MECHANICAL STUDY GUIDE

LOCOMOTIVES WITH MODEL 244 ENGINES

ALCO DIESEL-ELECTRIC LOCOMOTIVE SCHOOL
INSTRUCTION SERIES

TYPES OF DIESEL-ELECTRIC LOCOMOTIVES

Diesel-electric locomotives may be divided into three general groups according to the type of service for which they are designed. The locomotives of one group may sometimes perform service for which those of another group are specifically designed, but in general they are not as well adapted to it. The three groups are yard switchers, road switchers and road locomotives.

The switching locomotive is designed to handle heavy loads at low speeds in yard, terminal and transfer service. Therefore, it is generally provided with less horsepower capacity in relation to its weight than road locomotives, which must operate at higher speeds. Since visibility in both forward and backward directions is of great importance, the operating controls are placed in a cab with windows on all sides. The power plant is enclosed in a narrower hood so that the crew can see past, and sometimes over it. Doors in the side of the hood give ready access to the power plant for servicing and maintenance of the power plant, while hatches in the top permit removal of parts such as cylinder heads and pistons from the engine. The entire hood may be removed and the diesel engine lifted from the locomotive frame for overhauling. The cab is located at the rear of the locomotive when only one engine is used, which is the most common practice. When two engines are used the cab is located in the center with a hood housing one engine at each end.

Switchers are sometimes used for short main line or branch line runs. For such service they may be equipped with multiple unit control.

The road switcher, designed for operation on main or branch lines in either freight or passenger service as well as in yard and terminal switching, is similar in general appearance to the yard switcher. Thus it has the high visibility in either direction and accessibility for maintenance of the switcher. Behind the cab, however, it carries a short hood in which a steam generator may be mounted to provide steam to heat and air condition passenger trains. It is also equipped with trucks better suited for high speed service than are those of the yard switcher. It is frequently equipped for multiple unit operation.

Road locomotives are of two types. Both are designed for through, main line service with little switching or backing. The control cab is located at the front end of a unit with windows in the front and sides only. It is raised above a rounded nose which houses miscellaneous auxiliary equipment. The high forward location of the control cab gives excellent visibility forward and to the sides. The contour of the control cab is carried on back to the rear of the locomotive to house the power plant and provide enclosed space around it for inspection and adjustments while the locomotive is in motion. These locomotives are equipped with high speed trucks and air brake equipment designed to give satisfactory control of both the longest and the fastest trains.

Road locomotives designed to handle freight trains and moderately fast passenger trains are equipped with four-wheel trucks. If intended for passenger

service they are also equipped with steam generators. They are frequently used interchangeably in passenger and freight service.

It has been shown that train resistance becomes high at very high speeds and that the combination of high tractive effort requirements and high velocity results in a very high demand for horsepower. Consequently locomotives designed to pull high speed passenger trains exclusively are provided with power plants which produce higher horsepower than those provided for slow or medium speed service. These larger power plants make the locomotive units heavier and require six-wheel trucks to carry them without unduly heavy concentrated loads on the rails. The six-wheel trucks also provide better riding at high speeds. Since the power requirements rather than adhesive requirements determine the weight of such units, it is unnecessary to place motors on all axles. The center axle of each truck is usually an idler. The weight carried on the remaining four motored axles of each unit is sufficient to provide ample adhesion for starting and accelerating trains which can be hauled at the high speeds for which these locomotives are designed.

The high speed road passenger locomotives are always equipped with train heating steam generators. Steam from these boilers is also used to operate some types of air cooling equipment as well as to heat water for wash rooms in the coaches and kitchens in the dining cars.

In addition to the two-motored, three-axle trucks used on high speed passenger locomotives, some road switchers are equipped with shorter three-axle trucks. These are used where track structures require lighter loads per wheel than would be obtained with two-axle trucks. Some of these trucks are equipped with only two motors each, the center axles being idlers. However when maximum tractive effort is required all three axles are motored, so that the total weight of the locomotive is adhesive weight.

