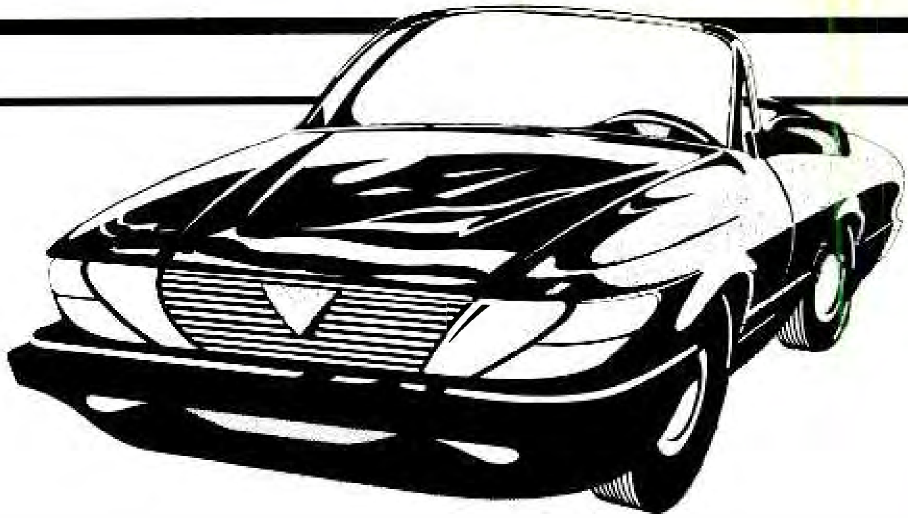
Project

Automatic Headlamps Circuit



Automatically turns on your car's headlights when you turn on the ignition and disables them when you turn off the ignition

By Kenneth R. Cooper

Some time ago, in the interest of driving safety, I started driving my car with its headlights on at all times. I made this decision because it is sometimes difficult for other drivers to see my small dark-colored car. Everything went as planned until the first time I found I had a "dead" battery, the result of forgetting to turn off my headlights when I parked my car overnight. This was enough to spur me to find or design a device that would automatically disable my headlights when I parked for the night, a feature of many luxury-class cars. As it turned out, designing the device was a simple matter.

The Automatic Headlamps Circuit described here accomplishes what I had in mind, simply and inexpensively. Because there are variations in ignition systems from one manufacturer to another, several are discussed here. There are enough to accommodate just about any car on the road, whether domestic or imported, except those from Chrysler Motors (possible use for these is discussed).

About the Circuit

Checking over the schematic diagram of the headlights circuit in my car revealed that it would be relatively easy to install a relay that could be energized only when the vehicle's engine was running. Thus, a relay could be used to control the headlights.

Shown in Fig. 1 is the alternator circuit of my Chevette. The "Charge" indicator lamp is connected between the ignition switch and Terminal 1 of the alternator. Turning the ignition switch to "on" causes the lamp to light, indicating that the lamp itself is functional. After the ignition catches and the engine continues to run, the lamp extinguishes. This means that the charging circuit is operating.

Terminal 1 of the alternator connects internally to the regulator circuit and the rotor. Thus, it "sees" a low resistance to ground. When the ignition switch is closed ("on"), the lamp lights up because current flows through it to ground.

When the engine starts, the alternator begins to produce three-phase alternating current in the stator windings. This voltage is rectified by the six diodes. When the voltage is great enough in magnitude, current

