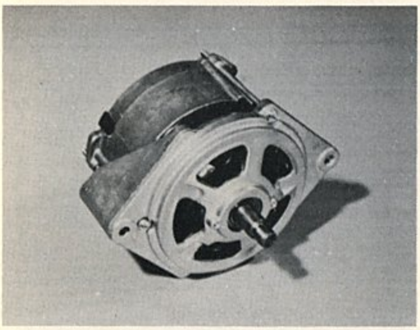
ALTERNATORS

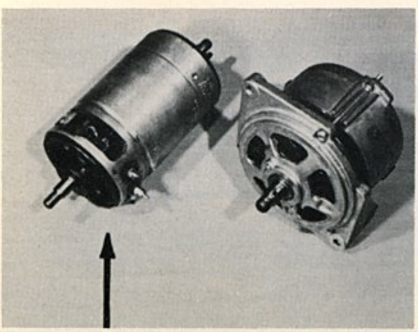
Dealer Level Training

ALTERNATORS

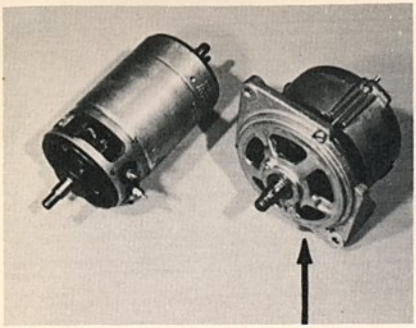
NARRATOR:
Volkswagen is well known for making continued improvements in the engineering of its cars. One of these advances is in the way it generates electricity.



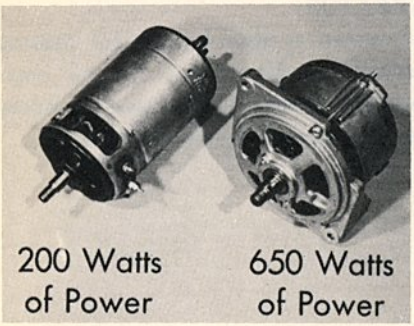
An Alternator is used on the Volkswagen 411 because it can be a more efficient source of electricity.



The D.C. Generator, as its name implies, makes direct current and supplies it to the automobile's electrical system and to the battery.

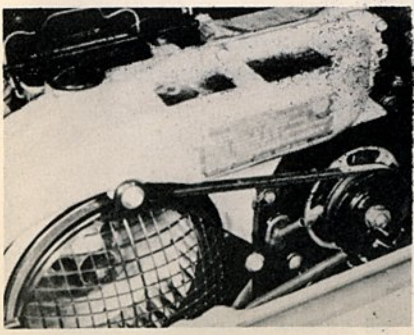


The Alternator or A.C. generator makes alternating current which must be rectified to direct current before storage in the battery.

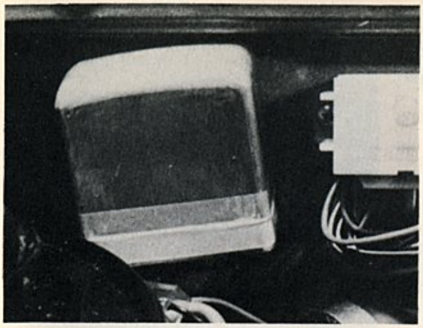


The advantage of the alternator over the D.C. generator is that it can produce more power for a given weight and size.

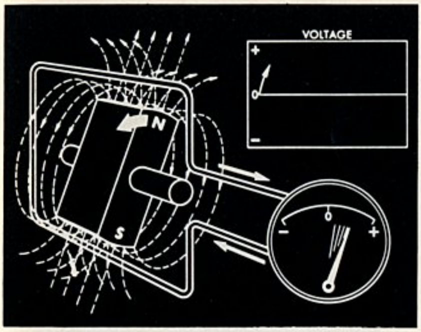
Even a moderate sized alternator can produce enough current to charge the battery and run many electrical accessories at engine idling speeds.



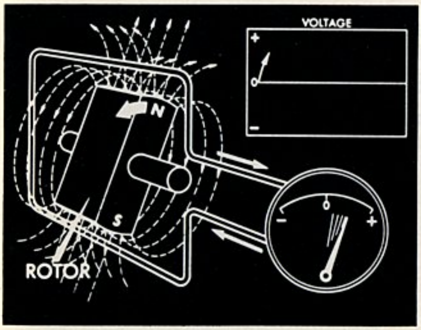
The Alternator, similar to the generator, is driven by a V-belt and is cooled by the engine fan.



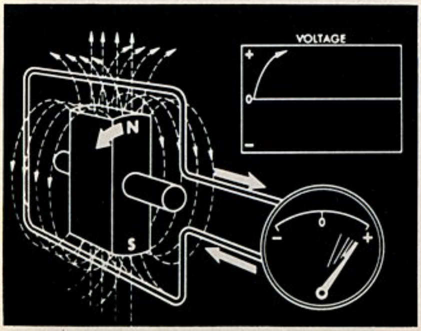
And a voltage regulator works in conjunction with the alternator to keep the electrical power within constant limits and to prevent overloading the electrical system.



