'Tis sweet to hear the watch-dog's honest bark
Bay deep-mouth'd welcome as we draw near home.—Byron.

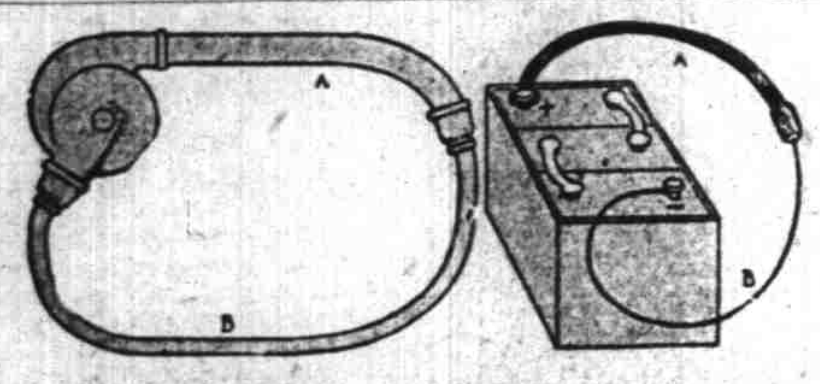
Honolulu Star-Bulletin

Half the miseries of life might be extinguished would man alleviate the general cause by mutual compassion.—Addison.

HONOLULU, TERRITORY OF HAWAII, SATURDAY, OCTOBER 7, 1916.

NEWS AND PRACTICAL INFORMATION ABOUT AUTOMOBILES

RELATIONS OF CURRENT, PRESSURE AND RESISTANCE IN CAR'S ELECTRIC SYSTEM EXPLAINED TO MOTORIST



Figs. 1 and 2—A series electrical circuit and a series water circuit compared. These are called series circuits because there is only one path in which the current may flow

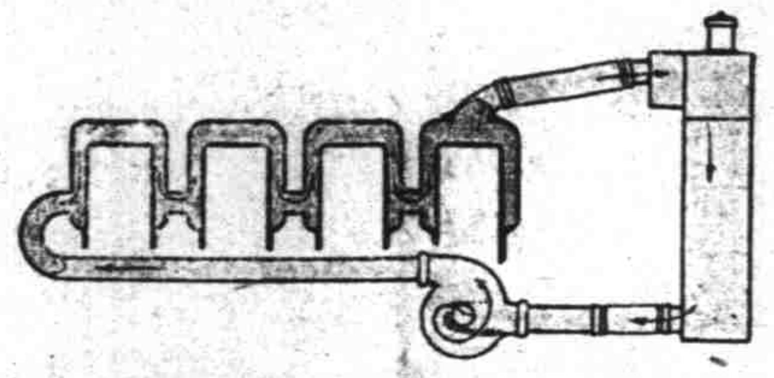


Fig. 3—A series water circuit as employed on some early cars. The pump, pipes, water jackets and radiator are in series, for the water has only one path in which to flow

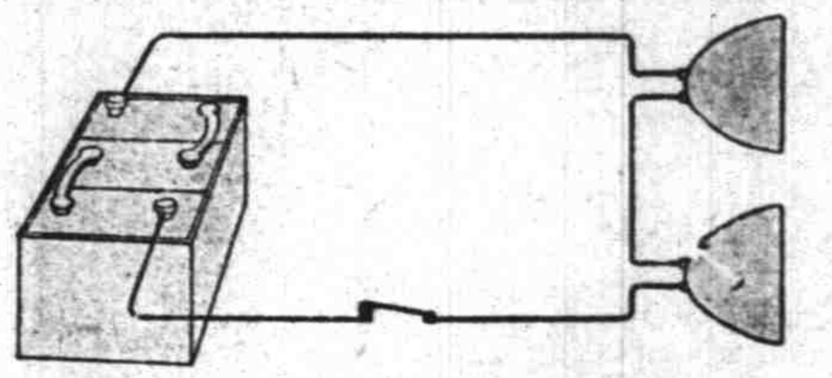


Fig. 4—A series electric lighting circuit. The battery, switch wires and lamps are in series, for the current has only one path in which to flow