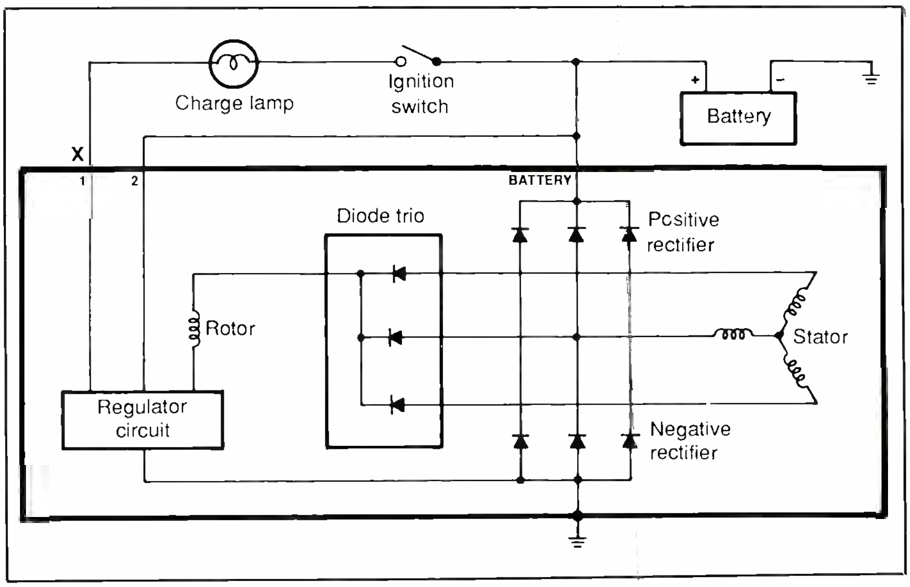


Fig. 1. Details of 1981 Chevette charging circuit.

flows into the battery. At the same time, current flows through the trio of diodes into the rotor. The lamp now extinguishes because it has the same potential at both ends of it and cannot conduct a current.

Alternator Terminal 1, which is at or near ground potential with the engine off, will be at battery potential when the engine is running. This provides the key to automatic control of your car's headlights.

If the coil of a relay is connected between alternator Terminal 1 and vehicle ground, the relay will energize whenever the engine is running. This relay's coil voltage rating must be the same as the 12 volts dc of the battery, and its contacts must be rated to handle at least 10 amperes.

The relay should have two sets of normally open contacts. One set is used to control the headlamps, and the other is for the marker lamps. This arrangement lets both headlamps and marker lamps come on when the relay is energized but keeps the two lamp circuits isolated from each other when the relay is not energized. This allows the marker lamps to be turned on (for parking) without the headlamps coming on as well.

In my Chevette, two self-resetting circuit breakers were used, one for each lamp circuit. In the event of a momentary short circuit in the headlamps circuit, the markers remain on, offering a degree of safety. Fuses would be a poor choice here because, when blown, they would require physical replacement.

Keep in mind that different manufacturers use different charging circuits in their automobiles. However, if your car is equipped with an "idiot light" as described, it should be fairly simple for you to install the relay.

Figure 2 shows the schematic diagram of a circuit that can be found in some older General Motors cars. The regulator is externally mounted and may be either electromechanical or solid-state in design. In either case, the indicator lamp will be connected

