

TERRAPLANE HUDSON

Service

TECHNICAL INFORMATION
PARTS—ACCESSORIES
MERCHANDISING

Issue 4

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1935 Series

Engineering and Service

The phenomenal improvement in automobiles in the present Terraplane and Hudson price class, which has taken place in the last five or six years, has brought with it corresponding service problems. Reviewing this evolution, horsepowers have increased from about 50 to the present standards of 80—125; compression ratios have gone up from about 5.0 to 1 up to 6.0 to 7.0 to 1; car speeds have increased from about 60 mph up to over 90 mph and engine revolutions have increased from 3000 rpm to 4500 rpm and above. This tremendous advance has been made with very little increase in engine displacement, with only a relatively slight increase in weight and no increase whatever in cost. Riding qualities have been vastly improved; body dimensions have been greatly increased. In short, almost every feature of de luxe cars is today incorporated in the lowest price range.

The technical problems which have faced every company in this field have been tremendous. A few years ago many of you, like myself, have driven down to Indianapolis to see skilled and fearless race drivers handle specially prepared track cars on that track and have marveled at the ability of the machines to stand up and of the drivers to handle the cars. Today we are delivering stock sedans to totally unskilled drivers for use on all kinds of highways, the performance and top speed of which is as good as the race cars of a few years ago.

These really wonderful, modern, low-priced cars naturally require a quite different type of service from the low compression, slow, inefficient automobile of a few years ago, and their vastly improved performance has brought many new service problems to the front which were non-existent a short time ago. A car capable of only 60 mph naturally never experienced handling problems, cooling problems and brake problems which are immediately apparent when the same car is capable of 80 mph.

Both our Terraplane and Hudson stand in the very front rank in this development of low priced vehicles, particularly in the maintenance of *silence* and *smoothness* with high performance. Your department is one of the most important in our organization in its function of maintaining this remarkable performance for continued owner satisfaction.

S. G. BAITS
Assistant General Manager

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Spring Service Campaign

The purpose of a Spring Service Campaign should be, first, to bring into your place of business as large a number of car owners as possible and, second, to sell them the service their cars require rather than just the service they ask for.

In planning a campaign of this kind, the first consideration should be given to the Service Department, to get it in order to handle the services that are most essential to owners during the spring season, instructing the mechanics and the service salesmen to do their jobs efficiently and preparing the parts and accessory stocks to take care of requirements. After all these things are in order, the campaign should then be started to bring in the customers.

Appearance of the Shop

In preparing the shop, general appearance should be taken care of first. Regardless of the present appearance of the shop, a fresh coat of paint both inside and outside will improve the general appearance. Possibly your place is being overlooked because it has looked the same too long. A change of color may be all that is necessary to attract attention and new customers.

Use clean, cheerful colors; red, blue, green and orange, in proper combination, look clean and are attractive. Inside of the building, it is particularly important that bright colors be used to improve the lighting. Aluminum or white gives a good reflection of light from upper walls and ceiling.

The colors for the lower walls and the equipment are important to keep a clean appearance and to make the equipment noticeable, giving the customer the impression of a well-equipped shop. A bright red or orange for the lower walls with a border of black to separate it from the upper lighter color will give a good background, against which the equipment will stand out if painted in a good bright green or blue.

Proper colors not only make the shop look clean but help to keep it clean. When painting the lower walls be sure to paint back of the benches, clear down to the floor, and then paint the floor from the walls out to the line of the front of the benches the same color as the walls. Any old parts or dirty rags that may be thrown there can be easily seen and won't be forgotten. Try it and see how much easier it is to keep a good clean appearance.

Identify your building as a Terraplane-Hudson Service Station. Place a standard Terraplane-Hudson Parts and Service Sign near the entrance so that it is conspicuous to car drivers.

This sign is a durable vitrolite sign in red, white and blue, and can be obtained on regular parts orders for \$4.75.

A Radio Display Stand—with radio installed—will help dress up your department and attract prospects.

Arrangement of Equipment

Maybe you have thought of changing things around a bit to make them more convenient. Now is a good time—a change in appearance will do your old customers good and possibly help get new ones. Get your equipment for lubrication, motor testing and brake work out where it can be seen; remember you are competing with the super-service stations down the street and most of their equipment can be seen from the street—**don't hide yours!**



A well constructed gasket board which makes stock handling easy, requires a minimum of space and is a good display.

The dimensions of the board are: overall height 87½"; overall length 77¼"; overall depth—shelves 13½"; base 24½".

Distance between shelves—8".

Slope of shelves—2" in 4".

Distance from floor to top of bottom shelf—(measured at front of upright)—12¾".

MATERIAL REQUIRED:

2—Uprights—4" x 4" x 84¾".

9—Shelf Boards—1" x 15½" x 6".

1—Top Brace—1" x 3" x 6' 5¼".

2—Upright Base—2" x 6" x 24½".

4—Upright Sub Bases—2" x 4" x 9½".

4—Angle Braces—2" x 4" x 15".

1—Cross Number Plate Holders.

2—Cross Right Angle Screw Hooks—¾" x 2½".