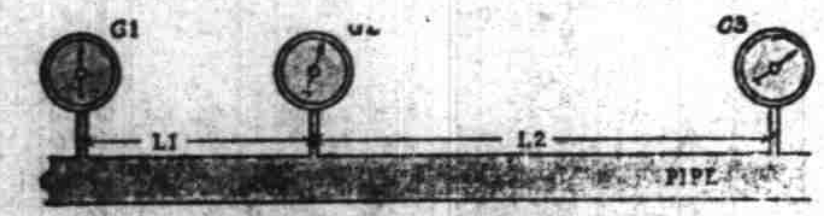


Fig. 5—The difference in pressure along a water circuit is proportional to the length of the pipe

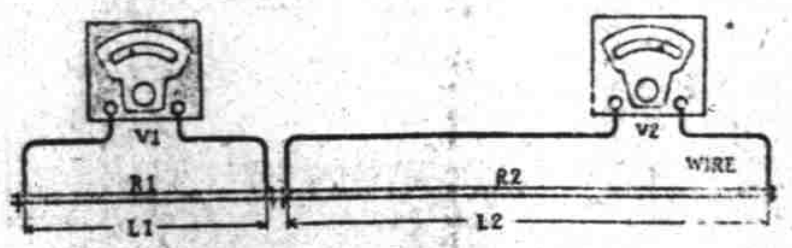


Fig. 6—The difference in pressure along an electrical circuit is proportional to the length of the wire

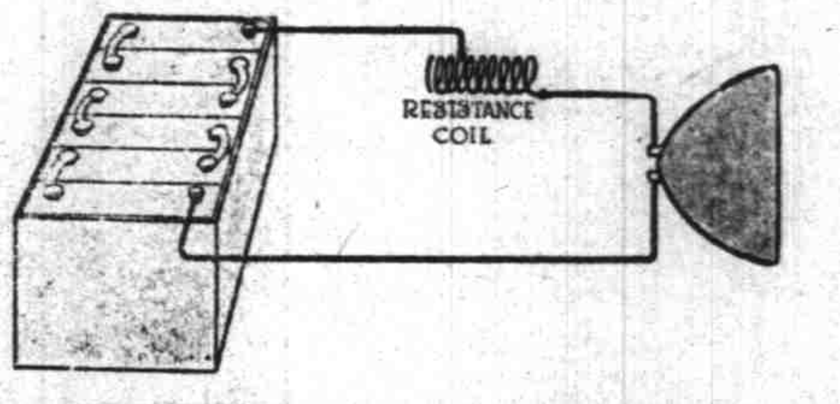


Fig. 7—Using a 6-volt lamp with a 12-volt battery by putting a resistance in series