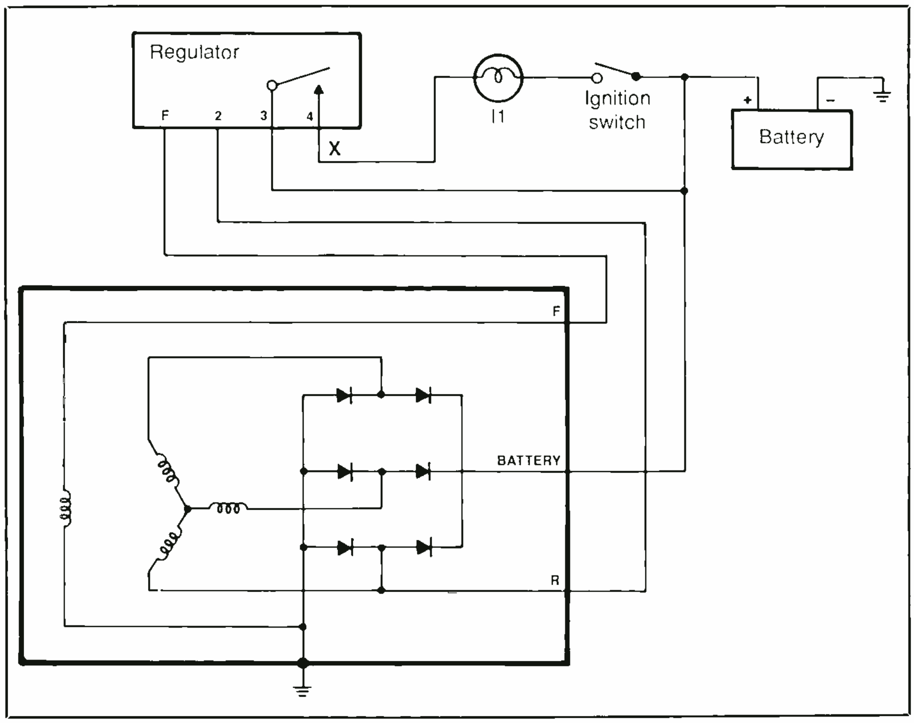


Fig. 2. Schematic diagram of circuit found in some older General Motors cars.

to a relay contact with the regulator. Terminal R of the alternator energizes the coil of the relay whenever the alternator is producing current. The headlamp relay of this project connects to regulator Terminal 4.

Figure 3(A) is the schematic diagram of a typical Ford circuit. Except for terminal markings, it employs much the same design as the General Motors circuit discussed above. The lamp is connected to Terminal I, which is where the headlights control relay should be connected as well.

Shown in Fig. 3(B) is the schematic diagram of a similar circuit to that shown in Fig. 3(A). The difference here is that the Fig. 3(B) circuit uses an ammeter movement in place of the lamp. In this configuration, Terminal I is not used and, thus, is not suitable for the headlights-controlling relay. The STA (stator) terminal of the alternator is not connected to the regulator. It may not be used, or it may be connected to an electric-choke heater. The headlights relay could be connected to the STA terminal in this arrangement.

Some American Motors cars use a Motorola alternator, as shown in Fig. 4, that uses isolation diodes. In this arrangement, the lamp is connected between these diodes and the usual rectifier diodes. This is the point to which the lamp is connected and is shared by the headlights-controlling relay. The characteristic common to these circuits is that if an "idiot light" is used to indicate alternator function, the point that sinks current for the lamp can also "source" current for a relay.

Shown in Fig. 5 is the schematic diagram of a circuit used in Toyota cars. I used this circuit for experimenting. The alternator and regulator are mounted on a circuit board and driven by a variable-speed air motor. The neutral point of the stator windings is brought out to Terminal N and controls the regulator. When the experiments were finished, the air motor was replaced with a 1-horsepower electric motor, and the whole thing is now being used as a battery charger.

