

springs, ball and roller bearings, wheels, tires and other similar parts—but these will be sufficient to illustrate the point in mind.

Before the development of the motor car industry all of these parts were used for other purposes. Coil and leaf springs have been used as parts of other mechanical devices for many years, though perhaps in much smaller quantities, and these parts are, of course, still so used. Logically, therefore, being produced in a separate plant as a separate business, they can be produced more economically than a single manufacturer of motor cars can produce them in his own factory, unless the quantities required are greater than those produced in any single plant. The same conclusion can be reached with respect to ball and roller bearings, because their use is even more general perhaps than leaf springs.

Wheels and tires were made for wagons, carriages and bicycles before they were used on automobiles, though the business of making them has become so specialized that no longer are wheels, at least for other than motor cars, made in a plant devoted to anything else.

The manufacture of tires involves not only tires of many different sizes but other rubber goods as well, and the sale of tires for original equipment is only approximately 30 per cent of the total sales of tires produced.

It is apparent, therefore, that certain parts that are essential to the construction and operation of an automobile have been produced, generally more economically, outside the plant of the car manufacturer.

Going back now to those parts which are more generally and more recently classed as accessories, such as headlamps, starting and lighting equipment, speedometers, storage batteries and so on, we can perhaps apply the same reasoning to them.

All of these appurtenances with minor modifications of size and design can be used in all cars. All headlamps have lenses, reflectors, lamp sockets, connecting plugs and so forth, which with a few modifications in size and variations in design of shells and doors are adaptable to any design of car. The same facts apply to starting and lighting equipment and storage batteries. In addition, storage batteries have many other uses in telephone, radio and other electrical apparatus.

Speedometer heads with different combinations with other instruments and with individual designs of faces

and bezels and with connecting cables differing only in length, are made to suit the designs of individual manufacturers. The principal parts of the head mechanism and shafts are in general the same to fit any given requirement, so that with only a few different principles of design, they are all the same. It is logical, therefore, that they too can be produced more economically in a plant supplying these to several manufacturers than to one, unless, of course, the volume required by any manufacturer is greater than the volume required by several.

The subjects of development and design are also deserving of consideration in the study of economies. One has only to consider the millions of dollars that have been expended in development and design of all the parts of an automobile to appreciate the importance of this consideration.

Take for instance the matter of starting, lighting and ignition equipment. This development has gone on from the inception of the gasoline engine. Tremendous changes have been made almost from month to month during the years of the development to its present stage of seeming perfection, but still improvements are being made as the result of research in this field. What an appalling cost all this has entailed, and how impossible it would have been for each manufacturer of motor cars to have carried it on independently, as he would have had to do if each had engaged individually in the manufacture of such equipment!

As another illustration let us take the case of the development of the headlamp. The glare of headlamps with simple reflector and plain lens caused the development of the lamp capable of being dimmed. In recent years the requirements of safety in the increasing traffic of automobiles has occasioned the development of lenses to converge and deflect the beam to the road. The design of headlamps is still in an unsettled stage, as the requirements of state laws to insure safety are becoming more stringent. The cost of this development has been borne by the lamp manufacturers, who have been able to serve the manufacturers of automobiles more economically by spreading this cost over them all than each could have possibly served himself.

In the case of the second division of accessories, those which have not yet become of universal use in all cars, including bumpers, gasoline gauges, tire covers, motometers, spot lights, rear view mirrors and others, those who do not supply them as original equipment are not concerned with the question of

whether to buy them or make them. This class of article has a larger sale at present to the automobile owner than to the manufacturer, and they must be made by others than the car manufacturer. The discussion regarding the first classification of accessories, those which have become essentials, covers the second classification as well, because there are many illustrations that the accessory installed for convenience today becomes a necessity tomorrow.

The success of a manufacturer of an automobile is determined by his ability to serve the public with what it wants, and he must be responsible for the service which his product gives. If he makes an automobile that offers as much value to the purchaser as others sold at the same price, with proper sales effort and manufacturing methods, he will sell his proportion of cars and make a profit. Granting the ability to sell, it is only necessary to manufacture economically, and this involves the question of what to buy and what to make. The car manufacturer is responsible for what he buys as well as what he makes, because he is directly or indirectly responsible for everything that goes into his product. He must decide then, first, what he must have in his car that will serve best and for which he is willing to assume responsibility; and second, whether someone else, an accessory manufacturer for instance, can make this article more economically than he himself.

As previously pointed out, the problem of economy involves the cost of design and development and the relative volume of production—two interdependent and indeterminate factors, indeterminate, however, only with respect to general conclusions. One design of product will permit a certain price and bring a corresponding volume and another design will result differently. Simplicity of design will permit of lower price and bring larger volume, giving a wider distribution of development cost.

Each case then must be decided by itself, because what may be more economical for one manufacturer to buy may be more economical for another to make.

The answer to the question of our subject therefore depends upon two things: first, the design demanded in his product to best serve the purchaser, that is, whether he can afford to design an accessory peculiar to his car; and second, upon the volume of manufacture. It is evident that each manufacturer of automobiles has a different problem.

The answer to the question is further complicated by the fact that progress will change the answer for

each manufacturer, since change in his design or volume may create a different set of conditions, and consequently the facts which determine the economical method may not be the same at some future time.

## II. By F. C. SHAFER

THERE is a story told of a man who started a popcorn stand at the Pennsylvania Station in New York, studied his problem from A to Z, and became a specialist on popcorn in all its details. He established a reputation for making the best popcorn in New York and became rich. When he decided to expand and took on the preparation and sale of peanuts, he failed in six months. It is impossible to become a specialist in all things.

It occurs to me that there are really two kinds of accessories: first, those that do not vitally affect the mechanical running of the car; and second, those that are responsible for the correct functioning of the automobile. Those accessories entering into the building of the car that do vitally affect the mechanical running can be better purchased from accessory manufacturers whose reputation, engineering ability and success lie in making good in this one accessory. In the case of the other accessories it becomes largely a question of quality and comparison of cost.

Through specialists the automobile industry is able to market its product at practically 25 per cent under the pre-war selling price as compared with the average price of other commodities now 70 per cent above pre-war prices. Not only this, but the motor car of today, although it is submitted to the most severe service of any known piece of machinery, stands up under many cases of careless handling, inattention to lubrication, and so on. When we take into consideration that there are upwards of 1700 different parts entering in the modern car, this is an example of what can be accomplished by concentration on every detail entering into a product.

The automobile of today is a composite result of the work of specialists who have concentrated brain, material, resources and experience on the several parts entering into the whole.

Real engineering ability is hard to find. We have all known cases where a poor body design is responsible for the failure of a car to be popular, although mechanically the car is sound. The same is true of accessories. We think that it is impossible, with the diversified interests that are common to the manu-