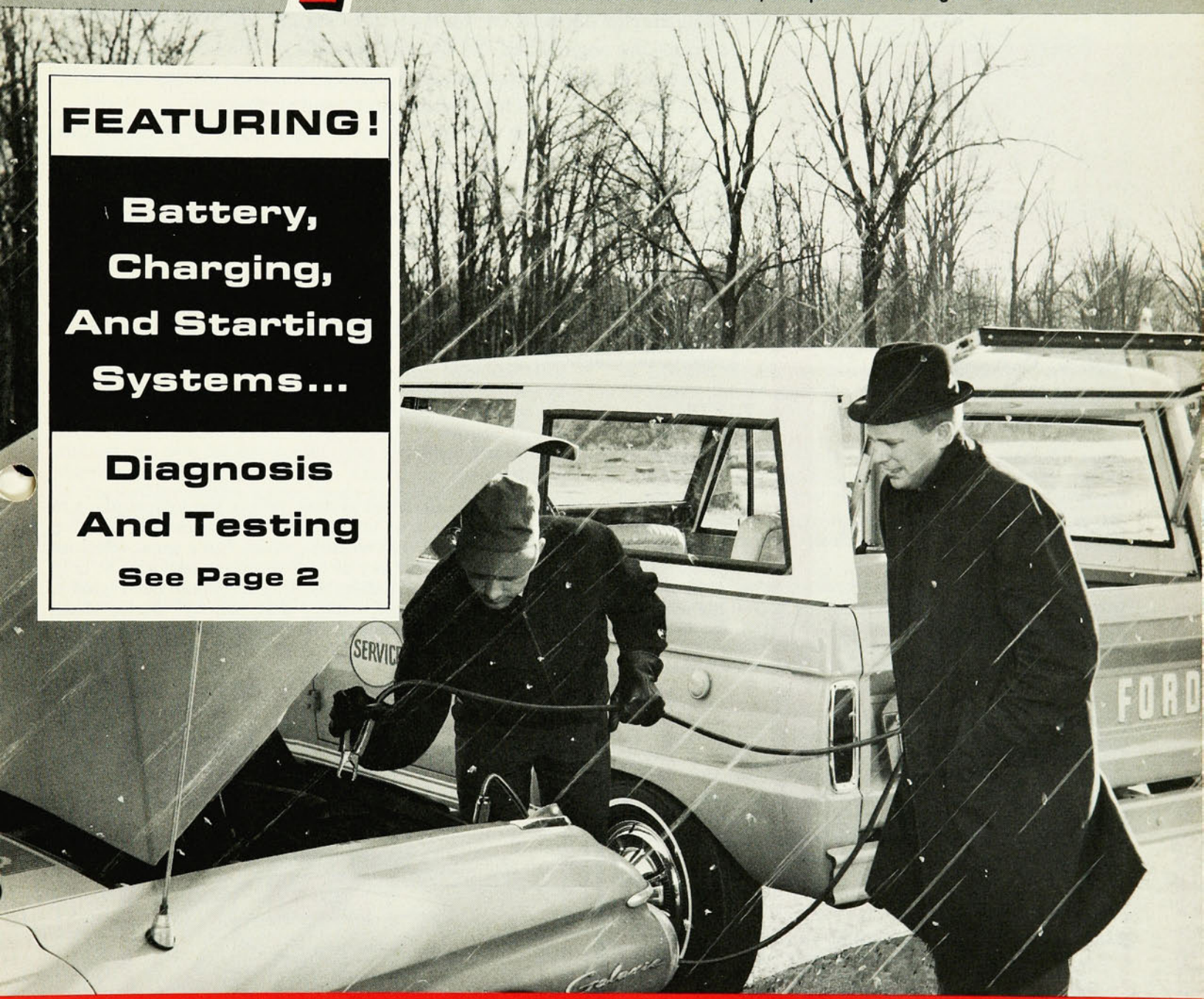


## FEATURING!

**Battery, Charging, And Starting Systems...**

**Diagnosis And Testing**

See Page 2

From Your Ford Dealer

Be sure to file this and future bulletins for ready reference. If you have any suggestions for additional information that you would like to see included in this publication please write to: Ford Division of Ford Motor Company, Parts and Service Promotion and Training Dept., P. O. Box 598, Dearborn, Michigan 48121.