Parts Department as a Display

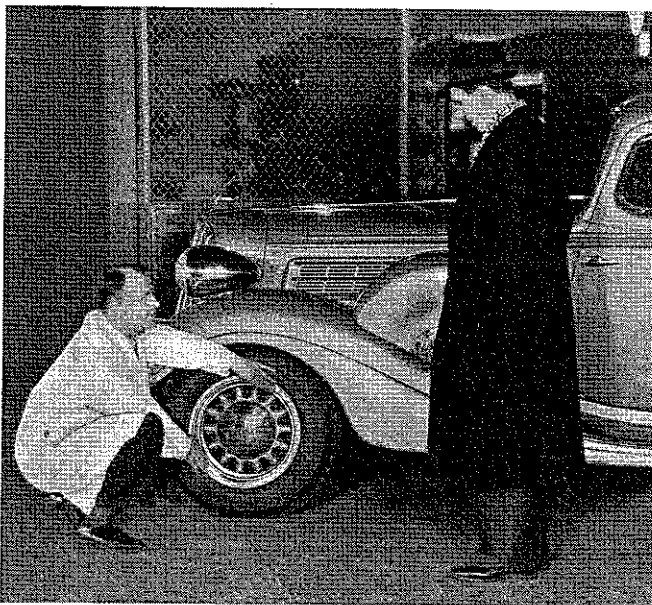
Analyze the location and setup of the parts stock room. Is it conveniently located for both the retail trade and the shop? Are the parts attractively displayed? It should be remembered that the primary function of this department is to sell, not merely to provide a storage space for parts and accessories. Just any odd corner will not serve as a location for

the Parts Department. It must be out where the customers can see it and be impressed with its completeness and efficiency. This applies to the smallest service station, as well as to the largest. This is also the time for the spring clean-up. The entire Parts Department should be thoroughly cleaned and painted. Nothing adds to the attractiveness of any place like a fresh coat of paint in suitable colors.

No one can expect to sell goods unless they are properly displayed. A proper display of automobile parts and accessories is just as productive of additional sales as the displays in drug stores or department stores.

Accessory Display

For the display of accessories we recommend the display board, photographs of which were shown in the December issue of the Service Magazine. It is equally important that your stock of fan belts,



Demonstrate Accessories on the Customer's Car

gaskets and other fast moving parts be displayed on a special equipment board provided for the purpose, and should be so placed that they are visible from the parts counter. If you have counter or showcase space this should be utilized for the display of seasonal parts and accessories, such as seat covers, cowl ventilator screens, wheel mouldings, bumper guards, radios and car polish materials. Such displays should be changed frequently to hold the interest and attention of customers.

Special attention should also be given to window display, if available.

Another point which should not be overlooked for display purposes is the Service Receiving Department. Customers bringing in cars for service are more easily approached on the subject if a display is readily available.

Customer Impression

After you have finished painting and rearranging, take a mental inventory and ask yourself the following questions: Do you have the equipment and material necessary to do a good job? Can you sell

the public on the idea that you can do as good a job if not a better one than any of your competitors? **Remember, it isn't enough to be able to do the job, you have to sell it before you get any profit.**

Your sales in engine tune-up and lubrication, brake jobs, and wheel alignment depend almost entirely on the equipment you have, as the public has been taught by specialized service stations that equipment is necessary for this work. Accessory sales cannot be made unless you have the material in stock and properly displayed. You must meet your competition on an equal basis if you want your share of the business. Bring your stock and equipment up to date.

Spring Service Operations

Prepare specially at this time of the year for work that will renew the performance of the car, its safety at high speeds and reliability on long runs in the hot weather that is ahead, and sale of accessories which add to comfort, appearance and pleasure.

Lubrication

The lubrication equipment should be in a well lighted area adjacent to the receiving area. This equipment makes a good display and gives the owner an opportunity to see the underside of his car, see its condition, and this helps in the selling of service operations on tightening spring clips, replacing shackles, adjusting wheel bearings and steering gears, tightening body bolts, and similar operations. Do not overlook the opportunity to sell these operations during your spring campaign.

Shock Absorber Service

Shock absorber service should also be sold as a part of the lubrication service. This service is important both for comfort and safety and should be sold particularly in connection with any front wheel aligning or steering gear operations.

Engine Tune-up

The proper engine tune-up can certainly be included in every order during the spring campaign. Engines have become sluggish from the continuous relatively low speed operation during the winter months, the extensive choking that has been done in many instances, causing excessive carbon deposits in the cylinder heads and the piston rings and the valve stems. Tuning the engine without correcting this gummed and carbon condition will not be satisfactory to the owner. If a carbon and valve job cannot be sold, this condition can be temporarily relieved by injecting gum solvents into the intake manifold; however, complete removal will also require that an oil with carbon dissolving properties be added to the regular crankcase oil to complete

Parts and Labor Ratios

It must be remembered that the ratio of parts sales is always proportionate to labor sold. Your labor goes down and your parts volume goes down as surely as the sun rises in the heavens in the morning.

the job after the condition has been temporarily relieved by injection through the manifold. Although this may be considered as part of an engine tune-up, it should be sold separately, and it will give the shop an opportunity for an additional profit.



W. G. Stroud, Service Manager of Loscy Motors, Incorporated, sells air cleaner service. Bill says he got his idea at the National Parts and Service Managers' Convention at Detroit in December.

From his report on the number of air cleaners he is servicing, he will soon have the expense of his trip paid from these extra profits.

Electrical Inspection

The electrical system is an important part of the tune-up and should be checked completely from the battery ground strap to the spark plugs. Your inspection will reveal numerous cables that require replacement, including in many instances the high tension cables. The appearance of the high tension cable does not indicate the condition of the insulation. It should be tested with proper equipment to determine the electrical losses when the engine throttle is rapidly opened.

In connection with the engine, do not overlook the air cleaner and muffler service. A clogged air cleaner or a clogged muffler will not only reduce the performance but may result in the burning of valves or excessive gasoline and oil consumption.