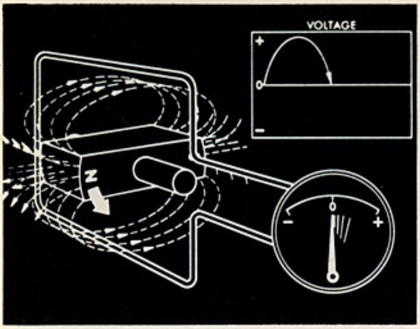
In an alternator, electrical current is produced by a magnetic field moving past a conductor and inducing voltage in this conducting loop.



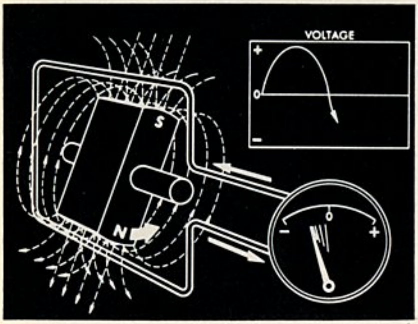
The magnet which produces the magnetic field is called the rotor.



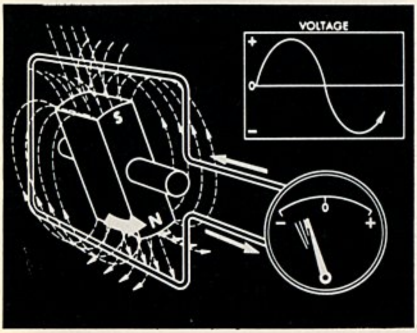
When the north pole of the magnet passes the upper loop, a positive pulse is induced in the conductor.



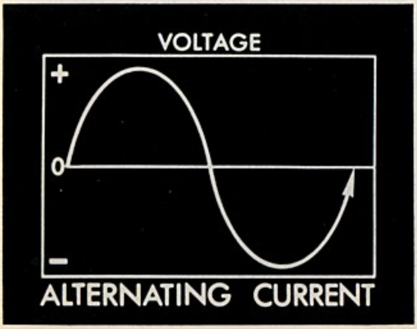
As the rotor reaches a 90° angle to the loop, there is no induction, and thus no pulse.



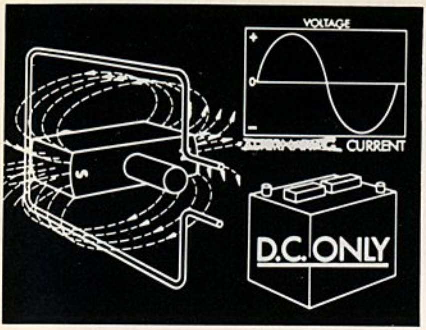
As the south pole approaches the upper loop, the pulse continues to build on the negative side. It reaches its maximum when the pole is closest to the loop.



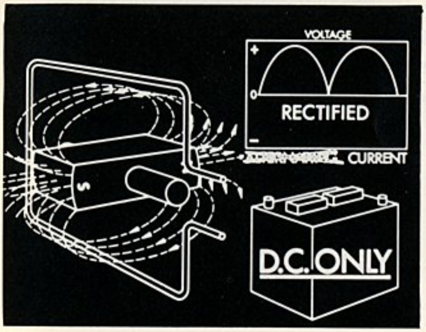
As the south pole continues to move away from the loop, voltage gradually drops off until it reaches zero, and the north pole again takes over.



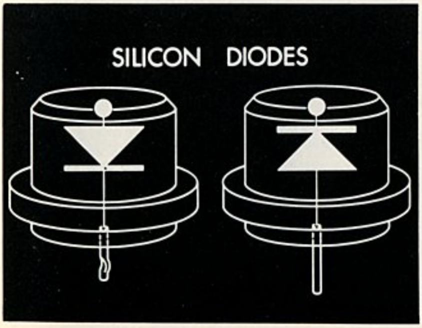
The changing poles thus create alternate positive and negative pulses, or alternating current.



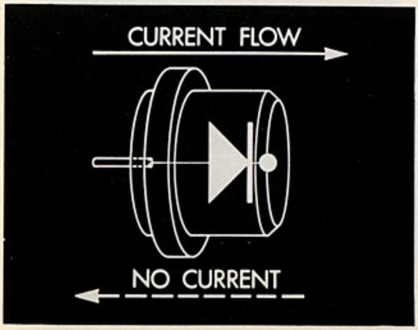
This alternating current cannot be used by the automobile system because only direct current can be stored in the battery.



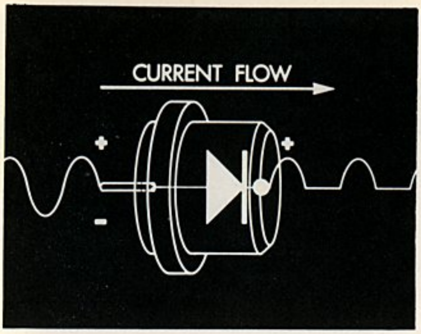
Therefore, the alternating current or A.C. from the alternator must be rectified or changed to direct current, or D.C.