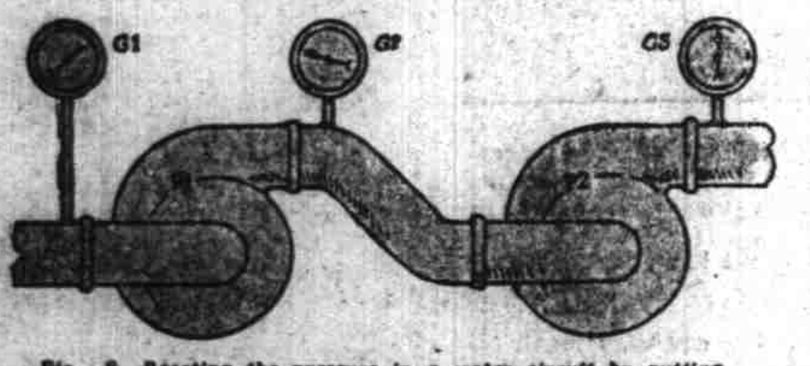


Fig. 8—Boosting the pressure in a water circuit by putting pumps in series

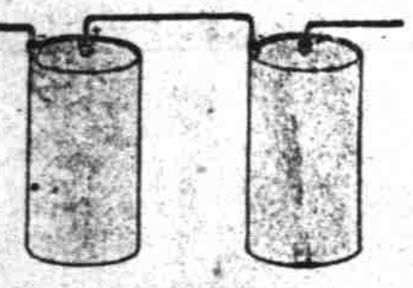
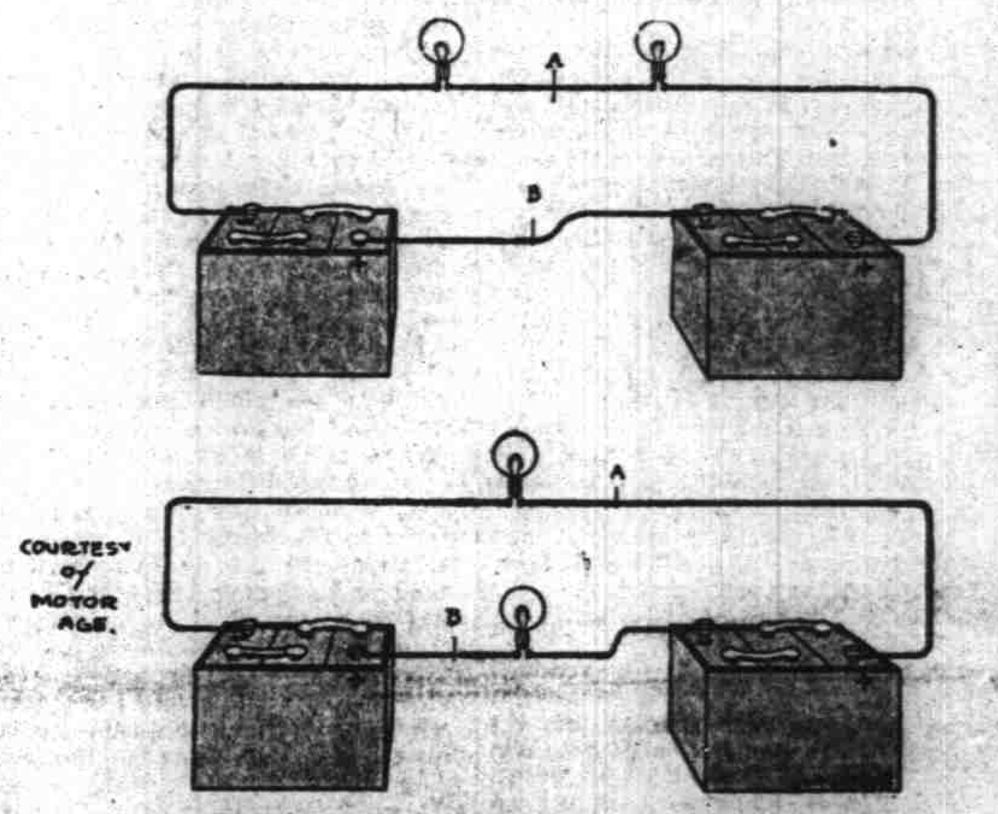


Fig. 9—Boosting the pressure in an electrical circuit by connecting dry cells in series



Figs. 10 and 11—Two methods of connecting [illegible] batteries in series

Herewith is presented the second instalment of a series of articles designed to give the motorist the knowledge necessary to enable him to care for and repair any and all of the electrical features of his car, no matter what make or model it may be.

For the sake of the majority of readers, whose knowledge of electricity is more general than definite, it has been thought wise to begin with the first principles of electrical phenomena, in order that owners may be able to follow the circuits on the electrical systems of their cars with the certainty that they are right. To the lay reader the first few instalments of this series are the most important, for without them wiring diagrams, trouble charts and repairing instructions are almost useless.

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If a water circuit be composed of two pipes and they are connected in the manner indicated at A and B in figure 1, they are said to be connected in series. There is only one path through which the water may flow in passing from the outlet of the pump and return to the pump. The current of water at any instant is the same at every point along the two pipes, and just exactly as much is returning to the pump in a given time as is leaving the pump. The water is not used up in the operation of such a circuit. The circuit is complete and, as in the case of the circle, has neither beginning nor end. Note that the water is not used up in this operation, but some of its ability to do work is used.

An electric circuit composed of two or more different wires of perhaps different sizes, lengths and materials, and connected as shown in Figure 2, is called a series circuit. In this case there is only one path through which the electricity may flow in passing from the positive terminal of the battery and return to the negative terminal of the battery. The current of electricity is the same at every point along the different wires, and just exactly as much electricity is returning to the battery in a given time as is leaving the battery in the same time. The electricity is not used up in the operation of such a circuit, but its ability to do work is used, just as in the case of the water. This will be explained more in detail in later instalments of the series.

A series water circuit is found in the operation of the cooling system of some early motor car engines, as shown in Figure 3. In this case the four water-jackets of the different cylinders, the radiator, the pump and the connecting pipes are all in series. The current of water through the different parts of the circuit at any time is exactly the same; just as much water returns to the pump as the pump sends into the circuit. This method of cooling is not a good one, but is used here for the purpose of bearing out the series circuit idea.