Shown in Fig. 6 is the schematic di-

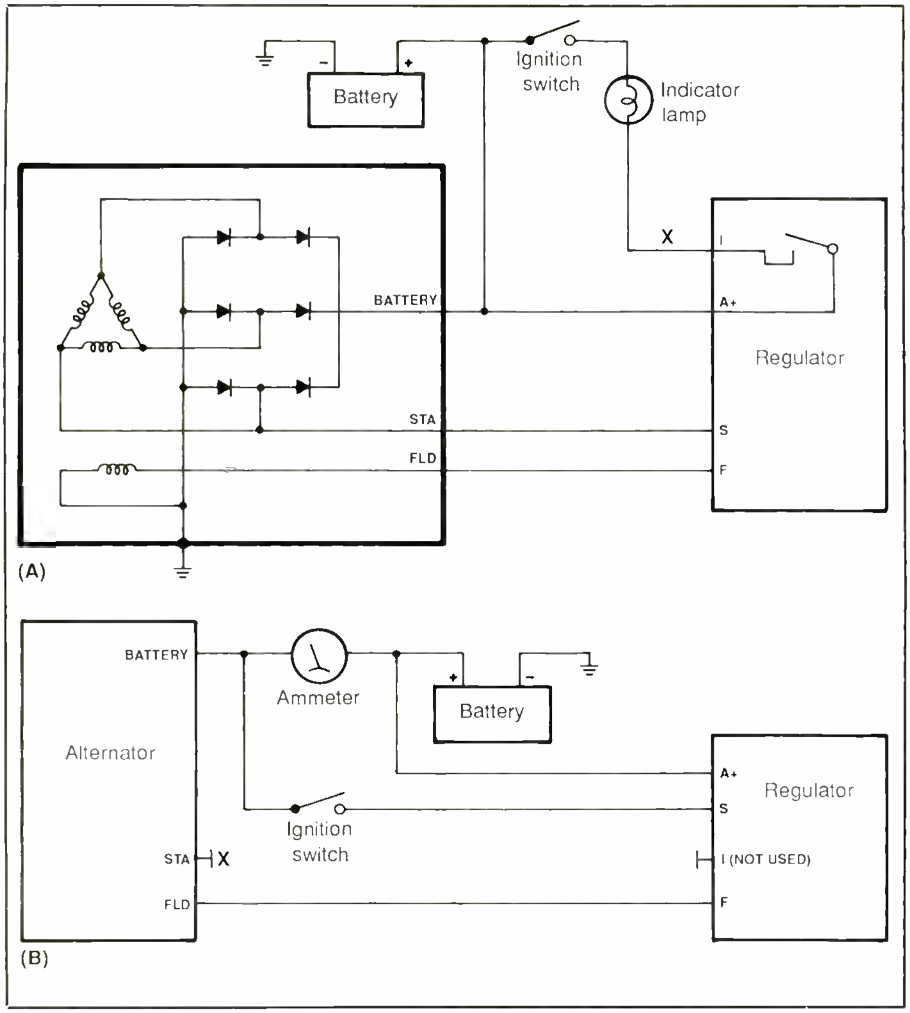


Fig. 3. Schematic diagrams of circuits that can be found in many Ford Motor cars: (A) with "idiot lamp" and (B) with ammeter charging indicators.

agram of a generator circuit that can be found in some older model automobiles. The output of the generator is fed to the battery through the cutout relay inside the regulator. This relay closes when generator voltage is greater than battery voltage. Should the generator's output fall to less than the battery voltage, this relay opens. This prevents current flow from the battery to the generator. The output terminal of the generator can be used to power the relay that controls the headlamps.

Figure 7 is the schematic diagram of the complete Automatic Headlamps Circuit. As you can readily see, this is a very simple circuit design. Here, the relay feeds the headlamp circuit at the point between the headlamp and dimmer switches.

Five conductors connect the project to your vehicle's electrical system. The two circuit breakers go to one side of each contact pair of the relay. The other sides of the circuit breakers tie together and go to any point that is always at +12 volts in the vehicle's electrical system. The best place to make the +12-volt connection is to the positive (+) terminal of the battery, as shown.

The opposite sides of the contact pairs of the relay go to the line between the Ignition Switch and Marker lights and between the Ignition and Dimmer Switches. One end of the relay coil connects to point "X" in your vehicle's charging circuit. Finally, the remaining line goes between the ground end of the relay coil and vehicle chassis ground, with the DISABLE SWITCH between these two points. The DISABLE SWITCH allows you to defeat automatic controller action if desired for any reason.

Construction

As you can see from Fig. 7, there is very little "construction" for this project. All you need other than the relay, circuit breakers and switch are a small utility box and a metal bracket.

Machine the box by drilling holes to mount the relay and two circuit breakers, to permit exit of the five conductors that tie into the vehicle's electrical system and to secure a plastic cable clamp for the conductors into place near the entry hole. Also drill two small holes through the floor of the box to permit the project to be mounted in place inside the engine well. If you are using an all-metal utility box, deburr all holes and line the exit hole for the conductors with a rubber grommet.

