Homemade Electric Locomotive Model and Track System

By A. E. Andrew

PART I—The Motor

THE electric locomotive described may be constructed by boys having average mechanical ability and the necessary tools. However, in any piece of mechanical construction care must be taken to follow the instructions. The material required is inexpensive, and the pleasure derived from such a toy is well worth the time used in its construction.

The making of the outfit may be divided into three parts, the first of which is the motor; second, the truck, which is to carry the motor and the body of the car, and third, the track system upon which the engine is to operate. A side view of the locomotive is shown in Fig. 1.

The motor is of the series type, having its field and armature terminals connected to the source of electrical energy through a special reversing switch. By this means the rotation of the armature may be reversed to make the locomotive travel forward or backward. The armature and field are constructed of sheet-iron stampings, riveted together.

The detailed construction of the armature and its dimensions are shown in Fig. 2. The shaft upon which the armature core and commutator are to be rigidly mounted is made of a piece of steel rod, $\frac{7}{32}$ in. in diameter. A portion of this rod, $2\frac{1}{4}$ in. long, is threaded with a fine thread, and two small brass, or iron, nuts are provided to fit it. The ends of the rod are turned down to a diameter of $\frac{1}{8}$ in. for a distance of $\frac{1}{8}$ in. These are to fit in the bearings that are to be made later.

Cut from thin sheet iron a sufficient number of disks, $1\frac{1}{8}$ in. in diameter, to make a pile exactly $\frac{5}{8}$ in. thick when they are securely clamped together. Drill a hole in the center of each of these disks, of such a size that they will slip on the shaft snugly. Remove the rough edges from the disks and see that they are flat. Cut two disks of the same size, from a piece of $\frac{1}{16}$-in. spring brass, and drill a hole in the center of each, so that they will slip on the shaft. Place all these disks on the shaft, with the brass ones on the outside, and draw them up tightly with the nuts provided. Be sure to get the laminated core in the proper position on the shaft by observing the dimensions given in the illustration, Fig. 2.

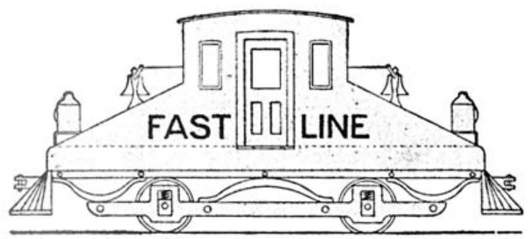

Fig. 1
Side View of a Locomotive Designed to be Operated with Either End Forward

After the disks have been fastened, clamp the shaft in the chuck of a lathe and turn down the edges of all the disks so that they form a smooth cylinder, $1\frac{1}{16}$ in. in diameter. Draw a circle on the side of one of the brass disks, $\frac{3}{32}$ in. from the edge, while the shaft is held in the chuck. Divide this circle into eight equal parts and make a center-punch mark at each division. Drill eight holes through the core lengthwise with a $\frac{3}{16}$-in. drill. If the centers of the holes have been properly located, all the metal on the outside will be cut away, as shown in the end view, at the right in Fig. 2. The width of the gaps, F, G, H, etc., thus formed, should be about $\frac{1}{16}$ in. Smooth off all the edges with a fine file after the holes are drilled.

A cross-sectional view of the commutator is shown at the extreme left, Fig. 2. It is constructed as follows: Take a rod of copper or brass, $\frac{7}{8}$ in. in diameter, and $1\frac{1}{4}$ in. long; clamp one end in the chuck of a lathe. Turn the other end down to a diameter of $\frac{3}{4}$ in., and drill a $\frac{1}{2}$-in. hole through it at the center. Cut away the metal from the end to form a disklike recess.

Cut off a disk, $\frac{5}{16}$ in. thick, measuring from the finished end, from the piece of stock. Place this disk in a chuck, with the unfinished end exposed, and cut away the metal in a dish form, as shown at B. Cut small slots, into which the ends of the wires used in winding are to be soldered, as shown at 1, 2, 3, etc., in the right-hand view of Fig. 2. Obtain two brass nuts, about $\frac{1}{4}$ in. in thickness, and turn their edges down so that they correspond in form to those shown at C and D. Divide the disk ring, just made, into eight equal parts, by lines drawn across it through the center. Cut eight slots at these points, in the rim of the disk. These cuts should be through the rim. Fill each of the slots with a piece of mica insulation.