Cooling System Service

The cooling system is ready for attention, and the suggestion that the heater be disconnected or turned off is a good means of approaching this servicing operation. A further check will also reveal that new hoses are necessary, or new side plate gaskets, and also that the cooling system should be cleaned.

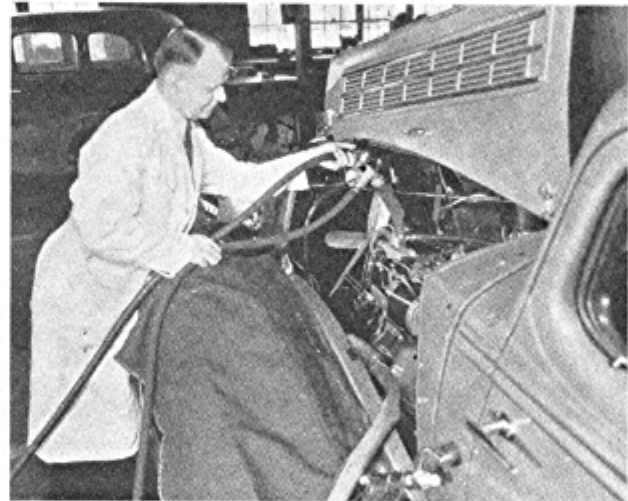
Since the average cost to the owner for having the radiator removed and properly cleaned is approximately \$5.00, the use of flushing equipment, which cleans not only the radiator but rather the entire cooling system, makes it easy to sell this operation at a very good profit. The reverse flushing equipment is not expensive, is easily installed, and requires only air and water to operate it. This equipment is not in

After the Spring Campaign—What?

Only consistent follow-up will keep them coming back regularly. The Terraplane-Hudson Owner Follow-up System provides the basis of intelligent owner contact.

as extensive use as it might be, and its installation in your shop gives you a real opportunity to merchandise this service, not only to owners of Terraplane and Hudson cars, but to owners of all makes of cars. This equipment is useful throughout the year; however, particularly so in the spring, summer and fall.

By using Terraplane-Hudson radiator cleaner to loosen hard scale, reverse flushing and adding Terraplane-Hudson Rust and Corrosion Inhibitor to the cooling system it can be kept from accumulating sediment throughout the entire summer and fall and insure efficient operation during the hot weather.



COOLING SYSTEM REVERSE FLUSHING

The illustration shows the reverse flushing of the cylinder block. Note the simplicity of the equipment and its use. An air hose and water hose connected to the injector nozzle is all that is needed for operation. The injector nozzle is stepped so that it will fit all popular radiator hose sizes. Note the outlet hose connected to the lower cylinder block hose leading the water and dirt away from the car.

To flush the radiator, the injector is attached to the lower radiator hose while the outlet hose is connected to the radiator filler. This equipment is available through the Hinckley Meyers Company, Jackson, Michigan, Part No. J-708 Cooling System Reverse Flusher, price \$7.00.

Wheel Alignment and Steering Adjustment

After a car has seen a winter's use either on slippery pavements, ice ruts, or mud-rutted roads, the alignment of the front wheels requires attention, both from the standpoint of preventing excessive tire wear and also for proper handling. In connection with this operation, be sure to include steering gear adjustment and shock absorber service. These are all essential to the proper handling of the car, particularly at high speeds.

Cooling System Service

Get rid of rust, corrosion and sediment in the *entire* cooling system and be ready for the hot summer weather.

A clean cooling system lasts longer and gives the engine proper protection.

Complete cooling system—(not radiator only) cleaned thoroughly and Hudson Rust and Corrosion Inhibitor put into the cooling system to keep it clean and efficient all summer—\$3.25.

An overheated engine will burn valves—destroy spark plugs—score pistons and cylinder walls—destroy piston ring seal—increase bearing wear—increase gasoline and oil consumption. Have the cooling system cleaned now!

Use Sales Posters in the Service Station to Call Attention to Your Specialized Service

Brake Service

Although the brakes may be functioning satisfactorily, remember that higher driving speeds will be maintained as soon as the roads are clear of snow and ice and will demand better brakes than have been necessary with the lower driving speeds of winter. The lining condition must be better, the adjustment equalized, and there must be more pedal to insure against brakes fading when attempting to stop rapidly from high speed. The genuine factory lining installed with brake mortar, which is included in every lining set shipped from the factory to give it a perfect seat on the shoe, not only gives you a good sales point with a car owner, but also insures more uniform brake action at a lower cost to you, due to the fact that you will not have as much readjusting to do after the lining has been applied.

Cleaning and Polishing

A good cleaning inside, outside and underneath can be sold in conjunction with most any of the spring service operations. Use Hudson Upholstery Cleaner to renew the inside appearance. Hudson Polish—either wax or oil base—will give a high luster to the outside finish. Hudson Running Board and Tire Dressing completes the job.

If you can't sell the job—sell the cleaner and polish.

A TIP FOR PARTS MANAGERS

Double spaced parts orders can be handled quicker and with less chance for error in filling and checking, both in your parts department and at the factory.



*Clutch Oil
Shock Absorber Fluid
Polish (Oil Base)
Polish (Wax Base)
Used Car Cleaner
High Gloss Wax
Tire and Running Board Finish (Black)
Tire and Running Board Finish (Clear)
Upholstery Cleaner
Radiator Cleaner
Rust and Corrosion Inhibitor*

Grouped above are the various items of cleaners, polishes and special lubricants. All have a very definite place in the spring campaign.