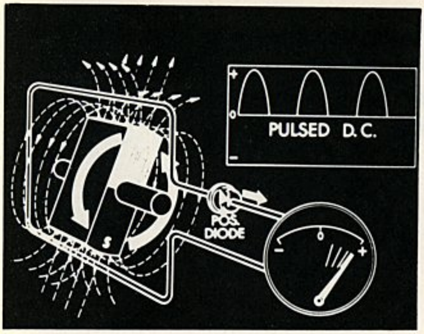
Conversion from A.C. to D.C. or rectification is done by Silicon diodes.



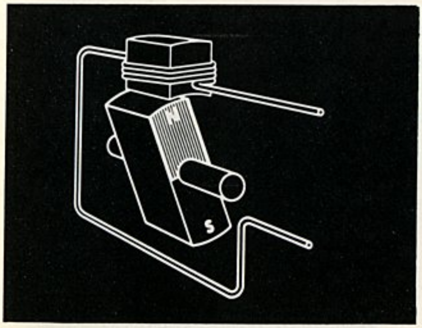
A diode is a semi-conductor device that allows current to flow in only one direction. It is like a one-way valve.



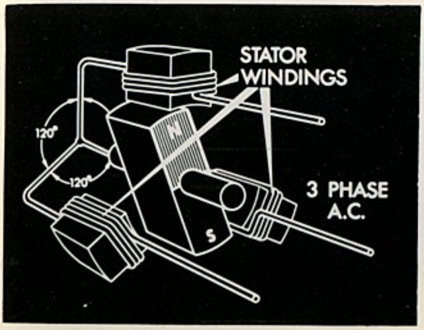
Alternating current fed through a positive diode passes only the positive half of the wave.



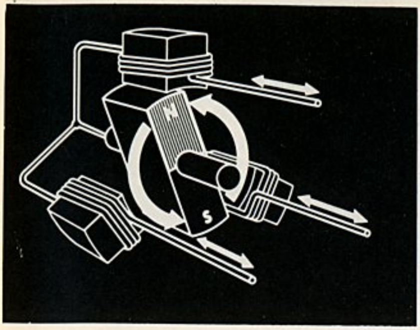
So if we place a positive diode in the upper loop of our alternator, only the positive half of the wave will get through, resulting in pulsed direct current.



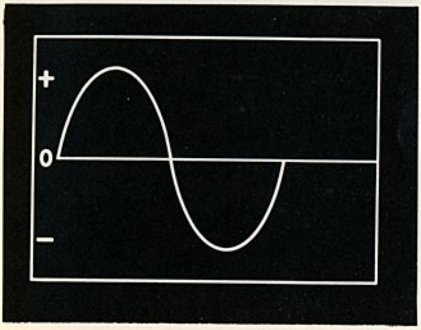
In an actual alternator, windings rather than loops are used since they produce far more power.



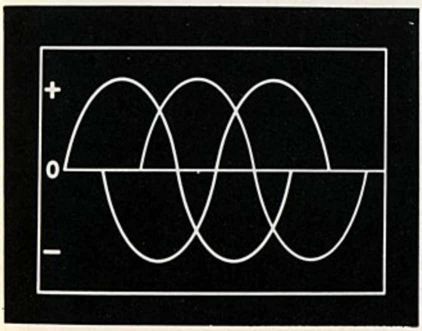
The Bosch alternator has 3 windings spaced 120° apart. Together they are called the stator and produce three phase alternating current.



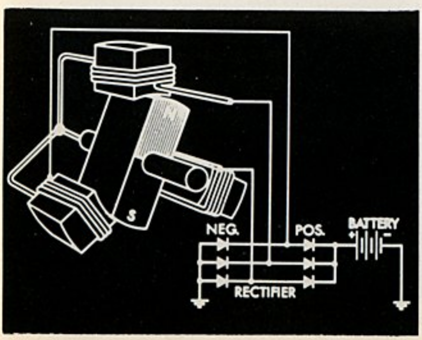
The north and south poles of the magnet pass each of the three windings in turn, inducing voltage in each coil as they pass.



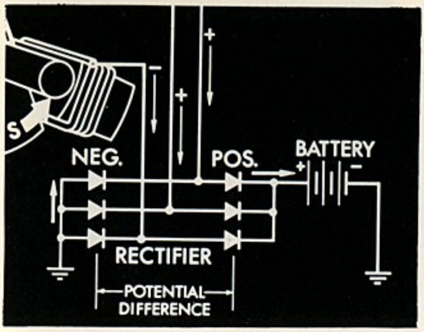
Now, instead of one electrical wave . . .



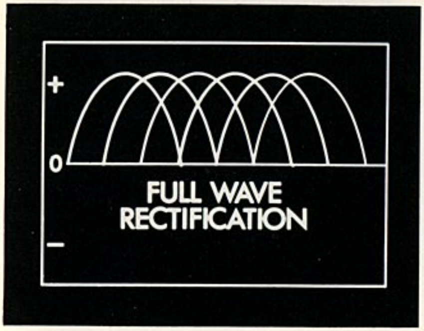
. . . we have three overlapping waves equally spaced.