When the headlights on motor cars are connected, as shown in Figure 4, they form a typical series electrical circuit. The current of electricity through the different parts of the circuit at any time is exactly the same; just as much electricity returns to the battery as the battery sends into the circuit. The electricity is not consumed in the lamps, but some of its ability to light lamps is used.

Resistance of Series Circuit

Since the resistance offered by a pipe to the free flow of water through it increases with an increase in the length of the pipe, it is evident that the resistance of two pipes connected in series will be greater than the resistance of either pipe alone. If the two pipes are of exactly the same size and length they will, when connected in series, offer twice the resistance to the flow of water through them that is offered by a single pipe. If the pipes are of the same size but of different lengths they will offer a combined resistance equal to that of a single pipe of the same size but having a length equal to that of the combined lengths of the two pipes.

Two wires of the same size and material will, when connected in series, offer a combined resistance equal to that of a single wire of the same size but having a length equal to the combined lengths of the two wires.

Any number of electrical resistances, such as motor car lamps, connected in series might be thought of as being equivalent to a number of wires of the same size and material, but having different lengths, and the combined resistance of any number of resistances in series is equal to the sum of the different resistances. For example, if the two lamps in Figure 4 have a resistance of 2 ohms each the combination will have a total resistance of 4 ohms. In order to get the total resistance of the circuit the resistance of the leads, switch, etc., should be added to the resistance of the lamps.

Pressure Relations for a Series Circuit

If pressure gauges be connected along a water pipe, as indicated in Figure 5, in which there is a current of water, the difference in the readings of the different gauges will bear the same relation to each other as exists between the distances between the points where the gauges are connected. For example, the difference in the reading of gauges G1 and G2 will bear the same relation to the difference in the readings of gauges G2 and G3 as the distance between G1 and G2 bears to the distance between G2 and G3. If the distance between G2 and G3, which we will represent by L2, is twice the distance between G1 and G2, which we will represent by L1, then the difference in readings of G2 and G3 will be twice G1 and G2.

The reason for this relation may be explained as follows: Since the resistance between the points where G2 and G3 are connected will be as many times the resistance between the points where G1 and G2 are connected as the length L2 is times the length L1, the pressure between the points where G2 and G3 are connected must be as many times the pressure between the points where G1 and G2 are connected as L2 is times L1, in order to produce the current in the pipe. The differences in pressure between different points along a series water circuit will bear the same relation to each other as exists between the resistances between the points where the pressures were measured.

In the electrical circuit the voltmeter measures the difference in pressure between the points along the circuit to which the terminals of the voltmeter are connected. Thus in Figure 6 there are two voltmeters connected so as to measure the difference in pressure between two different sets of points. If the wire composing the circuit is of the same material and same size all the way along the circuit, then the reading of the two voltmeters V1 and V2 will bear the same relation to each other as exists between the lengths L1 and L2.

If the length L2 is twice the length L1, then the resistance R2 is twice the resistance R1, and since the value of the current in R2 is exactly the same as the value of the current in R1—neglecting the current through the voltmeters—there will be twice as much pressure required to produce this current in R2 as is required to produce it in R1, which will result in the reading of V2 being twice the reading of V1. When the resistance R2 is three times the resistance R1, then the reading of V2 will be three times the reading of V1, etc.

The electrical pressure acting on a part of the resistance of a series circuit bears the same relation to the pressure acting on some other part of the same circuit as exists between the resistances of the two parts. That is, if two resistances are connected in series and they have exactly the same resistance, then the pressure acting on each of them will be exactly the same when there is a current of the same value through them. If, however, two resistances are connected in series, and the resistance of one is twice that of the other, then the pressure acting on the one of lower resistance will be one-half of the pressure acting on the one of higher resistance.

Resistances for Lamps

If two lamps having different resistances be connected in series, the pressure acting on one lamp will not be the same as the pressure acting on the other lamp. The lamp of higher resistance will have a higher pressure acting on it than the one of lower resistance. This relation accounts for the fact that two lamps of different candlepower and the same voltage will not operate satisfactorily in series, because the one of lower candlepower, or higher resistance, will have a larger part of the total pressure acting on it than the one of high candlepower, or lower resistance. Thus you cannot put a 6-volt 24-candlepower headlight in series with a 6-volt two-candlepower dashlight and operate them from a 12-volt battery, but you can put two 6-volt 24-candlepower headlights in series with a 12-volt battery, or one 6-volt two-candlepower dashlight and one 6-volt two-candlepower taillight in series with a 12-volt battery.