Make sure your supply on hand is sufficient to meet requirements.

Parts Stock

A practical survey should be made of your parts situation, as related to items and quantity, rather than dollar value. Based on this survey, you can estimate your needs for the future and build up your stock to the point where you will be in a position to render prompt and efficient service. Nothing is more aggravating to a dealer or an owner than explanations for not having a part **right now** when required for service jobs. The usual increased demand for parts because of seasons and better business conditions is always in proportion with an increase in car sales volume. Car production requirements will soon tax our plant. Our sources of supply on both current and past model materials will be in a like position. Therefore, we must all anticipate our spring requirements so that there will be no disappointments anywhere along the line.

Instructing Shop Personnel

A meeting of the shop personnel should be called to discuss the various operations which will be performed most frequently during the spring campaign, so each mechanic will know exactly what is to be done and will be able to perform the operations rapidly and efficiently. The mechanics should also be on the lookout for additional operations which the car may require, and where the owners are permitted to enter the shops, the mechanics should have full information as to why each operation is required and the value of its operation to the owner.

The Service Salesman's Job

The service salesmen must be able to point out the need of the various operations and convince the owner of the necessity of having the work done and also of its value to him. Most of the operations that will be covered in the spring campaign are so interconnected that, regardless of what an owner may ask for when he comes into your service station, the entire group of operations can be called to the owner's attention as the service salesman inspects the car.

To help remind the salesmen of the various items, it would be well to have a small card typed listing the various operations and have spaces for check marking the items sold. This will keep in front of them during the entire day a record of their sales and remind and encourage them as they approach each new customer.

The amount of a service sale depends almost entirely upon what the service salesman tells the owner. Therefore, it is essential that the service salesman not only knows the car thoroughly in order to make a proper diagnosis, but he must also be able to put what he sees into language that is understood by the owner, and further convince the owner that he is getting full value for the money spent.

Bring in the Customer

There is probably no other business that has so definite a prospective customer list as does the automobile dealer's service department. An **up to date** list of owners of Terraplane, Hudson and Essex cars is an accurate list of service prospects. Such lists are available through the R. L. Polk Company, Detroit, Mich., at a very nominal cost. If your list is not up to date, get a new one.

Owners of cars built prior to 1931 cannot be considered service prospects unless they have been coming to your service station. All owners of 1931 and later cars should be contacted during the spring campaign.

A series of letters mailed at intervals of one week, for six weeks to two months, has proven to be most successful in bringing owners in. Each letter should describe a definite service that you offer. In this manner, each spring campaign item can be made a "Special" for a period of a week.

In selecting the "Special" be sure it is a basic operation that the owner is capable of determining is necessary. For instance, do not offer a valve grind as a special, but rather an engine tune-up. The engine tune-up price is low and the owner can tell this is necessary. If the car needs a valve grind, that can be sold when the car is tested.

Brake adjustment should be offered and a reline will be sold if necessary. If you give your price on a reline in a letter, it may cause the owner, who actually needs a reline, to look for a shop that will give a lower price without any consideration to the quality of the job. If you offer an adjustment at a reasonable price, the owner who is inclined to save cost will probably come in hoping he can get by with an adjustment. The service salesman then has an opportunity to sell the work needed.

The other spring items already mentioned can also be handled in a like manner. Remember the purpose

of the mail campaign is simply to get the owner in—then the service salesman must sell the work needed if the business is to be profitable.

Follow Up the Spring Campaign

The spring campaign is only a starting point in building up the service business. If it is not followed up, a large part of its value is lost.

A record should be kept of each customer who has come in and each should be contacted regularly at least once a month. The method of recording customers and following up is covered in this issue under the heading of Owner Service Follow-up. (Page 61.)

A successful service business is the result of consistent planning and persistent follow-up of customers. Without aggressive selling effort even mechanical perfection in the shop will not produce a profit.

M. S. BALD, Service Department.

Merchandising 1935 Radios

An important point has been brought out to us where certain companies have been exceptionally successful in the sale of radios. Some of our own dealers and distributors have tried it with the same results.

When an owner purchases a new car, these dealers have been, at their own suggestion to the owner, installing a radio in the car for the owner to try over a period of, say, a week or ten days, and telling him that, if at the end of that period he does not want to purchase it, it will be removed without cost to him.

One dealer in Baltimore, representing another company, installed 250 radios by this method of merchandising during 1934 and, out of the 250, removed only 3.

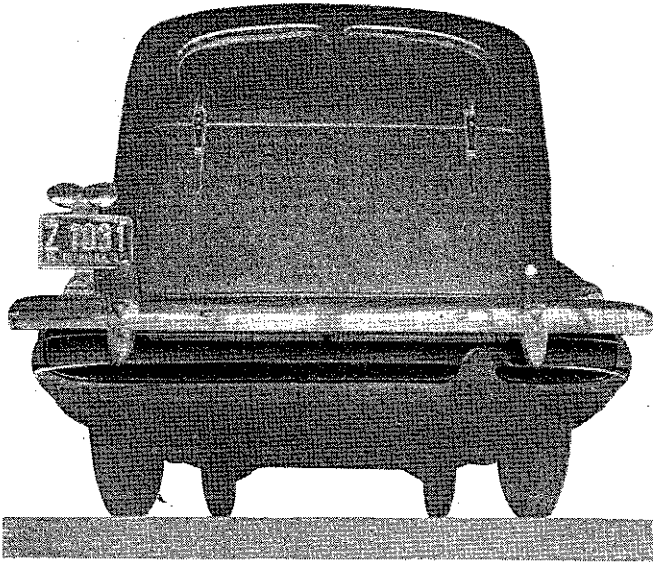
There is no obligation to the owner who, after once hearing the radio in his car, is reluctant to have it removed.