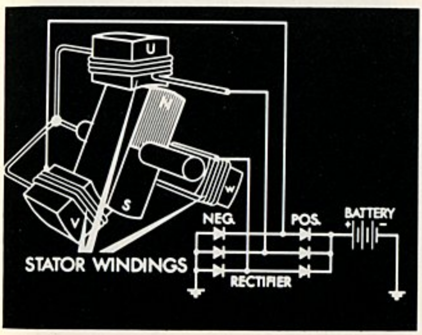
The three phase windings of the alternator are connected to three conductors which carry two diodes each.



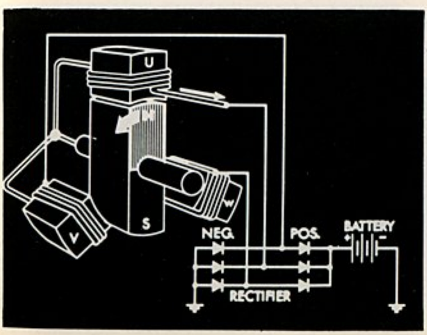
When a pulse of current arrives at the rectifier circuit, it produces a potential difference between the negative and positive diodes whether the pulse itself is plus or minus.



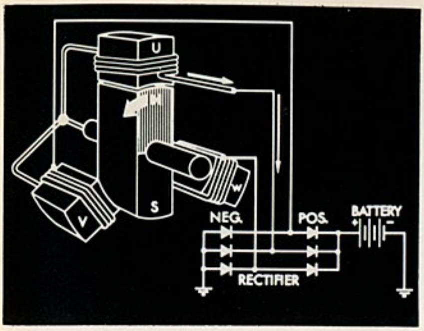
Thus, the direct current leaving the positive diodes now carries not only the positive portions of our A.C. wave, but also the negative portions which now appear as positive pulses. This is full wave rectification.



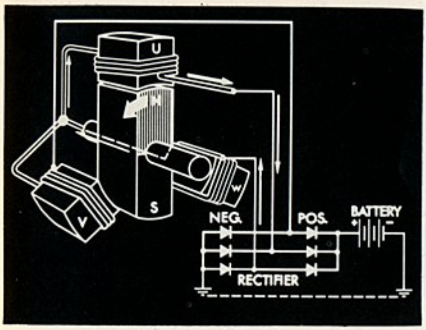
Let's see how current flows from the stator windings to the battery. The three stator windings, which we have labeled U-V and W, are joined in the center. As the rotor turns and its magnetic lines of force cut across each stator winding in turn, electrical pulses are induced in the stator windings.



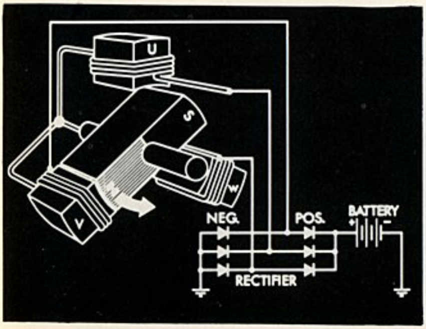
Shown here is the pulse leaving winding U, going . . .



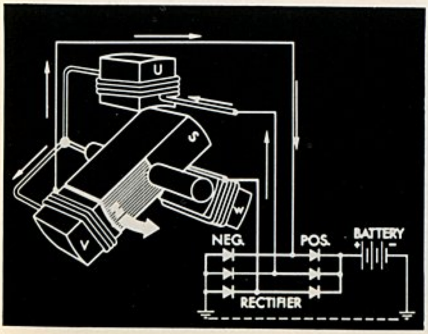
. . . through the positive output diode to the positive battery connection.



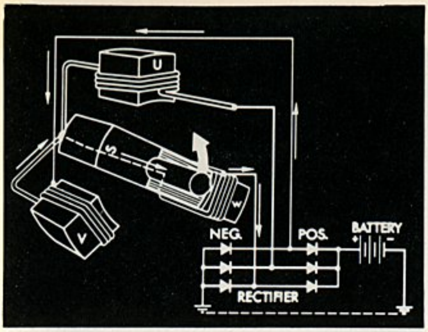
The circuit is completed through the battery to ground, through one of the negative diodes and through winding W which is negative at that moment, back to the common point of the stator windings.



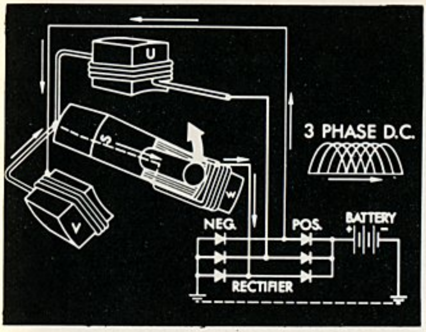
As the rotor continues to turn, winding U changes polarity due to the changing magnetic fields, and winding V becomes positive and shows up as a positive pulse on the wave form . . .



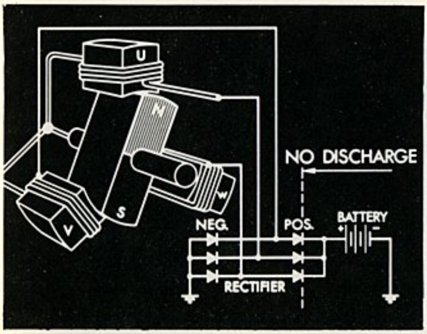
. . . and its pulse follows a similar course through a positive diode to the battery, and to ground then through the negative diode corresponding to the winding that completes the circuit.