FoMoCo GENUINE PARTS

ROTUNDA

# BATTERY, CHARGING, and STARTING

## IN THIS ISSUE





The battery, charging and starting systems are all inter-related to each other, and each must perform its individual function to insure the complete system works properly.

The starter depends on the battery to supply the necessary power to crank the engine, and the battery depends on the charging system to keep it at peak performance to supply electrical energy not only to the starter, but to the ignition system and accessories.

A failure in any one system sooner or later leads to perhaps the most irritating of all automotive problems—"failure to start". Dead or low charged batteries, excessive use of water by the battery, slow cranking speeds, extreme headlight dimming on idle, ammeter or indicator lights showing little or no charge are all signs that a problem exists which should be found and corrected.

Periodic service can usually prevent a "failure to start", but if it does occur, the best procedure to follow is to trace the cause in a systematic diagnosis procedure as recommended in this article.

## THE BATTERY

The battery is the heart of the electrical system, and is the logical place to start when looking for conditions that might cause an electrical or starting problem. This is especially true in cold weather, which has a great effect on battery efficiency. A fully charged battery at 0° Fahrenheit performs at only 40% of the capacity of a fully charged battery at 80° Fahrenheit. See Figure 1. It's easy to see that a partially charged battery that "got by" during warm weather is almost certain to cause trouble as the temperature drops.

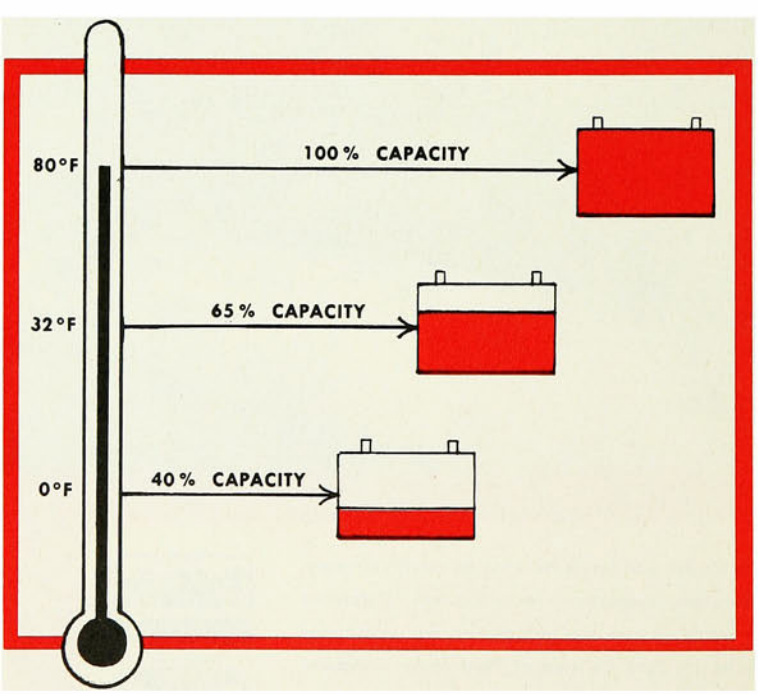



*Figure 1—How Temperature Affects Battery Capacity*

## DIAGNOSIS AND TESTING

The best approach to troubleshooting battery problems is to find out as much information about it as possible.

1. What is the battery complaint?
2. How long has the battery been in service (miles-months)?
3. Is this the first incident of trouble? If not, how long has the battery failed to perform satisfactorily?
4. Were any electrical units left on inadvertently for an extended period?
5. What are the driving conditions?
6. If the battery failed previously, how was it charged (amperes and hours)?
7. Has the regulator setting been checked against specifications?