Place one of the nuts on the shaft, and then a washer of mica insulation, shown by the heavy lines, near A and B; then the ring, a second piece of mica, and last the nut, C. The latter should be drawn up tightly, so that the insulation in the slots in the disk are opposite the drilled slots in the armature core, as shown in the right-hand view of Fig. 2. After the disk has been fastened securely, test it to learn whether it is insulated from the shaft. This is done by means of a battery and bell, connected in series, one terminal of the circuit being connected to the disk, and the other to the shaft. If the bell rings when these connections are made, the ring and shaft are not insulated. The disk must then be remounted, using new washers of mica insulation. Mica is used because of its ability to withstand a higher degree of heat than most other forms of insulation.

Each of the eight segments of the dished disk should be insulated from the others. Make a test to see if the adjacent commutator segments are insulated from each other, and also from the shaft. If the test indicates that any segment is electrically connected to another, or to the shaft, the commutator must be dismantled, and the trouble corrected.

The armature is now ready to be wound. Procure $\frac{1}{8}$ lb. of No. 26 gauge insulated copper wire. Insulate the shaft, at E, with several turns of thin

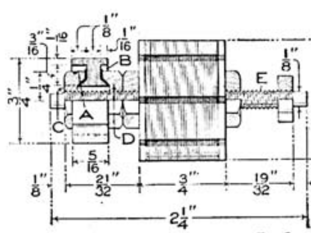

Fig. 2

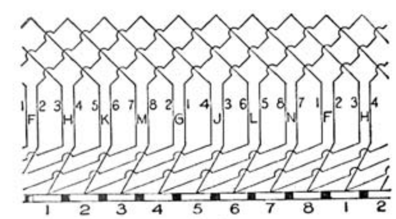

Fig. 3

How the Armature Core is Made of Soft-Iron Disks for the Lamination, at the Left. Diagram for the Winding of the Armature Coils and Their Connection to the Commutator, at the Right cloth insulation, and also insulate similarly the nuts holding the armature core and the inside nut holding the commutator. Cut several pieces from the cloth insulation, wide enough to cover the walls of the slots in the core, and long enough to extend at least 1/16 in. beyond the core at the ends. Insulate slots F and G thus, and wind 15 turns of the wire around the core lengthwise, passing the wire back through the slot F, across the back end of the core, then toward the front end through slot G, and back through F, and so on. About 2 in. of free wire should be provided at each end of the coils.

In passing across the ends of the armature, all the turns are placed on one side of the shaft, and so as to pass on the left side, the armature being viewed from the commutator end. The second coil, which is wound in the same grooves, is then passed on the right side, the third on the left, and so on. After this coil is completed test it to see if it is connected to the armature core. If such a condition is found, the coil must be rewound. If the insulation is good, wind the second coil, which is wound in the same slots, F and G, and composed of the same number of turns. Insulate the slots H and J, and wind two coils of 15 turns each in them, observing the same precautions as with the first two coils. The fifth and sixth coils are placed in slots K and L, and the seventh and eighth, in slots M and N.

The arrangement of the half coils, slots, and commutator segments is given in detail in Fig. 3. Each coil is reduced to one turn in the illustration, in order to simplify it. From an inspection of this diagram it may be seen that the outside end of the second coil in the upper row of figures, at the left end, is connected to the inside end of the fourth coil at segment 1, in the lower row of figures, representing the segments of the commutator. The outside end of the fourth coil is connected with the inside end of the sixth coil, at segment 2; the outside end of the sixth coil is connected with the inside end of the eighth coil at segment 3; the outside end of the eighth coil is connected to the inside end of the coil 1 at segment 4; the outside end of the coil 1 is connected to the inside end of the coil 3 at segment 5; the outside

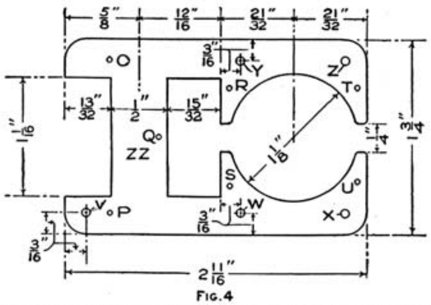

FIG. 4

Pattern for the Field Stampings, Several Pieces being Used to Make the Desired Thickness

end of the third coil is connected to the inside end of the fifth coil at segment 6; the outside end of the fifth coil is connected to the inside end of the seventh coil at segment 7; the outside end of the seventh coil is connected to the inside end of the second coil at segment 8, and the outside end of the second coil is connected to segment 1, completing the circuit.

In winding the coils on the core, their ends should be terminated close to the commutator segments to which they are to be connected, in order to simplify the end connections. After all the coils are wound and properly tested, their ends may be connected as indicated. They are then soldered into the slots in the ends of the commutator segments. The completed winding is given a coating of shellac.