By using electric control of governor settings and motor connection switches, it is possible to connect the controls of several units to the operating station of one unit so that the several units will operate as one locomotive. Cables known as jumpers, with plugs on each end, are plugged into receptacles provided on the ends of the locomotive units to connect the control circuits. This is known as multiple unit control, commonly abbreviated MU. As many as four units may be thus controlled from one cab.

If switchers or road switchers are equipped for MU they may be coupled together with either end of any unit ahead, although they are usually arranged with the front ends of the end units of the combination pointed away from the other units.

Road locomotive units are constructed as "A" or "B" units. An "A" unit is complete in itself, having a control cab from which it or a combination of units may be operated in train service. The "B" unit has no control cab and is designed to be operated in train service only as part of a multiple unit locomotive controlled from an "A" unit. Some "B" units, however, have hostler's controls from which they may be operated independently for movement about locomotive terminals and shops. The "B" units lack the streamlined noses of the "A" units,

having flat ends so that they present a relatively smooth contour when coupled together or behind an "A" unit.

When road units are coupled for multiple unit operation they have an "A" unit leading. This may be followed by from one to three "B" units. Such a combination, however, provides a control cab at one end only so that the locomotive must be turned around to pull a train in the opposite direction. Turning of the locomotive at terminals is often eliminated by using an "A" unit with its nose trailing as the last unit.

THE LOCOMOTIVE STRUCTURE

The locomotive structure may be divided roughly into three parts; trucks, frame and cabs, and hoods.

The locomotive trucks support the locomotive and carry the traction motors and brake rigging. Except for very small locomotives, whose use is largely restricted to the movement of a few cars at a time within an industrial plant, virtually all diesel-electric locomotive units are carried on either 8 or 12 wheels. These wheels, nearly always forged and rolled from steel and usually 40 inches in diameter,and the gear by which the wheels are driven are pressed on the axles so that the assembly turns as a unit. The tread of the wheel is turned to a carefully designed contour with a flange on the side toward the center of the track. This tread contour and flange guides the wheel along the rail.

The ends of the axles are carefully machined to a very smooth finish to form the journals which turn in the bearings carrying the weight of the locomotive. On switchers these bearings are usually of brass similar to those used on freight cars. On road locomotives roller bearings are usually employed, in which case the inner race is pressed on the end of the axle.

The journal bearings are housed in boxes which, on the usual style of truck, are free to move vertically in guides known as pedestals which are part of the main frame on the truck. The main frame is a steel casting, roughly rectangular in shape, with pedestals on the sides near the corners. For a six wheel truck an additional pair of pedestals is provided at the centers of the sides. Plain bearing boxes are lubricated by wool waste or felt wicks soaking oil up from a reservoir in the bottom of the box. Roller bearings are lubricated by an oil bath through which the rollers travel as the axle rotates.

In the center of the truck and extending crosswise is the truck bolster. On switching locomotives this is commonly cast as an integral part of the main frame. On all locomotives designed for operation over the road at ordinary or high speeds, including road switchers, the bolster is hung to the frame by links so it is free to swing a limited distance from side to side. This cushions the lateral shocks which would otherwise be transmitted to the body of the locomotive and improves its riding qualities. The bolster is restrained by guides from any fore and aft movement relative to the truck frame so that the thrust

of the wheels and axles as the motors turn them or the brakes retard them is transmitted through the journal bearings, boxes, pedestals and main frame to the bolster, which in turn transmits the thrust to the locomotive frame.

The bolster is connected to the locomotive frame by center plates which allow it to turn or swivel under the locomotive so that it can negotiate curves. The center plate on the underside of the body frame protrudes into a circular depression in the truck center plate. This carries the weight of the locomotive body to the truck bolster and the mating of the protrusion on the body center plate with the rim of the truck center plate transmits the thrust of the truck to the body.

The weight of the locomotive body is carried through the bolster and truck frame to springs which cushion vertical shocks.

On rigid bolster trucks, usually used on switchers, the springs support the frame on equalizers, steel bars lying across the tops of the journal boxes, which distribute the load to the axles. On the truck approved by the American Association of Railroads as standard for diesel-electric switchers the springs on each side consist of a semi-eliptical leaf spring and two coil springs on each side of each truck. The leaf spring extends lengthwise of the locomotive, carrying the load of the truck frame at its center and supported by the equalizers at each end. The coil springs are located over each end of the leaf springs.