In the event that the car has been sold on the time payment basis, it is easy enough to re-write the papers and have the payments included with the car payments.

Merchandising 1934 Radios for 1934 Cars

There isn't any reason why the same plan cannot be adopted in the sale of 1934 radios to owners of 1934 cars. The boys in the service station will have an opportunity to contact with owners on this matter, and we are very sure that a large number of 1934 radios can be sold on the 1934 cars if it is suggested to the owner that he permit the installation of a radio in his car for a period of a week or ten days to see how he likes it, and we are quite sure you will find the results almost equal to those in connection with installing radio when a new car is sold.

Competition is very keen today and our dealers want to take advantage of every opportunity to sell merchandise through every available method.



REAR APRON SHIELD STONE BREAKER

The photograph above shows the application of the Rear Apron Shield Stone Breaker on Hudson and Terraplane cars. This shield is designed to prevent tires from throwing stones against the rear apron of the car, which, in time, causes the finish to chip off.

The shield is particularly essential on cars being operated on gravel roads and should find ready sale to owners driving cars under such conditions.

Governor

When delivering a new car to a customer, be sure he is advised of the governor which is installed on the carburetor. This gives the owner assurance that his car has not been abused before it was delivered to him and starts him off in a good frame of mind.

If the owner's attention is not called to the governor, he may get a poor impression, due to its restricted performance. Use the governor as a sales point—it's much easier than making an explanation after the owner becomes concerned about the performance of his car.

Accessory Catalogs

The appreciative and complimentary letters on the Accessory Catalog, received from the field, confirm our belief that this is a valuable addition to your accessory merchandising equipment.

The catalog has the advantage of covering the entire accessory line with pleasing photographs, and

the prospect can better judge their appearance than by a verbal description from the salesman.

It is an interesting book that will claim the attention of prospects from cover to cover and, if consistently used, will close many a sale that would otherwise not be made.

Be sure that each member of your organization who contacts the public has a copy for his own use.

License Plate Frames

We have added a new type License Plate Frame to the accessory line. This new frame is adjustable to all sizes of license plates, fully chrome plated, and carries the same guarantee of quality as other accessories.

The inclusion of this low price set of frames will not in any way affect your sale of the other frames listed under Part No. 111028, but will enable you to get the business in that price class which would otherwise be lost.

The Part Number of the License Plate Frame Kit is 115526, and the list price is \$1.50 per pair, subject to your regular discount.

Accessory Stock

Accessories Which Have a Definite Place in Spring Campaign:

- Water Temperature Gauges
- Windshield Cleaner Blades
- Gas Tank Locking Caps
- Clutch Oil (Hudsonite)
- Shock Absorber Fluid
- Polish (both wax base and oil base)
- Body Cleaner
- High Gloss Wax
- Radiator Cleaner
- Rust and Corrosion Inhibitor
- Running Board and Tire Finish
- Upholstery Cleaner

Other Accessories Can Be Most Profitably Merchandised Through Spring Season:

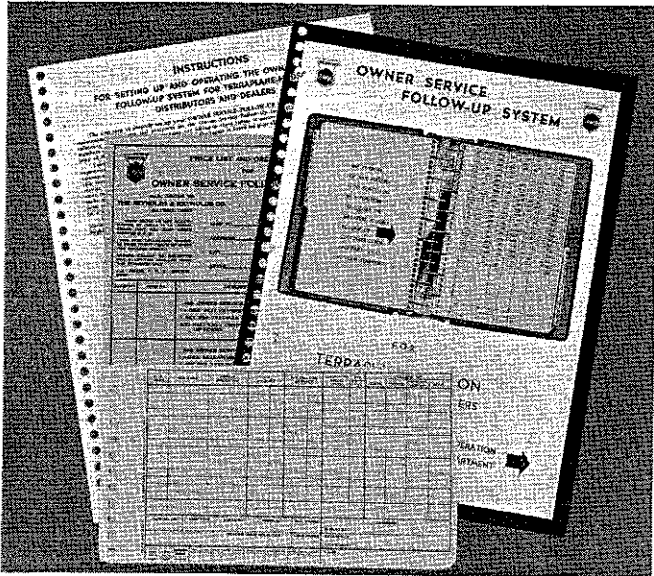
| | |
|--------------------------|------------------------|
| Radios | Seat Covers |
| Bumper Guards | Cowl Ventilator Screws |
| Trunks | Mirrors |
| Luggage Carrier Racks | Clocks |
| Double Windshield Wipers | Wheel Mouldings |
| Inside Visors | |

Equipment Necessary

Don't make things look complicated when they can be done simply and efficiently. Testing and adjusting of the Electric Hand can be done much more quickly and accurately—without guesswork—by using Testing Kit No. 47898.

The cost of this equipment is so low that the saving in time alone will pay for it on a very few jobs. We are supplying this equipment through our distributors at our cost. Take advantage of this special offer to improve your service to your customers.

Owner Service Follow-up



Illustrated above are the leaflets describing the Terraplane-Hudson Owner Follow-up System and its operation, also the price list and order form. These have been mailed direct to each Distributor and Dealer in the United States. Orders should be placed direct with Reynolds and Reynolds Company, Dayton, Ohio

Customers are as necessary to operating a Service Department as operating capital, equipment or men. Without customers there is no work to be done.