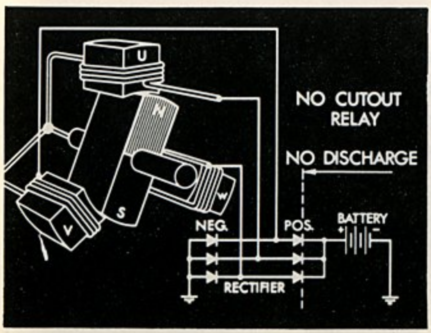
The rotor continues to turn and the positive wave pulse from winding W follows this path, while the circuit is completed through V.



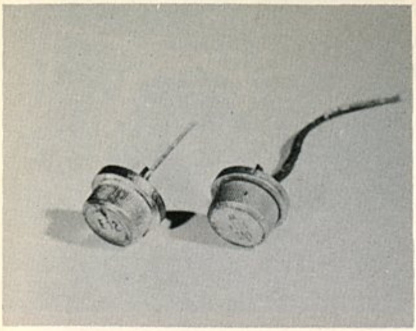
The result of the 3 phase full rectification is reasonably smooth direct current.



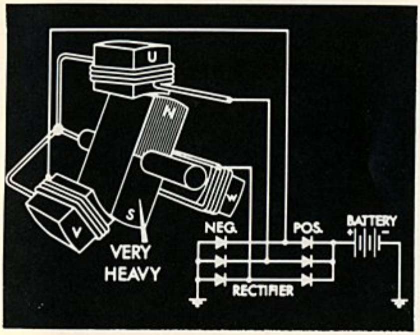
There is another important function of the rectifier diodes. They prevent the battery from being discharged through the alternator windings.



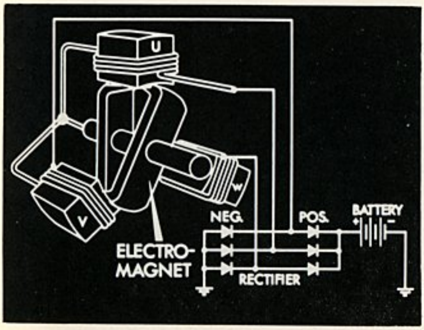
Therefore, a cut-out or reverse current relay, which is necessary for D.C. generators, is not needed for alternators.



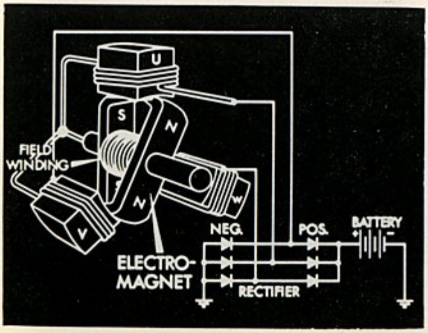
As you can see, positive and negative diodes look the same but internally each is constructed the reverse of the other. It is very important not to interchange the two types, when making repairs.



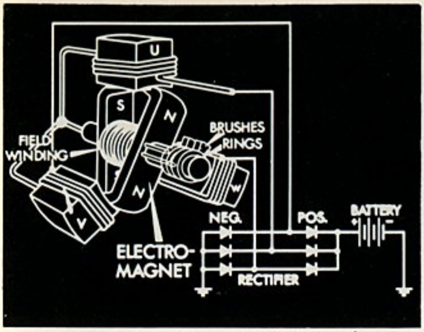
So far, we have shown the magnetic field of a rotating magnet inducing voltage in the 3 coils, but a permanent magnet large enough to create the magnetic field needed would have to be very heavy, and it would be difficult to control alternator output.



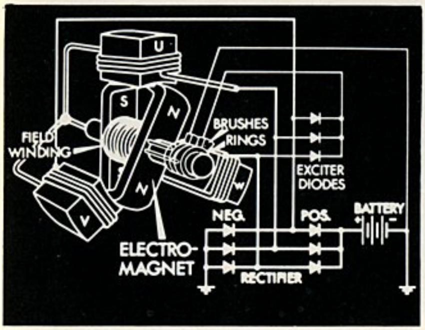
Therefore, an electromagnet is used for the rotor.



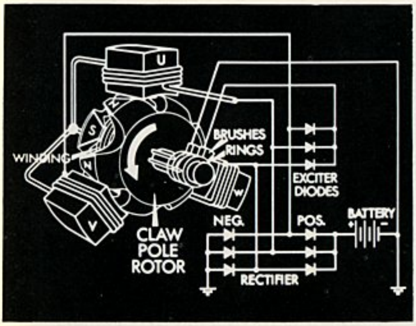
The magnetic field is created by a field or exiter winding on the rotor which carries a small amount of direct current.



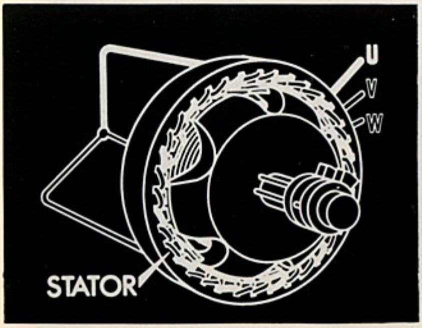
The current is provided through two carbon brushes and slip rings on the rotor shaft.