A six-volt lamp may be operated on a 12-volt battery by connecting a resistance in series with the six-volt lamp, as shown in Figure 7. The resistance in series with the lamp must be equal to the resistance of the lamp in order that the pressure over the lamp be six volts, or one-half of the total pressure. The pressure over the lamp may be decreased by connecting more resistance in series, or increased by decreasing the amount of resistance in series. This principle is used by some companies in dimming the headlights, as the decrease in pressure on the lamp decreases its candlepower.

Current Relations in a Series Circuit

The reader must always have in mind that the current in every part of a series circuit is exactly the same and that there is no accumulation of electricity at any point along the circuit. An ammeter connected at any point in a series circuit will indicate the same current as long as there is no change in the value of the resistance of the circuit or the total pressure acting in the circuit.

If a series circuit be opened at any point by means of a switch, if a lamp burns out or a wire break there will be no current in the circuit, and an ammeter connected in the circuit will indicate zero current regardless of where the ammeter may be connected.

The current in a circuit, in amperes, is usually represented by the capital letter I, the pressure in units by the capital letter E and the resistance in ohms by the capital letter R.

A certain six-volt headlight takes a current of four amperes when it is connected to a pressure of six volts. What resistance must be placed in series with the lamp in order to operate it from a 12-volt battery? Since the pressure necessary to operate the lamp is one-half of the total pressure in this case, then the resistance required in series with the lamp will be equal to the resistance of the lamp. The resistance of the lamp, which we will represent by RL, will be equal to the pressure required to operate it divided by the current the lamp takes, or

$$RL \text{ equals } \frac{6}{4} \text{ equals } 1\tfrac{1}{2} \text{ ohms.}$$

Therefore the resistance that must be placed in the circuit is 1½ ohms.

If this same six-volt lamp is to be operated on a 24-volt battery the procedure in determining the value of the resistance to be placed in circuit is a little different. The resistance and the lamp will carry the same current, since they are in series. The pressure over the resistance, which we will represent by ER, will be equal to the total pressure, E, of the battery, minus the pressure over the lamp, EL, of

ER equals E minus EL
ER equals 24 minus 6
ER equals 18 volts.

The value of the resistance, then, is equal to the pressure acting on the resistance divided by the current through the resistance, or

R equals 18 divided by 4, equals 4½ ohms.

The resistance of the lamp, if it takes a current of two amperes, is equal to

6 divided by 4, equals 1½ ohms.

It is interesting to note that in each of the above cases the relations between the resistance of the lamp and the resistance to be connected in series with it is the same as the relation between the pressure acting on the lamp and the pressure acting on the resistance in series with the lamp.

Since the lamp requires a pressure of 6 volts, the pressure acting on the resistance to be placed in series will be the difference between the total pressure, or 24 volts, and the pressure acting on the lamp, or six volts, which gives 18 volts. The resistance that must be placed in series with the lamp will be equal to as many times the lamp resistance as the pressure which is to act on the series resistance is times the pressure acting on the lamp. The pressure acting on the series resistance in this case is three times that acting on the lamp, hence the value of the series resistance must be three times the value of the resistance of the lamp. The resistance of the lamp is equal to the pressure on it divided by the current through it, or 6 divided by 4, or 1½ ohms. Hence the value of the series resistance will be equal to 3 times 1½, or 4½ ohms.

Pressure in Series

If two pumps be connected as shown in Figure 8, the pressure produced by the other pump and the combined pressures of the two pumps will act upon the water circuit to which the combination is connected. Several pumps may be connected in this manner, and the sum of the pressures produced by the combination when they are producing a pressure in the same direction around the circuit will be equal to the total pressure acting in the circuit. Thus, if each of the pumps indicated in Figure 8 is producing a pressure of 50 pounds the total pressure acting in the circuit to which the pumps are connected will be equal to the sum of two pressures, or 100 pounds.

If the pressure produced by the pumps is unequal the total pressure is equal to the sum of the pressures, just the same. For example, if the pumps are producing pressure of 75 and 25 pounds a square inch, respectively, the total pressure acting on the circuit to which they are connected will be equal to 75 plus 25, or 100 pounds a square inch. If two men shove against a car in the same direction with a force of 100 and 125 pounds, the total force acting on the car is equal to the sum of the two forces or 225 pounds.