The dimensions and form of the field stampings are given in Fig. 4. A number of these cut from thin sheet iron to make a pile 5/8 in. thick when clamped together is needed. The dimensions of the opening to carry the armature should be a little less than that indicated in the sketch, as it will be necessary to true it up after the stampings are fastened together. Use one of the stampings as a pattern, and drill seven small holes in each, as indicated by the letters O, P, Q, R, S, T, and U. Fasten them together with small rivets, and true up the opening for the armature to a diameter of 1 1/8 in. Drill five 1/8-in. holes, as indicated by the letters V, W, X, Y, and Z, to be used in mounting the pieces, which are to form the armature bearings, brush supports, and base of the motor.

Cut two rectangular washers from a piece of thin fiber insulation, with outside dimensions of 1 1/8 in. and 1 1/4 in., and an inside opening, 1/2 in. by 5/8 in. Cut open these washers and slip them in position on the portion of the field marked ZZ. Wrap two turns of the cloth insulation about this part, which is to form the field core, and wind the space full of No. 18 gauge enameled insulated copper wire. Give the completed winding a coat of shellac. The terminals of this winding should be brought out through two holes drilled in one of the fiber washers, one near the core and the other near the outer edge. It is better to have the field terminals at the lower end of the part ZZ than at the upper end.

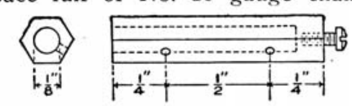

FIG. 7

Detail of the Brush Holders, One Inch Long, with Holes as Shown

Now cut two pieces from 1/16-in. sheet brass, similar to those shown in Fig. 5. Place them on opposite sides of the laminated field structure, shown in Fig. 4, and carefully mark the position of the holes, V, W, X, Y, and Z, as indicated in Fig. 4, and drill 1/8-in. holes, where the marks were made. Lay out and drill 1/8-in. holes, A, B, C, and D, Fig. 5. Bend the upper portion of the pieces at right angles to the lower portion, along the dotted lines E, and then bend the end of the horizontal portions down along the dotted lines F, until they are parallel with the main vertical parts of the pieces. The latter should be bent so that one forms the left support and the other the right, as shown in Fig. 6.

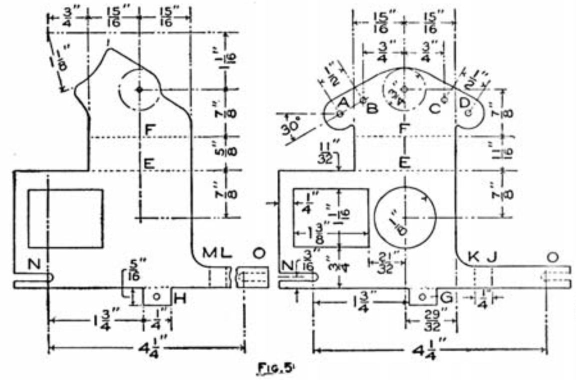

FIG. 5

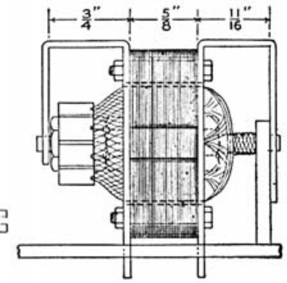

FIG. 6

Detail of the Field-Structure Supports, One Being for the Left Side and the Other for the Right. The Supports are Shown in Place at the Right

Bend the projections G and H at right angles to the vertical main parts. The parts at the bottom are bent, one back along the dotted line J and forward on the line K; the other forward on the line L and back on the line M. The pieces are then mounted, on the side of the field structure, as shown in Fig. 6. The supports are fastened in place with five small bolts. The grooves N and O, in Fig. 5, are used in mounting the motor on the axles of the truck. They will not be cut until after the truck is constructed.

The brush holders are made of two pieces of hexagonal brass, each 1 in. in length, having a 1/8-in. hole drilled in one end to a depth of 7/8 in., and a threaded hole in the other end, for a small machine screw, as shown in Fig. 7. Two holes are drilled and threaded in one side of each of these pieces. These holders are to be mounted, by means of screws, through the holes A, B, C, and D, Fig. 5. Each holder must be insulated from its support. The distance of the holder from its support should be such that the opening in its end is in the center of the commutator. The brushes are made of very fine copper gauze, rolled to form a rod. They are made long enough to extend about 1/2 in. into the holder, when they are resting on the commutator. A small spiral spring is placed in the holder, back of the end of the brush, and which will serve to keep the latter in contact with the commutator.

Temporary connections are made and the motor is tested with a six-volt battery. The construction of the motor may be modified as to the length of shaft, and other minor details, and may be used for other purposes by fitting it with pulleys, a countershaft, or other transmission devices.