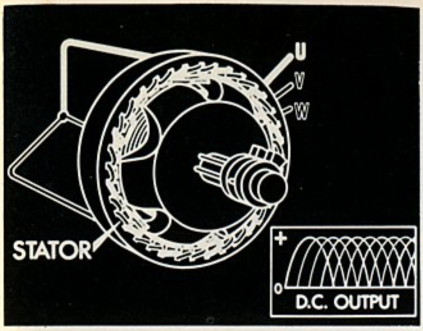
The brushes get current from three exiter diodes which rectify the alternating current generated in the stator windings.



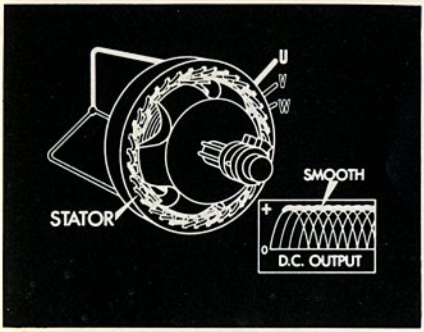
The Bosch alternator uses a claw pole rotor. The annular or ring shaped winding is surrounded by two sets of iron claws which present North and South magnetic poles to the stator in rapid succession.



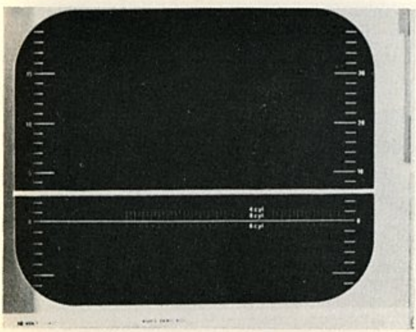
The stator is actually a slotted ring. The phase windings are distributed in sequence in the slots.



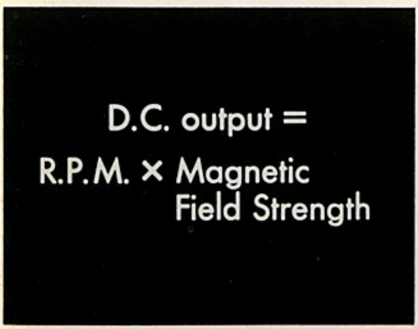
This arrangement greatly increases the output of positive pulses per revolution.



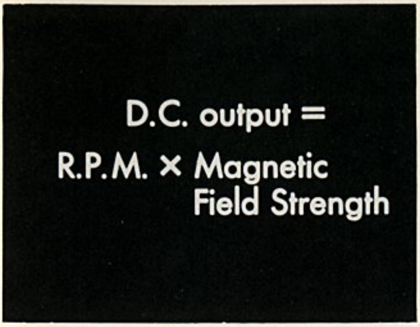
And we now have smooth direct current.



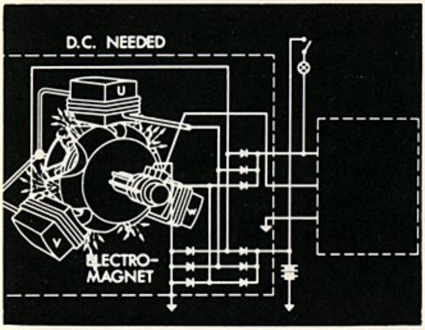
On an oscilloscope, the output of the alternator looks like this.



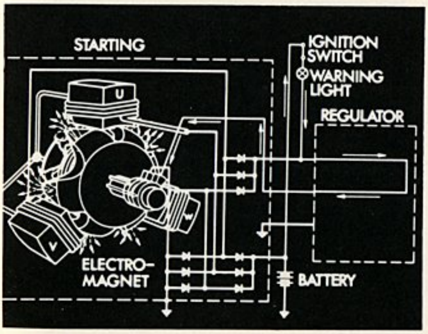
D.C. output is a product of the speed of rotation of the rotor and the strength of its magnetic field.



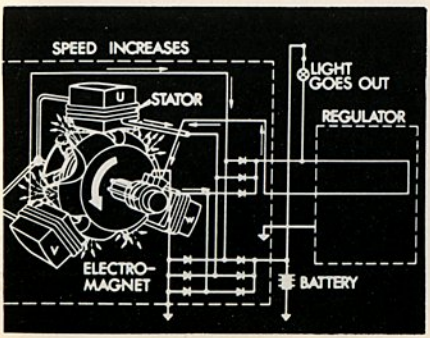
In the Volkswagen, alternator output is controlled by regulating the strength of the rotor's magnetic field.



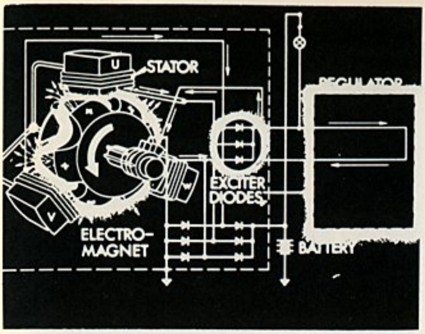
As you know, the rotor is an electro-magnet. Direct current is needed to exite the rotor so it will act as an electro-magnet.