Determine where in the engine compartment of your car the utility box will be mounted. Set the box in place and mark the locations of its mounting holes on the surface of the vehicle. Drill a small hole at each marked location. Then start a No. 6 or No. 8 sheet-metal screw into each hole. Remove the screws and loosely mount the box in place.

Use only No. 14 stranded insulated wire for all conductors in this project. Now determine how long each conductor must be to bridge from the utility box to the various points in the vehicle's electrical system and cut each to length, leaving 6 to 8 inches of slack for each. Note that three conductors go from the utility box to the vehicle's + battery terminal, the point identified with an "X" in the ignition system and the marker lights conductor. The other two conductors go to the under-dash-mounted DISABLE SWITCH and line conductor that bridges the Ignition and Dimmer switches inside the passenger compartment.

Strip ¼ to ⅜ inch of insulation from both ends of each conductor. Tightly twist together the fine wires at all ends and sparingly tin with solder. Route one end of all conductors into the box through the grommet-lined hole and secure a plastic cable clamp to all five conductors about 5 inches from the end *inside* the box. Pull the cable clamp very tight to assure that the conductors will not pull loose from inside the box. Crimp and solder the ends of each of two conductors to one side of each relay contact pair. Then crimp and solder the ends of each of two more conductors to the coil lugs of the relay.

Strip ¼ to ⅜ inch of insulation from both ends of three 3-inch-long No. 14 stranded insulated conductors. Again, tightly twist together the fine wires at all ends and sparingly tin with solder. Mount the relay and circuit breaker in place inside the box, using suitable machine hardware and outside-tooth lockwashers between screw head and box and between component mounting lug and nut. Secure the plastic cable clamp in place via its mounting hole with No. 6 or No. 4 × ⅜-inch machine hardware and an outside-tooth lockwasher between nut and box.

Now crimp and solder two of the 3-inch conductors to the remaining contact lugs of the relay. Crimp and solder the other ends of these conductors to one lug on each circuit breaker. Crimp one end of the remaining conductor to the remaining lug of either circuit breaker and solder the connection. Then crimp and solder the free end of this conductor and the remaining conductor that exits the box to the remaining lug of the other circuit breaker.

Place a flat washer on each of two No. 6 or No. 8 × ½-inch sheet-metal screws and start a small rubber grommet onto each screw. Plug the screw ends into the holes in the floor of the box from the inside, and start another small rubber grommet onto the protruding ends. Mount the box in its selected location via the screws. Tighten the screws only enough to slightly compress the rubber grommets; do not make them so tight that the box is very rigidly mounted.