## VISUAL INSPECTION

The first step is a visual inspection of the battery. The top must be clean and dry. If wet, dirty, or acid soaked there will be a constant discharge of electricity. Note the level of the electrolyte. If it is allowed to get below the top of the plates and water is not added, permanent damage can result and the battery can never be fully recharged. Check the battery case for damage or signs of cracks. If seriously damaged, it should be replaced. Also check the condition of the battery cables. Loose, worn or corroded cables can cause battery discharge.

## CAPACITY TEST

The next and most important step is checking battery capacity, which is the ability to furnish current and maintain minimum necessary voltage. If the battery passes this test it is in satisfactory condition. However, it may require some additional charging to bring it up to peak performance. The test MUST be performed with the BATTERY SOLUTION between 60° F and 100° F, since temperature affects capacity. A high rate discharge tester, such as a Battery-Starter tester with a carbon pile resistor and a voltmeter is used to make the first part of the test.

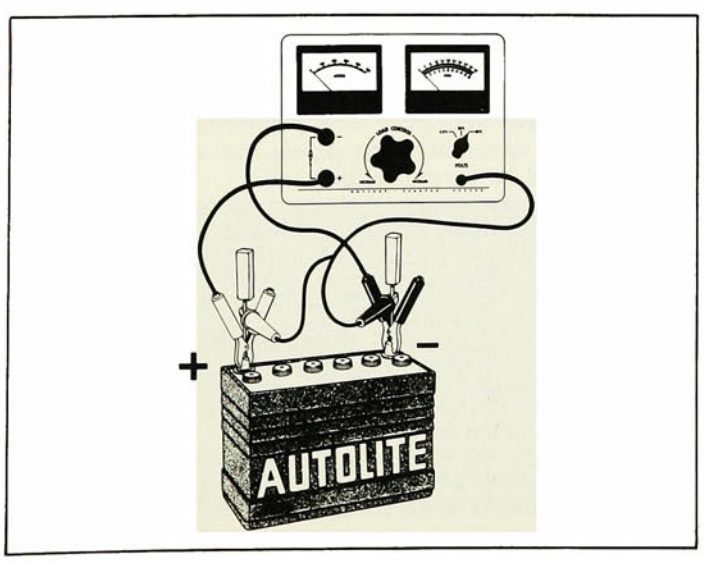



*Figure 2–Capacity Test Connections*

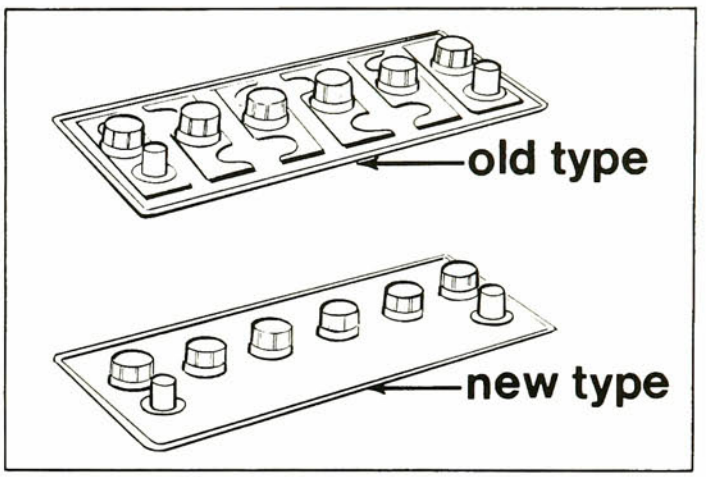



*Figure 3–Battery Comparison*

## TEST CONNECTIONS

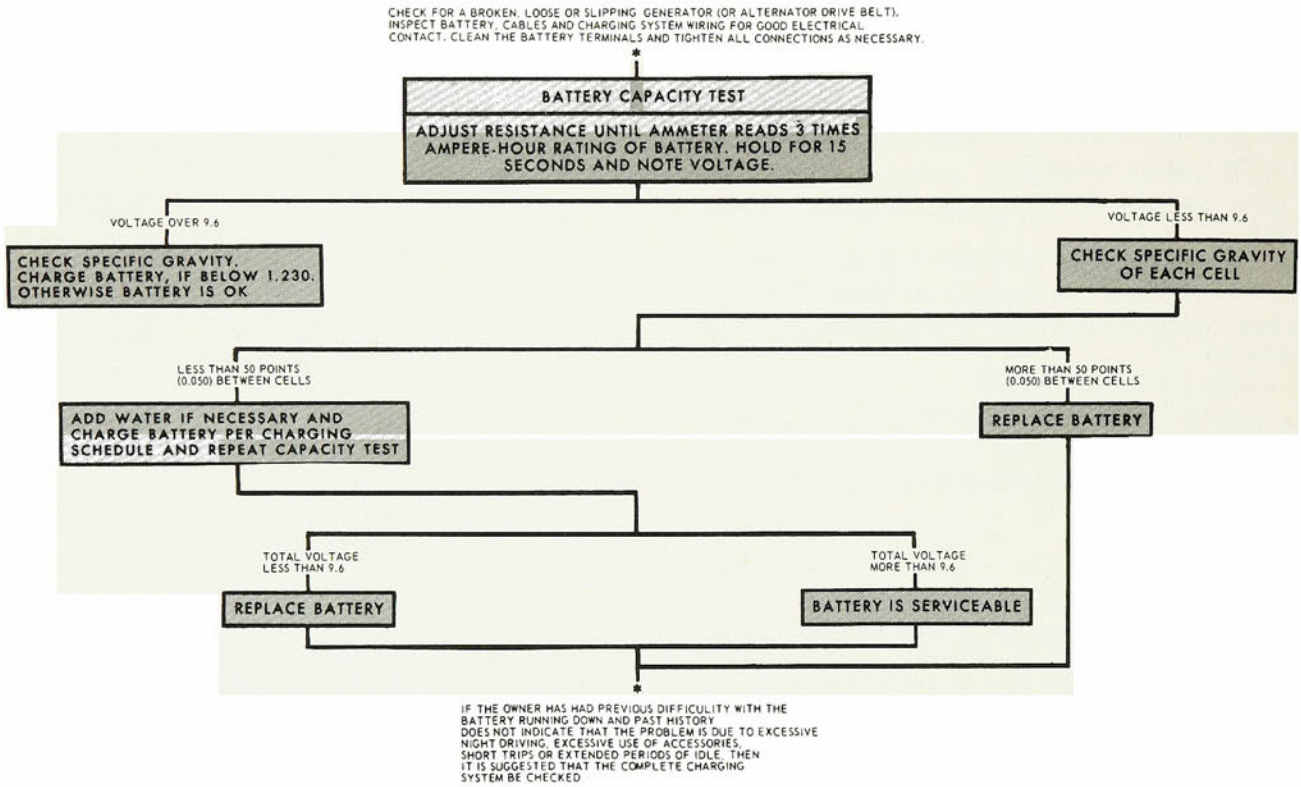
1. Connect the appropriate leads to the battery posts. (See Figure 2.) Be sure the voltmeter clips are connected DIRECTLY to the battery posts, and not to the heavy tester clips.
2. Adjust the carbon pile resistor until the ammeter reads 3 times the ampere-hour rating of the battery. (A 45 ampere-hour battery should read 135 ampere load).
3. Hold for 15 seconds and note the voltage reading. Avoid leaving the high discharge load on the battery more than 15 seconds.
4. If the voltmeter reading is 9.6 volts or more, the battery has good output capacity and should readily accept a charge, if required. If the voltmeter reads less than 9.6 volts, additional charging is required. Follow the procedure shown in the Battery Test Road Map, page 4.

