

called a terminal, is fastened at the top of the carbon pole. Another brass screw or terminal is fixed at the top of the zinc wall of the cell. The carbon pole is the positive pole, and the zinc the negative pole. The screw terminals are called the positive and the negative terminals, respectively. If the terminals are connected by a wire, the electric current is started, running from positive to negative.

Another necessary part of the make-and-break equipment is the spark coil. This is a quantity of insulated wire wound around a soft iron core. Its purpose is to intensify the spark.

The make-and-break block is a piece of steel which passes through the wall of the cylinder into the part where the explosion takes place. It is heavily wrapped around with mica or other insulating material, to prevent possibility of touching the metal of the cylinder. Inside the cylinder a hammer of steel rests on the end of the make-and-break block. A cam on the cam shaft, connected with this hammer, makes the hammer rise from the block to break the circuit to get the spark at the right moment.

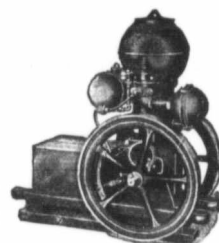
Now, this is how the make-and-break system works. Let us assume a battery of four primary cells connected in series; that is to say, the positive or carbon pole of the first cell is connected by a short wire to the negative or zinc of the next cell. The positive pole of this second cell is connected in the same way to the negative or zinc of the third cell and so on. From the zinc or negative of the first cell a wire is led to the metal frame of the car. From the positive or carbon pole of the fourth cell, a wire is led to a switch. From the switch another wire is led to the spark coil, and an insulated wire from the spark coil is fastened to the end of the make-and-break block outside the cylinder. The circuit is now complete, the switch being closed. The electric current starts from the battery and travels first to the switch, next to the spark coil, where it gathers force, then on to the make-and-break block, through this block into the cylinder, then from the inside end of the make-and-break block to the hammer, and thence to the walls of the cylinder. It is grounded here, and runs to the wire which connects the zinc of the first cell with the metal frame of the car. In this way the current gets back to the battery. An electrical current will not run unless provision is made for its sure return to the place it starts from.

A complete electrical circuit having been provided described above, the spark is got by lifting the hammer inside the cylinder at the right moment for the power stroke, as already explained; namely, with the aid of a cam on the cam shaft.

We use what is called a primary current to get a spark by the make-and-break method. This

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current is measured in an amperes for our purpose, and amperes are measured with an instrument that looks like a watch, and is called an ammeter. A new battery should give a current of about 20 amperes. It weakens gradually with use, and when it gets below five amperes it is time to get a new set of cells. To use the ammeter, connect the positive and negative terminals of a cell to the terminals of the ammeter. The amperage will be indicated on the face of the instrument. Do not keep the ammeter terminals touching those of the battery longer than is necessary to get a reading, as the use of the ammeter is hard on the battery. The cells should be tested individually, and those which are below the required amperage should be put aside and replaced as soon as possible. In the meantime, the battery can be used with less than the full number of cells. It is usual for engines using dry cell batteries for firing purposes to carry two sets of cells, each set forming a complete battery. These batteries can be used separately or in combination, the cells being connected in series of multiple. As already explained, a series connection is got by connecting the positive of one cell to the negative of the

next, and so on. By the multiple method, all positive poles are connected on one wire, and all negative on another. The current is carried from the positive terminal to the engine, and back to the battery by the negative.

The need of thorough insulation of all electrical apparatus has already been mentioned. Most troubles in an ignition system can be traced to some flaw in the insulation, causing the current to turn away from its intended path. The man in charge of an engine should overhaul his electrical outfit regularly, seeing that wires are well covered, and that all exposed parts are kept clean and bright, and particularly that no carbon or soot, is allowed to gather on parts inside the engine.

Besides the dry-cell battery, there are three other ways of getting the electric current in the make-and-break system. These are by (1) Storage Battery; (2) Low-tension Magneto; (3) Dynamo.

A storage battery consists of a number of cells containing "grids" or perforated plates of metal and filled with a mixture of water and sulphuric acid. This battery must be charged before it can be used.

A magneto is a series of horse-

shoe magnets set up to form an arch. Inside this arch, in the lower part, an armature turns on a spindle. This armature is a shuttle wound lengthways with insulated wire. The armature is turned from the shaft. As it turns rapidly a current of electricity is started. No spark coil is needed with the magneto; but cars equipped with magnetos usually carry batteries as well. The battery is used at starting, and when the engine is going, the battery is switched off and the magneto switched on.

When a small dynamo is used to get the current, the dynamo is driven from the shaft, like the magneto. It is also necessary that the engine should be running before the dynamo is put to work.

We need a primary and secondary circuit to get a jump spark in the engine cylinder. The primary circuit or current is that which starts from the battery, follows a certain path and comes back to the battery. The secondary circuit is that which is "induced" in an induction coil by the interruption of the primary current. The secondary current runs from the induction coil through a spark plug to the inside of the cylinder. Inside the

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