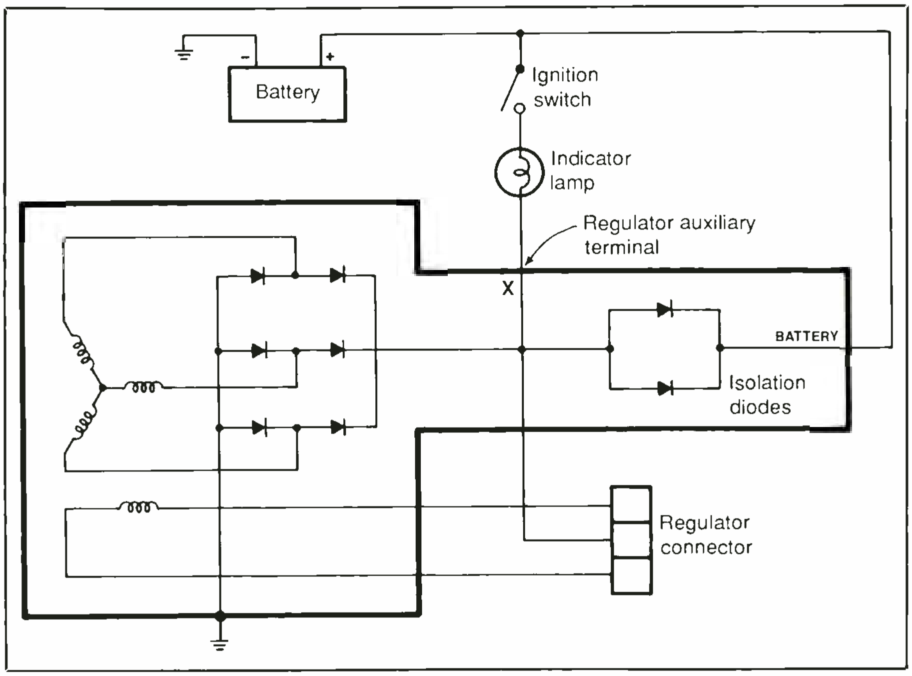


Fig. 4. Details of charging circuits used in American Motors cars.

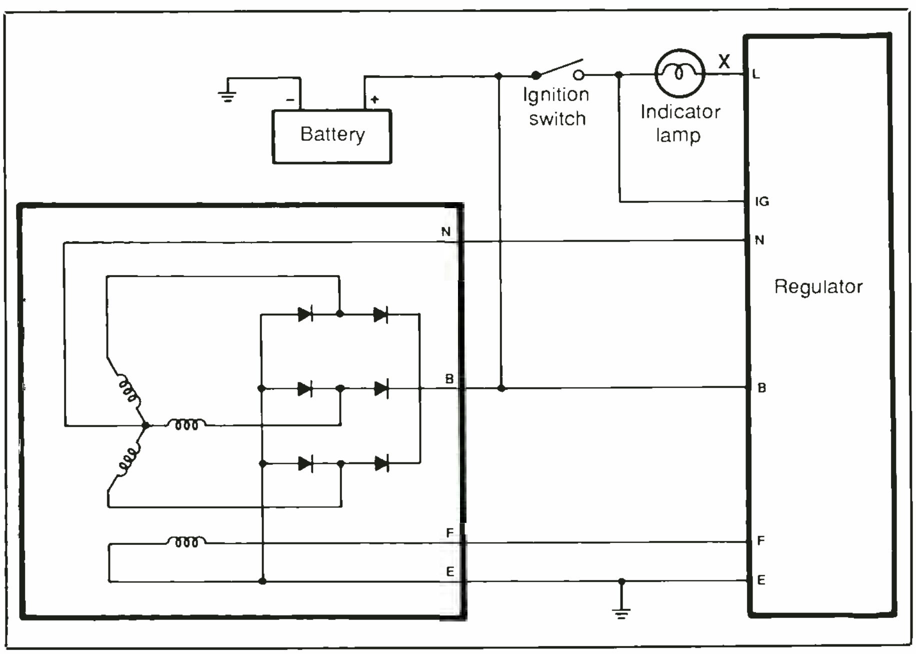


Fig. 5. Schematic diagram of circuit used in Toyota cars.

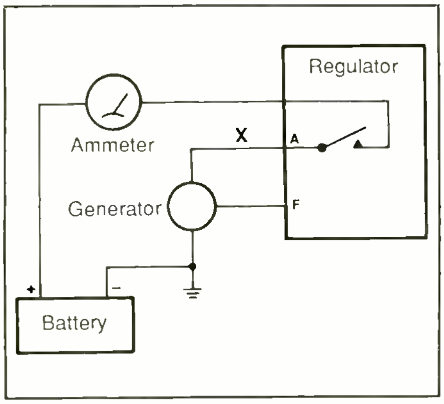


Fig. 6. Schematic diagram of generator circuit in some older model cars.

Before closing up the box, identify the destination of each conductor exiting it. If you did not use color-coded wire for the conductors, use an ohmmeter or signal tracer to make sure that the destination of each conductor is properly identified.