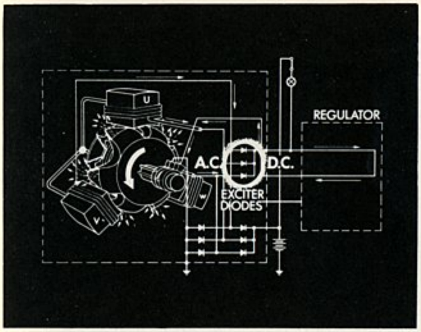
To begin with, exiter current is supplied by the battery, through the ignition switch, charging warning light and the regulator, so without some slight charge in a battery the alternator's magnetism cannot be set up.



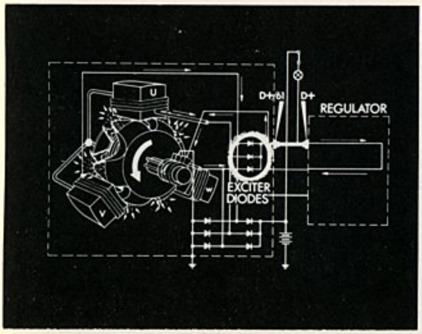
As the alternator RPM increases, the warning light goes out and the output of the stator windings supplies current to the field winding.



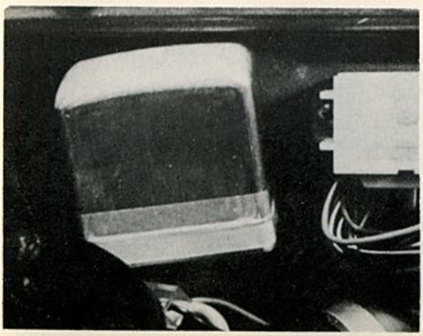
This current is passed through the exiter diodes and through the regulator, to the positive pole of the rotor.



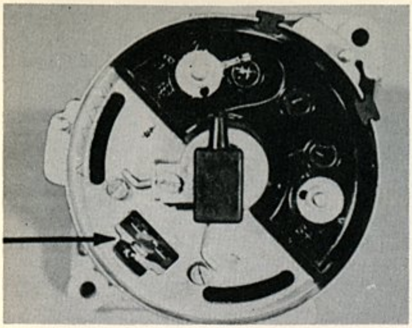
The exiter diodes rectify the alternating current generated in the stator windings for the field winding.



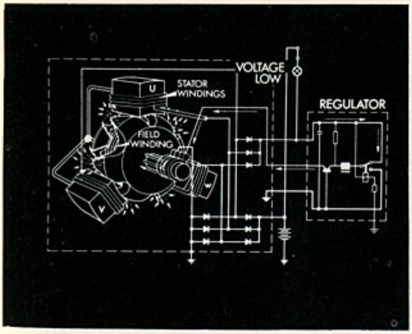
Their positive poles meet at terminal D+/61 of the alternator. The same terminal which the regulator is connected to.



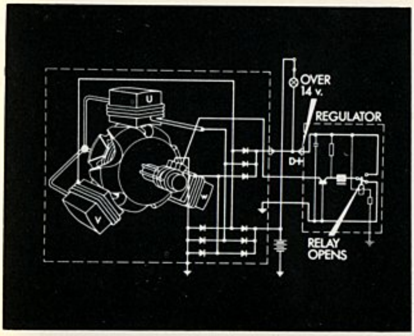
The voltage regulator is a simple switching device which is sealed and requires no adjustments.



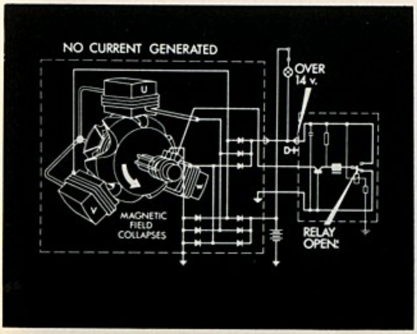
The regulator senses the battery voltage at D+/61 of the regulator terminal of the alternator.



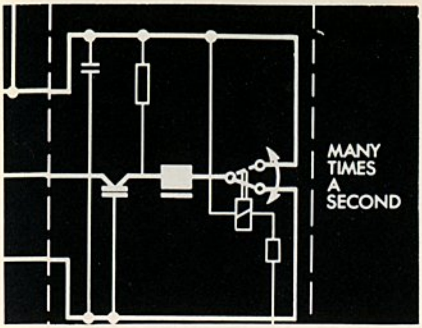
And when voltage is low, it allows current to flow to the field winding of the rotor, thus inducing more voltage in the stator windings.



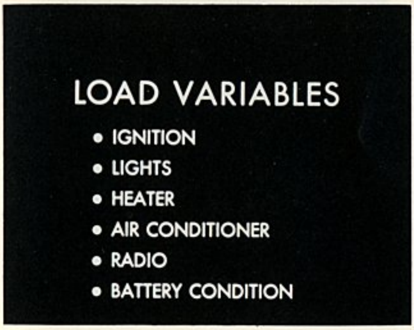
When the regulator senses over 14 volts in the battery, a relay opens, cutting off current to the field winding.