Several electrical pressures may be connected in a similar manner to the pumps, as indicated in Figure 9, which represents two dry cells in series. If the pressure produced by each of the dry cells acts in the same direction, then the total pressure will be equal to the sum of the pressures of the two cells, regardless of whether the pressures produced by the cells are equal or unequal in value. Thus, if the pressures produced by the two dry cells are 1.2 and 1.4 volts, respectively, the pressure will be equal to 1.2 plus 1.4, or 2.6 volts.

If a number of equal pressures be connected in series so that they all act in the same direction around the circuit, then the total pressure will be equal to the product of the number of pressures connected together and the value of one of the pressures. For example, if six dry cells, each producing a pressure of 1.5 volts, be connected series, then the total pressure will be equal to six times 1.5, or 9 volts. If ten men are all pushing on a car in the same direction and each is pushing with the same force, say 100 pounds, then the total force acting on the car will be equal to ten times the force of a single man, or 1000 pounds.

In order that the pressures produced by the pumps act in the same direction around a water circuit it is necessary to connect the sides of the pumps of lower pressure to the sides of higher pressure in regular order. If pressure gauges be connected to the circuit, as indicated in Figure 8, it is possible to determine the pressure produced by either of the pumps or any combination by observing the indications of the proper gauges.

For example, the pressure produced by the pump P1 is equal to the difference in the pressure before and beyond the pump, which may be determined by reading the gauges G1 and G2 and then subtracting the lower reading from the higher reading. The pressure produced by the pump P2 may, in a similar manner, be determined by taking the difference in the readings of the gauges G2 and G3. The pressure produced by each pump tends to cause the water to flow through the pump itself from the terminal of lower pressure toward the terminal of higher pressure, and through the water circuit to which the pump is connected from the terminal of higher pressure toward the one of lower pressure. All of the pumps will be acting in the same direction when the pressure gauges on, say, the right hand side of the different pumps all read higher than the pressure gauges on the left hand side, or all of the gauges on the left hand side read higher than all of the gauges on the right hand side.

If some of the pumps are connected in the circuit so that the pressure they produce is opposed to the pressure produced by the other pumps, then the pressure acting in the circuit will be equal to the difference between the sum of the pressures acting in one direction and the sum of the pressures acting in the other direction. If the sum of the pressures acting in one direction is exactly equal to the sum of the pressures acting in the opposite direction, then the pressure acting in the circuit tending to produce a flow of water will be equal to zero.

The direction of the pressure acting in the circuit when there are pressures in both directions will correspond to the larger sum. For example, if six pumps are connected in such a manner that the pressure produced by two of them is in the opposite direction to the pressure porduced by the remaining four, it is obvious that the pressure acting in the circuit to which the pumps may be connected is not equal to the sum of the pressures produced by all six pumps, but it is equal to the difference in the sum of the pressures produced by the four pumps and the sum of the pressure produced by the two pumps.

If each of the six pumps is producing a pressure of 10 pounds the pressure acting in the circuit may be determined as follows: The pressure produced by the four pumps will be equal to the pressure produced by a single pump multiplied by four, or 10x4, or 40 pounds. The pressure produced by the two pumps likewise is equal to 10x2, or 20 pounds.

Direction of Pressure

The pressure acting in the circuit is equal to the pressure in one direction subtracted from the pressure in the opposite direction, or 40—20=20 pounds. The direction of this pressure of 20 pounds will be the same as the direction of the larger sum of 40 pounds. The same result could be accomplished by using two pumps alone instead of six, as the pressure of two of the six pumps which are acting in one direction is exactly neutralized by the pressure of the two of the six pumps acting in the opposite direction.

It is obvious that if 10 men are pushing on a car—say, six in a certain direction and four in an exactly opposite direction—the force tending to move the car is not equal to the combined forces produced by the 10 men, but it is equal to the force produced by the six men minus the force produced by the four men, or 600—400=200 pounds. The direction of this resultant force corresponds to the direction in which the six men are pushing.