Route the two conductors that go inside the passenger compartment to their respective locations. Connect and solder the DIMMER SWITCH wire to the appropriate lug on the dimmer or headlights switch. If access to these switches presents a difficulty, cut into the existing conductor that bridges them and make the connection there. After cutting the conductor, strip ½ inch of insulation from both cut ends. Tightly twist together the fine wires in both cases. Slide onto one conductor a 2-inch length of heat-shrinkable tubing. Tightly twist together (use an axial twist, rather than parallel one) the stripped ends of the conductor and solder the connection. Now wrap the end of the DIMMER SWITCH wire around the connection and solder the three-way connection. Make certain that this connection is both electrically and mechanically sound. Slide the heat-shrinkable tubing along the conductor, center it over the connection and shrink it into place.

Mount a small switch bracket under the dashboard where it will be easily accessible but will not interfere with the driver or front-seat passenger. Crimp and solder the DISABLE SWITCH conductor to one lug of the switch. Strip ¼ to ⅜ inch of insulation from both ends of a suitable length of No. 14 stranded wire. Twist together the fine wires ar both ends and sparingly tin with solder. Crimp and solder one end of this wire to the other lug of the switch and terminate the other end in a spade or ring lug. Mount the switch on the bracket with the hardware provided with it.

Terminate the free end of the loose wire connected to the switch at any convenient point on the vehicle that is at electrical ground. This can be an existing screw or a new screw for which you must drill a hole. Whichever the case, burnish the mounting location down to bright metal with fine emery cloth. Then secure the conductor in place with a sheet-metal screw with an outside-tooth lockwasher between spade or ring lug and metal chassis.

Return to the engine compartment and connect the free end of the "X" conductor to the appropriate point in the vehicle's charging system. If the wire already connected to that point has a spade or ring lug on it, terminate the project's conductor in the same type of lug. Otherwise, crimp

PARTS LIST

CB1,CB2—20-ampere, self-resetting automotive circuit breaker
K1—12-volt dc dpdt relay with 10-ampere or more contacts and socket (see text)
S1—Spst heavy-duty (10-ampere or more) toggle switch
Misc.—Suitable enclosure (see text); bracket for S1 (see text); rubber grommets; heat-shrinkable tubing; spade or ring lugs; plastic cable clamp; heat-shrinkable tubing; ½-inch No. 6 or No. 8 sheet-metal screws; machine hardware; external-tooth lockwashers; No. 14 insulated stranded wire; solder; etc.

