# The Gas-Electric Bus

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The increasing reliability of the automobile as a means of travel, the continuous extension of a network of surfaced highways and the relative inflexibility of the railways have been the principal factors in the growth of bus transportation.

Among the development in bus design have been the substitution of gas-electric drive for the clutch gear shift especially in view of the advantages of greater comfort and safety, longer life and lower maintenance. The Public Service Transportation Company, of Newark, N. J., U. S. A., placed in service the first buses of ACF design utilizing Westinghouse electrical equipment.

On buses of this design the electrical equipment consists of a generator, rated 29kw., two series motors, rated 240 volts, 78 amp., at 1800 rpm., a main controller, a foot-operated battery field switch, a foot-operated field resistance switch, a motor cutout switch and engine test terminal, a set of resistors and a set of braking resistors.

The scheme of control is simple and requires a minimum of effort and operating skill on the part of the driver. Yet it is sufficiently flexible to afford the engine output and performance necessitated by various load or grade conditions. To move the bus the controller is placed in the "off" or "neutral" position, then the engine is started. The main controller handle is next moved to the desired operating position, and the bus accelerated by simply depressing the foot throttle. Improved acceleration may be obtained, particularly with heavy loads, or on grades, by depressing the accelerator and foot-operated field resistance switch simultaneously. By so doing, resistance is cut into the generator shunt field. The effect is to reduce the generator voltage and consequently the load on the engine. This permits the engine to speed up, thereby increasing the power available for acceleration. As the bus gains momentum, the field resistance button is released and operation continued at reduced engine speed.

Good performance on grades is assured by the scheme of control provided. On slight grades, the use of the foot-operated button for inserting resistance in the generator shunt field, as described above, may suffice. On more severe grades, the controller is shifted to the "motor series" position, while on very severe grades, a combination of these two schemes may be necessary. No actual grade values can be set down at which one or another of the above mentioned methods should be used. The selection of a scheme is best dictated by the performance desired, as it is evident that a combination of the grade and the load handled, and not alone the grade, will determine the method to be used. Engine condition must also be taken into consideration as well as road conditions.

Acceleration on grades is accomplished in the same way as on the level. On heavy grades, the controller is placed in the series position at the start, and left there until the grade is ascended. Should it be necessary to shift to the "motor-parallel" position, the throttle must be completely released before the shift is made.

The generator, is located directly behind the engine and is connected directly to it through a hollow shaft and two flexible couplings. This arrangement works out very satisfactorily in actual service. The two series motors are located near the middle of the chassis. Each unit drives a rear wheel through a drive-shaft, two universals and a worm and gear. An 11:1 gear ratio is employed. Both the generator and motors are so mounted that they may be lowered and removed from the chassis without disturbing the body.

The breaking resistor is mounted midway between generator and motors and equidistant from the chassis side rails. It is placed low enough to insure adequate ventilation of the unit and yet high enough to prevent damage thereto when the bus ascends a ramp or passes over a hump in the road.

The vertically mounted main controller is conveniently located to the left and just forward of the driver's seat. The generator field resistance switch is mounted below the floor plate, with the operating button projecting through the floor board, and so located that it can be operated by the driver with his left foot. The battery field switch, mounted on the floor board in front of the main controller, is inter-connected with the engine foot throttle. Arrangement is such that the battery field circuit can be closed only when the throttle is depressed, thus eliminating unnecessary drain on the battery. The motor cut-out switch, engine test terminal, and the field resistor are mounted under the longitudinal seat directly behind the driver.

The generator has a self-excited shunt field, a battery field and a small amount of series field for compounding. In order to obtain the high power output essential to rapid acceleration, a resistance is placed in the shunt field circuit so as to reduce the excitation and thus allow the engine to run at higher speed. This is accomplished by depressing a foot-operated resistance switch. The battery field serves as a teaser field and is controlled through the field switch which is operated from the foot throttle. The compound field is employed to minimize the amount of battery current required.

The generator is equipped with a uni-directional cast aluminum fan, which draws air in through openings in the frame below the commutator and forces it over the commutator and field coils. Air is also taken in through openings in the commmutator and housing, and is drawn through the center of the armature. All cooling air currents are expelled radially at the engine end of the generator.

Particular care has been taken to obtain quiet

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operation. Fan and air outlets have been constructed so as to eliminate whistling noises that might be created by the air drafts. Magnetic noises have been reduced to a minimum by the use of skewed slots in the generator armature.

The generator is arranged with a hollow shaft, through which the drive-shaft passes. On each end of the drive-shaft is a Spicer rubber ball type flexible coupling. The engine, therefore, drives the generator armature through two flexible couplings and a shaft, connected to the armature at the commutator end. This drive-shaft is supported at the engine end on a large ball bearing and on the commutator end by a large roller bearing. To assure long life of windings and the safe handling of the short, heavy overloads incident to bus operation, high temperature insulation is used. Good commutation and long life of brushes and commutation are assured by the use of interpoles.

The motors are of the series, interpole type. Methods of ventilating and insulating are similar to those used in the generator. In both the generator and motors, the commutator and brushes are readily accessible through large openings in the frame. Inspection of these units is afforded from inside the bus by means of a trapdoor over the motors and another over the commutator cover of the generator. Both motor bearings are of the ball bearing type, and are of liberal size.

The main controller is of the drum type. It provides three operating positions in addition to an "off" and a "braking" position, as shown by an accompanying diagram. There are two "forward" positions—one connecting the motors in series, and the other connecting them in parallel. The latter is the normal operating position. In the braking position, the motors are connected in series, as series generators, with the braking resistor and the generator armature absorbing the energy.

The controller handle is provided with a button latch so arranged that the button must be depressed before the handle can be shifted from neutral into either reverse or forward parallel position. However, the handle may be pulled directly into the braking position from the off, forward series, or forward parallel position, without any manipulation of the button.

To protect the braking controller fingers from damage due to arcing in the event that the operator neglects to close the throttle before shifting the controller handle from one position to another, an arc barrier is provided. This controller also incorporates a safety feature in connection with starting the engine. The wiring of the engine starting motor is carried through this controller in such a way that the circuit is completed only when the controller is in the "off" position. This insures that the bus cannot be unintentionally moved.

Daily, twelve of these buses are in service; nineteen units will be added very soon, and the entire fleet will virtually consist of sixty-five.

## A CATASTROPHE

Molly Cassidy—Shure, Pat, I had a certificate ov karacter, but I lost it c'omin over. Phawt shall I do?

Pat Murphy—Niver moind, Molly; I'll write ye wan. (Writes like this.)

"This is to certify that Molly Cassidy had a good karacter before she lift the old counthry, but losht it on shipboard comin' over!—Buick News.

## A CEREAL STORY

They walked among the Shredded Wheat,
When Grape-Nuts were in season.
He asked her why she looked so sweet,
She answered, "There's a reason."

## FOREWARNED

A student failed in all the five subjects he took. He telegraphed to a brother. "Failed in all five. Prepare father."

The brother telegraphed back: "Father prepared. Prepare yourself."