Do you know who **your** customers are? Do you know who your **good** customers are? Do you know where you can find **new** customers?

Memory is not reliable to accumulate all these facts and make use of them. Records must be kept, accurately, and in such a way that they are readily accessible.

The Terraplane-Hudson Owner Service Follow-up System makes possible an accurate record of each customer and each prospective customer and tells the complete story of your work on any car **at a glance**.

When you want to know who has been spending money with you and will likely spend more, the Owners Service Follow-up System supplies this information. This class of customer is the backbone of your business and should be given frequent personal attention. Keep in regular touch with them through a systematic follow-up.

You can make good customers out of other owners by consistent effort. Again, the Owner Service Follow-up shows which customers should be given attention and the progress you are making by your efforts.

This record is invaluable in keeping old customers and in getting new ones. You can also show an owner what work you have done on his car, when it was done and how much he paid for it—a quick reference when the owner's memory gets facts confused and blames you for conditions for which you are not responsible.

One new customer gained or one old customer satisfied will easily pay for the entire cost of the record.

You keep accurate records of your money. Why not do the same with customers? They are the source of your profits.

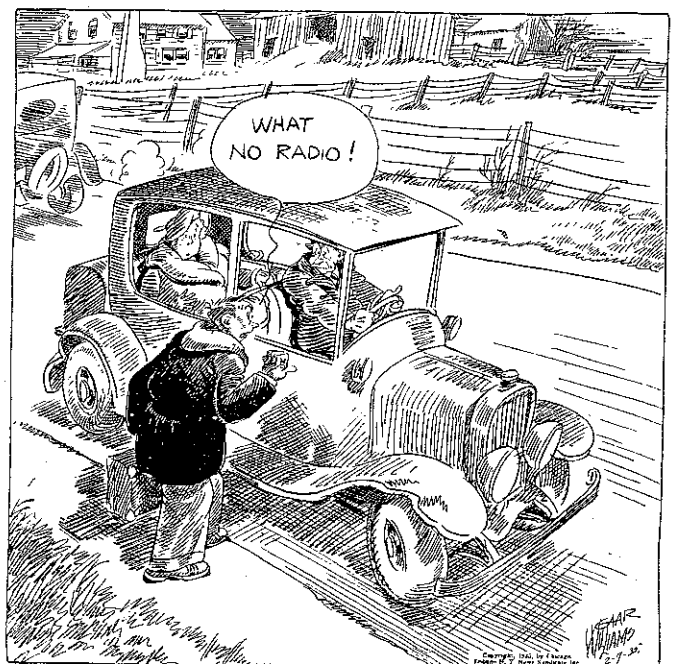
Merchandising Vanity Mirrors

A few days ago the Service Manager of one of our distributors brought to our attention his plan for merchandising Vanity Mirrors, which is proving extremely successful. We thought the plan so good that we are passing it on to you for your consideration.

Each service salesman carries a Vanity Mirror in his coat or jacket pocket and, when a car comes in for service, especially with a lady driver or passenger, the salesman immediately clips one of the Vanity Mirrors onto the visor and, in the majority of cases, collects the \$1.00. Very few of the mirrors installed in this manner are removed unsold.

As you probably know, the Vanity Mirror which we list under Part No. 114539 is an all-metal mirror, highly chromium plated, and is therefore unbreakable. Its convenience and attractiveness immediately appeals to every feminine motorist or passenger, and it has been proven that it is only necessary to call it to their attention to make the sale.

Why not give this plan a try-out for at least a week on your own service floor? **RIGHT NOW**, before other matters occupy your attention, instruct your parts man to release a Vanity Mirror to each service salesman. Give them the story and watch the results.



Courtesy Chicago Tribune

Engine Tune-up

The operation commonly referred to as engine tune-up may be performed to give easier starting, smoother operation, greater power or reduce gasoline consumption. The final goal is to obtain the original performance built into the engine by the manufacturer.

In order to get this renewed performance, everything which has to do with the burning of fuel and conversion of the heat of burning into mechanical power must be brought up to its original standard.

The various items to be considered can be divided into three groups, as follows:

- (1) Carburetion—Those parts which have to do with supplying fuel to the engine.
- (2) Electrical—All parts which have a part in supplying the spark to ignite the fuel.
- (3) Mechanical—The parts which convert the heat of burning of the fuel into mechanical power.

Each of these groups has its particular part in the efficient operation of the engine. Only with full knowledge of the function and systematic testing of each part can the final results be certain to be successful.

In this discussion, the second group—those having to do with igniting the fuel—will be considered first.

The Electrical System

The Battery

The battery may be considered the heart of the electrical system. It stores the electrical energy and supplies the current to the system as needed. In addition to supplying current for ignition it has also to take care of the demands for starting, lighting and accessories. Although the demands on the battery by the ignition system are comparatively small (2 to 5 amperes), it is essential that sufficient voltage is available for ignition at all times.

Starting the engine is the battery's biggest job. The battery must be able to supply the maximum current required for starting and retain sufficient voltage under this high discharge for ignition. Less than three and one-half volts will not supply the requirements for ignition, so it is important that the battery have sufficient capacity to maintain at least this voltage.

Battery Capacity

The capacity of a battery is reduced as the temperature is reduced, while the maximum demand on the battery is when starting in cold weather. For this reason, batteries are selected for Hudson and Terraplane cars which have a known capacity at 0° Fahrenheit under a 300 ampere discharge.