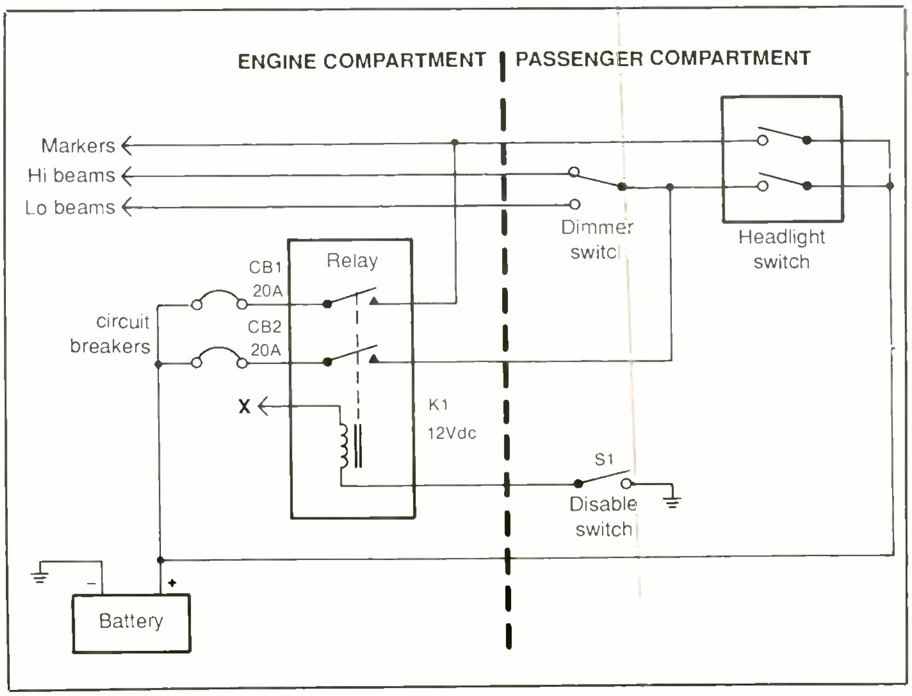


Fig. 7. Complete schematic diagram of the Automatic Headlights Circuit. It consists entirely of a 12-volt dc relay, two 20-ampere self-resetting circuit breakers, a single-pole, single-throw toggle switch and No. 14 insulated stranded wire.

and solder the end of the conductor to the connection point.

Terminate the free end of the circuit-breaker conductor at the battery's + terminal. This can be done by soldering the free end of the conductor to the appropriate battery cable clamp. Finally, connect and solder the free end of the remaining project conductor to the markers light conductor in the same manner described above for the in-line ignition/dimmer switch connection.

While researching this article, I had some difficulty locating detailed information on Chrysler Motors products. It would appear that Chrysler cars always use ammeters instead of "idiot lights," which means that there is no place to connect the relay. It should be possible to open the alternator and attach a wire to one of the stator terminals and bring this wire out to the relay. However, I have not actually tried this. If you have a Chrysler vehicle, check with your dealer to find out if such a connection is possible.

Another alternative with Chrysler cars is to use the circuit published in Mr. Wright's article that appeared in the October 1988 issue of *Modern Electronics*—with some changes. That circuit does not show any connection for the marker lamps, so use a double-pole relay instead of the one specified. Eliminate the fuse in the battery-feed to Terminal A and replace it with circuit breakers in series with each set of relay contacts. Also, instead of routing the headlamp circuit through two sets of relay contacts, wire the contacts of *K2* in series with the coil of *K1*, rather than to the contacts of *K1*. This arrangement allows *K2* to be a lighter-duty relay, similar to *K3*.

If your particular situation requires driving the relay from the alternator R, N or STAT terminal, it is a good idea to check the voltage at that point before selecting your relay. Some alternators use the neutral point of a wye-connected stator (see Fig. 5). This will produce only half the output voltage, which will be 6 volts in a 12-volt system. Consequently, you need a 6-volt dc relay instead of the 12-volt one specified in the Parts List.

I used a Potter & Brumfield No. KRP11DG 12-volt dc relay in my installation, mainly because I had it on hand. It would have been a good choice in any event. In experiments I performed on this relay using a variable dc power supply, I determined that it energizes at potentials as low as 7 volts but it does not drop out until the feed drops to about 2.8 volts. This hysteresis is good because it means that, once energized, the relay will hold solidly closed even if the engine slows almost to a stall.

While the P&B relay is a good choice for this application, it is fairly expensive. Relay and socket cost about $25. Radio Shack has a similar relay and socket at a much lower price, but the socket will require that you use some sort of mounting bracket. Whatever relay you choose, make certain that each set of its contacts can handle a 10-ampere load.

In Closing

While I was using this retrofit modification this past winter, I noted an unexpected cold-weather benefit. On cold mornings, I like to start my car's engine and let it run a while before leaving for work. It used to be difficult to tell if the engine had stalled, but now all I have to do is look out the window to see if the headlights are on. If they are, the engine is running and all is well. Also, should the engine stall without my knowing it, at least the headlights will extinguish and not drain the battery.

My car is long past any warranty; so installation of this modification was of concern only to me. If you plan on installing this project in your in-warranty car, check with your dealer to find out if it will void your protection. **ME**