In order that the electrical pressures produced by several batteries may act in the same direction around the electrical circuit it is necessary that the terminal of lower electrical pressure of one battery be connected to the terminal of higher pressure of the next battery; that is, that the negative terminal of one battery be connected to the positive terminal of the next one. The pressure produced by the battery causes the electricity to pass through the battery itself from the terminal of lower pressure, or negative terminal, toward the terminal of higher pressure, or positive terminal, while in the part of the electrical circuit outside of the battery it causes the electricity to pass from the terminal of higher pressure toward the terminal of lower pressure.

The action of a generator is exactly the same as the battery, inasmuch as the current is from the negative to the positive terminal within the generator and from the positive to the negative terminal through the circuit outside the generator. If several electrical pressures be connected in series in such a manner that part of them are acting in one direction around the electrical circuit and the remainder in the opposite direction, the total pressure acting in the circuit will not be equal to the sum of all the different pressure, but it will be equal to the difference in the sums of the pressures acting in the opposite directions.

The difference in the sum of the pressures acting in the two directions around the circuit is called the effec-

(Continued on page 26)

AUTO AN ECONOMY AS COMPARED TO USE OF HORSES

"When we kept a horse and outfit," says George Anderson, a farmer, who owns a motor car, "the first cost of which exceeded the cost of our car, the expense of maintenance of the horse outfit was more than $2 a day right here on the farm.

"The horse had to be fed three times a day. It had to be groomed and exercised every day, whether we wanted to use it or not. Trips to the blacksmith shop were frequent. Expense was never-ending. Added to this was our sympathy for the poor horse in very hot and very cold weather. Thought of our own comfort finally led us to purchase a Hudson Super-Six.

"Immediately our eyes were opened to the greater economy of the motor-driven vehicle. It did not have to be exercised. It cost nothing when not in use. The upkeep was far less for a vastly greater amount of work than that of the horse. The car was always ready to go anywhere at any time and get us back home again, regardless of distance, at fine speed. Where formerly a 20-mile drive was a hardship for the horse and ourselves, our Super-Six makes easy work of 100 miles, or even 200 miles, in a day. And we ride in perfect comfort.

"When we see our neighboring milkmen, butchers, fishmen and farmer friends speeding about on their trading errands in motor cars, doing their work quickly and covering much greater territory in less time and with less effort and expense than ever was possible with horses, we congratulate ourselves on buying our trusty automobile. We wish we had realized its value long before we gave up our horse. We cannot look on the modern, practical, useful, reasonably priced automobile as a luxury. It has become the farmer's necessity for work and pleasure. Every farmer should own one."

BATTERIES MUST HAVE WATER TO PROVE SUCCESS

Expert Compares Storage Battery With Human Being; Overheating an Evil

Harry Henry, in charge of the local Willard storage battery service station, claims that water is just as essential for battery health as for the health of a human being.

"This is especially true in hot summer weather," he says. "Neglecting to keep the battery filled with pure distilled water will shorten its life quicker than anything else.

"The solution inside your storage battery is constantly evaporating. If its level is permitted to reach a point below the tops of the plates, the upper portion is left exposed to the air and useless as far as furnishing electrical energy is concerned.

"Overheating is one of the most common battery evils, and inasmuch as we are having a great deal of hot weather this summer, it pays to be careful. While you cannot see the damage that is being done to your battery plates it is going on, nevertheless, and results in considerable expense later.

"In hot weather a person needs plenty of pure water to keep him in good physical condition. It is just the same with a battery. Pure water has a cooling and refreshing effect and by keeping your battery filled at regular intervals you can avoid a battery doctor bill."

IF YOU DESIRE TO SPEED UP DO NOT TAKE PUBLIC ROAD

Watch the expressions on the faces of a motoring party when a street car slowly starts up and blocks their crossing—perhaps for four seconds. Mother frowns; the children kick the footrest in rage; the impressions of a row of gritted teeth are along father's jaw and he shakes his fist as if he had just heard that his cashier had sneaked away from his office with $1,875,943.52.

Why this hurry, good people? When you drove a buggy 15 years ago you were well content to draw up for two or three minutes to permit the horse to switch a fly.

High-speed men and women, your place is on the race track. Public roads are for motorists not for speed nuts. We are building a whole series of nice speedways all over the country for you. Here you may hit it up, chasing your tail-light to your heart's content, and people may pay to see it.

All new motorists should consider what a mule-headed, dangerous fool is the speed fan. He has no place of glory. Each day he becomes more unpopular. Let's push him off every road!