## SPECIFIC GRAVITY TEST

To complete the battery test, a hydrometer must be used to test specific gravity. NOTE–An open circuit voltage tester with probes to test individual cells must not be used in place of the hydrometer on batteries that have a completely sealed top. (Figure 3) The sealing compound must not be pierced with test probes, as the holes will cause battery self-discharge due to surface dirt, acid or contamination.

**CAUTION: A specific gravity test should never be used by itself to determine if a battery is serviceable. The capacity test must be made first. The specific gravity test only indicates the strength of acid in the electrolyte and thus the degree of charge on the battery. Only the capacity test actually tests the condition of the battery to deliver current by putting a load on the battery. Only a capacity test can detect internal short circuits, excessive sulfation, and other types of internal, mechanical, and chemical damage that affect a battery's ability to deliver current. Such "old" or deteriorated batteries may pass the hydrometer test, but will soon become discharged again causing further electrical problems.**

## BATTERY TEST




The hydrometer measures the degree of charge on each cell by weighing the amount of acid in the electrolyte. The electrolyte consists of water and acid, and the acid is used up as the battery is discharged. When fully charged, electrolyte at 80° F has a specific gravity of 1.280 times that of water. Figure 4 shows specific gravities for various percents of discharge.

In reading a hydrometer, the barrel must be held vertically with the fluid at eye level. Readings taken at sharp angles usually are very inaccurate. Just the right amount of fluid must be drawn up into the barrel, with the bulb fully expanded to lift the float freely, so it neither touches the sides, top nor bottom of the barrel. Always use a hydrometer kept clean with soap and water so the float will not stick to the sides. The float should also be inspected for cracks, which would allow acid to enter the air tight float and make readings unreliable.

Also a temperature corrected hydrometer should be used, because specific gravity is affected by temperature. The standard is 80° F. The volume of acid expands when heated and shrinks when cooled. For every 10° F ABOVE 80° F, four gravity points (.004) must be added to compensate for expansion, and for every 10° F BELOW 80° F, four gravity points (.004) must be subtracted to compensate for contraction. Most hydrometers today include this feature.

If water is added to facilitate a specific gravity reading, or if the battery is in a low state of charge from a rapid discharge such as prolonged cranking, the battery must be charged until all the cells are gassing freely, before taking a specific gravity reading. Otherwise the readings will be unreliable.

## BATTERY CHARGING

**SLOW CHARGING** is the only method which will fully charge a battery. Slow charging should be at a rate of 1 ampere for each positive plate per cell for a sufficient time to fully charge the battery. The battery is fully charged when the cells are all gassing freely and the specific gravity ceases to rise for three successive readings taken hourly. It may sometimes require more than 24 hours to fully charge a battery, since badly sulphated batteries require more charging time than normal batteries.

**HIGH-RATE CHARGING** can be accomplished with the battery in the car. High-rate chargers cannot be expected to fully charge batteries in an hour, but they do charge a battery sufficiently to allow continued service commensurate with its condition and state of charge. A high-rate charge should always be followed by slow charging to bring the battery up to full charge. High-rate chargers, can inflict irreparable damage on a battery if the safeguards provided by the manufacturer are ignored or circumvented by the operator. Therefore, the operating instructions issued by the manufacturer should be carefully followed.

| SPECIFIC GRAVITY | STATE OF CHARGE |
|---|---|
| 1.260—1.280 | 100% CHARGED |
| 1.230—1.250 | 75% CHARGED |
| 1.200—1.220 | 50% CHARGED |
| 1.170—1.190 | 25% CHARGED |
| 1.140—1.160 | VERY WEAK |
| 1.110—1.130 | DISCHARGED |

*Figure 4—Specific Gravities For Percents Of Discharge*

The charge rates and time schedules shown on page 5 are based on an average charge rate of 35 amps for the

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