Testing a battery at normal temperatures is no indication of its capacity at low temperatures. However, for service purposes, testing must be done at normal temperatures and it is, therefore, important, if a battery replacement is to be made, that a

battery of known cold characteristics be used. This makes the service test a comparison with the original capacity at normal temperatures and it is then safe to assume that the cold characteristics will be in like relation to the original.

Lost Capacity

The following conditions reduce the normal capacity of the battery:

- (1) Discharge
- (2) Low electrolyte level
- (3) "Local action"
- (4) Loss of active plate material
- (5) Internal "short"

The normal gravity of a fully charged battery is from 1.270 to 1.285. When the gravity gets below 1.250 the capacity decreases rapidly.

Low electrolyte in the battery reduces the available plate area. The electrolyte should be kept at a level about $\frac{3}{8}$ " above the plates at all times.

If a battery is allowed to stand idle, it gradually loses its charge. The rate at which this discharge takes place depends upon the temperature. The higher the temperature, the more quickly the battery will become discharged. The chemical action inside the battery is confined almost entirely to the negative plate when a discharge of this kind takes place (instead of the normal chemical action on both positive and negative plates when a battery is externally discharged), so that a gravity reading of 1.250 indicates almost twice as much discharge as a normally discharged battery of the same gravity.

It is impossible to restore a battery to its original state after an internal discharge which reduces its gravity below 1.250. In attempting to get the negative plate into its normal charged condition, a part of the lead in the positive plate grid is converted into lead peroxide (the active material of the positive plate) and the positive grid is weakened and soon cannot retain the active material. As this falls out the capacity of the battery is reduced and it becomes useless.

Active material is normally lost to some extent during the life of a battery. Overcharging increases the rapidity of this loss due to weakening the positive grid as explained in the preceding paragraph.

Contrary to general belief, buckled plates or separator failure is due to a discharged battery condition. As the battery becomes discharged, the negative plate is changed from lead to lead sulphate. The lead sulphate is bulky and, as it increases with the discharged condition, extremely high pressures are exerted which either buckle the plates or split the separators, allowing an internal short circuit. The gravity of the battery should be maintained above 1.250 at all times.

Battery Testing

In testing a battery there are three important things to check—

- (1) Condition of charge. This is tested by use of a hydrometer. If the gravity is below 1.225,

the battery should be charged from an external source.

- (2) Comparative cell voltage under a relatively high discharge rate. It is generally agreed that a battery showing a variation of cell voltages of one tenth volt is worn out. Low cell voltage is usually due to separator failure.
- (3) Capacity. A battery may show a fully charged condition and equal voltage in all cells, but have a low capacity due to plate wear. Loss of active material will reduce the capacity of a battery as definitely as the removal of part of the plates of each cell. For example, the capacity of a 19-plate battery may be reduced by loss of active material from the plates to that of a 13, or even an 11-plate battery. Unless a definite test is made for this condition it will not be revealed until it fails to start the engine. It is important to owner satisfaction for you to be able to detect worn battery conditions of this kind. Testing equipment for this purpose is now available.

Battery service has an important place in every automobile dealer's service station. Records show that the average battery is charged three times during its life. In other words, three out of four times a "dead" battery has been allowed to become discharged because of neglect of some other part of the electrical system or the engine. If your customers do not come to you for battery service, you lose the job of correcting the condition that has caused the battery to become discharged.

Starting Motor Circuit

If you opened a water faucet and did not get water out of it as fast as you need it, what would you do—go build a larger reservoir? If the faucet is connected to a city water system that has been designed by competent engineers and is operated by engineers trained for the purpose, you probably would never give the reservoir a thought—you would clean out the pipe, or, finding it clean, install a larger pipe from the water main to the faucet.

The automobile battery is an electrical reservoir designed by competent engineers to supply the needs of the car in which it is installed as original equipment. If it has been properly tested and found in good condition, failure in the electrical system—particularly the starting motor system because of the large current flow required—is due to restriction in the circuit. Removing resistance in an electrical circuit is similar in effect to cleaning dirt out of a water pipe.

The starting motor circuit consists of the battery ground strap, the battery, the starting motor cable, starting motor switch, internal circuit of the starting motor, its mounting to the engine, the engine ground to the frame and the frame itself. A poor or undersized cable or ground strap or a poor electrical connection any place in the starting motor circuit will reduce the quantity of current available from the battery. This loss can readily be detected with an accurate ammeter and a low reading voltmeter.

Use Accurate Instruments

Since the insertion of an ammeter into an electrical circuit introduces additional resistance, the clamp-on

type is preferable where the current draw is sufficiently high to permit its use. An ammeter of this type can readily be slipped over the battery cable to read the current draw of the starting motor.

There is only 6 to 6.5 volts to begin with at the battery so that any voltage loss in the circuit is serious. This loss is due to resistance and is indicated by voltage drop. For checking such losses a voltmeter reading in tenths of a volt to a maximum of ten volts should be used.

Testing Voltage Available for Starting Motor

By grounding one terminal of the voltmeter to the frame of the car and attaching the other to the starting motor terminal, a reading can be taken while the motor is turning the engine over for a few revolutions. This will show the voltage available for the starting motor. With a good fully charged battery this should not be less than $4\frac{1}{2}$ volts in a warm garage, but may be as low as $3\frac{1}{2}$ volts if the battery is at a very low temperature. If the voltage is less than this, tests should be made to determine where the excess loss occurs.

Testing Voltage Drop in Starting Motor Cable

The ammeter should be clamped onto the starting motor cable and one terminal of the voltmeter connected to the battery post (not the cable clamp) and the other to "ground." With the starter turning the engine, readings should be taken on both the ammeter and voltmeter. If the difference between this reading and the one already taken at the starter motor is more than .3 volt per 500 amperes shown by the ammeter, the cable has too much resistance or the terminals are not properly connected to the battery and the starting motor terminals.