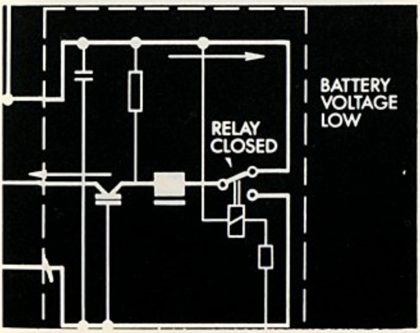
Of course, when the field winding on the rotor gets no direct current, its magnetic field collapses and without magnetism it can no longer induce current in the stator windings. The alternator stops generating current even though the rotor continues to turn.



This "on-off action" of the relay may occur many times a second . . .

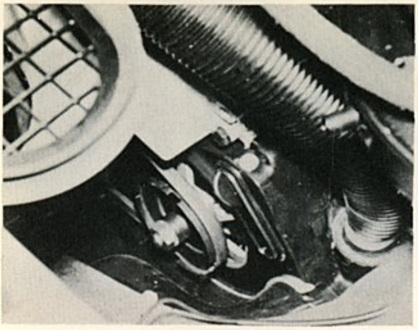


. . . as the electrical supply voltage varies in response to the load.

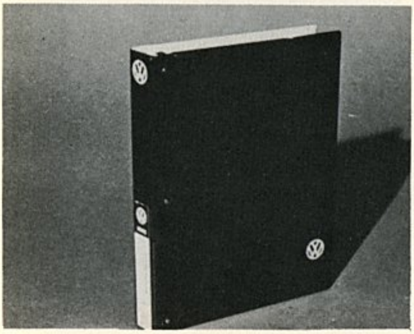


For example, if the battery voltage is low, the relay will remain closed allowing full current to flow to the field coil. The alternator will put out its maximum.

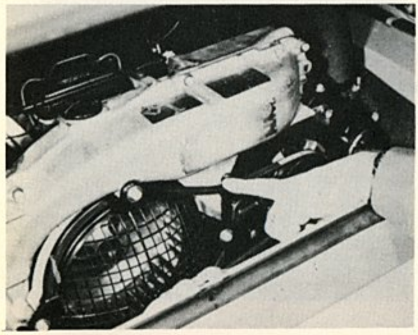
On the other hand, when the car is operating normally with only the ignition load and the battery is at full voltage, the relay will close only enough to supply field current for the small requirement at the time.



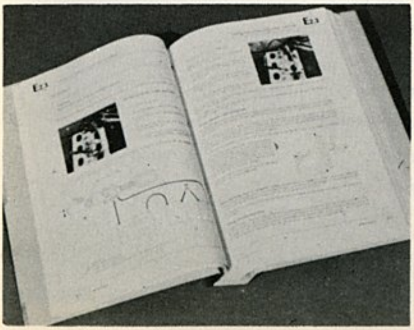
The alternator-regulator combinations are quite trouble-free and usually do not require service for the life of the car.



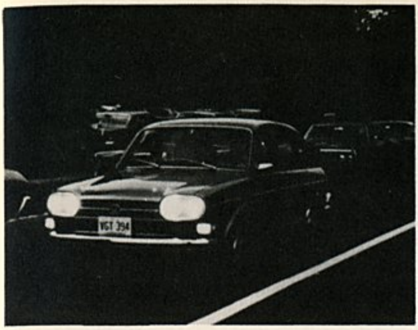
When problems do occur, trouble-shooting and repair procedures are covered fully in your workshop manual.



As is often the case, what may seem to the owner to be a major problem can have a simple solution, such as a loose drive belt.



Remember that by using systematic trouble-shooting procedures you can quickly isolate the faulty part and repair or replace it.



The electrical system is a vital part of any car, and the alternator lives up to the Volkswagen tradition of excellence.

Test the ALTERNATOR and REGULATOR

Now that you understand how an alternator works, let's go to the workshop and test the charging circuit.

SERVICE TRAINING

Volkswagen of America, Inc.

NOTES

QUESTIONS

Complete the following statements:

1. *The components within the alternator which change or rectify A.C. to D.C. are called* ____________________

2. *Alternator output is controlled by regulating the strength of the* ____________________ *or the* ____________________

3. *Can an alternator equipped car with a completely discharged battery be push started?* ____________________
   Why? ____
   ____

4. *What keeps the battery from discharging back into the alternator when the car is not running?* ____________________

5. *What will happen if the charge indicator bulb is missing or blown out?* ______________________________

ANSWERS

1. *The components within the alternator which change or rectify A.C. to D.C. are called DIODES.*

2. *Alternator output is controlled by regulating the strength of the MAGNETIC FIELD or the ROTOR.*

3. *Can an alternator equipped car with a completely discharged battery be push started? NO.*
   Why? SOME ELECTRICITY MUST BE AVAILABLE TO MAGNETIZE THE ROTOR.

4. *What keeps the battery from discharging back into the alternator when the car is not running? THE + DIODES.*

5. *What will happen if the charge indicator bulb is missing or blown out?*
   THE ALTERNATOR WILL NOT CHARGE.

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