Particular attention should be given to the size of the cable. There are replacement cables sold which have approximately the same outside diameter as original cables, but obtain their size by addition of insulation and do not have enough copper to carry the required current. Current carrying capacity depends upon the amount of copper in the cable and the surfaces of the connections. Be sure terminals are cleaned and securely connected.

Voltage Drop in Starting Motor Return Circuit

The return circuit from the starting motor to the grounded battery terminal should also be tested. With the voltmeter attached to the grounded battery terminal and to the starting motor frame, the voltmeter reading should be less than 1 volt when the starting motor is cranking the engine. The two points in which voltage drop is most frequently encountered are the battery ground strap and the engine ground strap.

In old cars some cases of high resistance in the return circuit may be encountered due to loosening of rivets in the frame members or rusting of frame parts. The surest and cheapest method of correcting difficulties of this kind is to "ground" the battery direct to the engine with a standard sized battery cable instead of "grounding" to the frame.

Starting Motor

Testing and repairing of starting motors should be done by a specialized service station and no reference to this work will be made here.

Generator

The generator is the source of electrical energy from which the electrical system, including the battery, is supplied. Many of the troubles in an automobile electrical system are caused by improper generator output.

Charging Rates

Low generator output will, of course, allow a battery to become discharged with the attendant inconveniences to the owner of not being able to use the starter and also tendency to reduce battery life as explained in the discussion on batteries. Often, however, the charging rate of the generator is increased because the battery has become discharged without sufficient checking to find out whether the generator output was low or some other condition caused the battery to become discharged.

If the charging rate is set too high, high voltages will be developed in the system which may damage the generator, burn the ignition points, shorten the life of the ignition coil, lamp bulbs and battery. *A generator charging rate should never be set without checking the output with both an ammeter and a voltmeter, both of which are known to be accurate.*

Automobile generators are of the shunt wound type. This means that there are two complete electrical paths in the generator circuit. The voltage is generated in the armature and collected by the brushes. The field winding is connected across the brushes—forming a complete electrical circuit so that current can flow from the armature through the field and back to the armature again. The external circuit (charging circuit) is also connected across the brushes so that current can flow out of the armature to the battery, ignition, lights, etc., and through the return ground circuit to the generator brush and armature. The relation of the resistances in these two circuits determine the output of the generator. If resistance is increased in the field circuit, the flow of current in the field circuit will be reduced and the voltage of the generator will be decreased, causing less current flow in the charging circuit. This is exactly what happens as a generator warms up as heat increases the resistance of a copper wire.

Low Voltage

If resistance is decreased in the external circuit, less current will flow through the field, producing a lower voltage and a lower generator output. The only means of getting a reduced resistance of any appreciable amount is by grounding the charging circuit. If the ground occurs between the generator and the cutout, the generator will have practically no output and the battery will not be charged. A voltmeter connected to the charging terminal of the generator will show no voltage with the charging wires connected, but will show an excessively high voltage as soon as the charging wire is disconnected from the generator.

If the ground in the charging circuit is between the relay and the battery, the generator will have no voltage. However, the battery will discharge through the ground. This will cause burning of insulation and will be immediately noticed by the smell of burning rubber.

High Voltage

If the resistance is increased in the external (charging) circuit, the flow of current will be increased in the field, increasing the voltage and the output of the generator. This is a condition which often exists due to poor connections, breaking of part of the strands in a wire, or the replacement of the original wires in the charging circuit with smaller wires.

In order to find conditions of this kind it is necessary to use a voltmeter to see that the voltage corresponds to the amperage. The air cooled generator used on Terraplane and Hudson cars has the following charging characteristics at 70° F. generator temperature when the third brush is properly adjusted. (Charging rate decreased 1 ampere for each 15° increase in temperature for a given voltage.)

Voltage Amperage

6—17
7—20
8—22

By testing to see that the voltage and amperage correspond, proper charging will be insured.

If the voltage is higher than 8 volts with a 22 ampere charging rate, the battery is either cold, overcharged or the circuit has increased resistance. The wiring and connections should be checked for this latter condition if the battery gravity does not show greater than 1.285.

Generator Voltage Regulator

With the introduction of the air cooled generator which permits continuous high charging rates without danger of damage to the generator a means of preventing high voltages due to cold or overcharged batteries was necessary.

The voltage regulator used on Terraplane and Hudson cars controls the resistance in the generator field circuit. When the voltage in the charging circuit reaches 8.5 volts, resistance is thrown into the generator field circuit, reducing the generator voltage and, consequently, the charging rate.

The calibration of the voltage regulator is a delicate operation. If a unit is found which does not cut down the charging rate when the voltage reaches 8.5 volts, it should be replaced and returned to the Electric Auto-Lite Company at Toledo, Ohio, for recalibration.

With a fully charged battery it is impossible to maintain a charging rate of 22 amperes, as the regulator will reduce the voltage as soon as it reaches 8.5 volts. **It is, therefore, necessary to positively ground the generator field terminal when setting the charging rate.**

The electrical system is too often overlooked when diagnosing engine trouble. It is with this in mind that so much space has been given to this subject prior to the discussion of the ignition system itself. With the material presented here as a background, the discussion of the ignition system which will appear in the April issue of Terraplane-Hudson Service will show the importance of correcting troubles in the electrical system before attempting to correct certain ignition troubles.