Swing bolster trucks usually have full eliptical leaf springs set crosswise at each end of the bolster. These rest on a spring plank, a steel plate or beam which is carried on the bottom ends of the swing links. The frame, in turn, is carried on the equalizers by coil springs. It is common practice to shape the equalizers so that they drop down low between the journal boxes so that the weight is applied to them below their points of support. These are known as drop equalizers.

Six-wheeled, or three-axled, trucks are constructed similarly to the four-wheeled trucks except that the bolster straddles the middle axle and is carried on four instead of two eliptical leaf springs. Instead of the two pairs of equalizers usually found on four-wheeled trucks, the six-wheeled trucks usually have four single equalizers. One of these spans from the center journal box on each side to one of the end boxes, so that two equalizers, one from each end, rest on each middle box. One coil spring rests on each equalizer. Six-wheeled trucks built to accommodate three traction motors are modified somewhat from the usual six-wheeled truck design to provide space for the center motor.

Each traction motor has a pinion mounted on one end of the armature shaft to drive the gear on the axle. On four or six-wheeled trucks to traction motors are suspended between the truck bolster and the axles with armature shafts parallel to axles. Each motor has on one side of its frame a pair of bronze bearings designed to support part of the weight of the motor and to resist the thrust of the gears against motor suspension journals machined on the driving axles. These motor suspension bearings are lubricated in a manner similar to the plain journal bearings on the ends of the axles.

The side of the motor next to the bolster is provided with a lug which fits between springs in a pocket in the bolster. Thus the suspension bearings on the axle furnish partial support for the motor and maintain proper meshing between the pinion and axle gear. The nose lug on the other side furnishes the rest of the support and keeps the motor from revolving itself around the axle instead of turning the axle.

Brake shoes are usually hung from the truck frame in front of and behind each wheel. They are forced against the wheels by a lever system which is actuated by air pressure acting on pistons in cylinders mounted on the truck frames. The air is conveyed to the brake cylinders from the air brake system on the locomotive body through flexible hose. Part of the brake shoes may be pulled up against the wheels by a hand operated mechanism mounted on the locomotive body and connected flexibly to the brake rigging on the truck. This mechanism multiplies the force of the hand many times, but is intended merely to hold the locomotive when it is standing.

Sanding pipes are also located on the trucks to guide sand from a supply carried in boxes in the locomotive body to the points of contact between wheels and rails to increase adhesion. This sand is conveyed from the boxes by gravity and a blast of compressed air.

The frame of the locomotive, as has been previously stated, is supported by the trucks through the center plates. It, in turn, supports the power plant, operating cabs, hoods or engine enclosures, and all auxiliary apparatus except that already described as being mounted directly on the trucks. In addition, as the motors drive the wheels, the frame transmits the pull or push of the trucks to the train through the coupler. A similar load is imposed on the frame when brakes are applied. If more than one unit is used, the frames of those units between the train and other units are required to carry the pull or push of the additional units.

In switching locomotives the frame is made in the form of a platform constructed of heavy steel beams and plates, usually welded into an integral structure. This frame then has cabs, hoods, power plant and auxiliaries set on it.

Road locomotives, with their streamlined bodies, have frames built on the principles of truss bridges. The load carrying frame work extends to the roof and across the top, so that it actually forms the skeleton for the cab and body of the locomotive. This results in a very strong frame with a minimum of weight. Remember that the weight inherent in the power plant capable of producing the high horsepower needed for speed in a road locomotive results in ample adhesive weight for tractive effort, so that any unnecessary weight in the locomotive structure would only add to the load to be hauled.

Locomotives are equipped with lights to illuminate the engine room or hood interiors, equipment compartments and operating cab. When the locomotive is moving at night the general illumination of the operating cab may be turned off and only the gauges illuminated.

Each road locomotive "A" unit is equipped with a powerful headlight in the nose to illuminate the track ahead at night. In addition many are equipped with

an oscillating searchlight which casts a moving beam into the sky to warn of its approach. If the train is stopped on double track by an accident which might obstruct the adjacent track, on which trains move in the opposite direction, this light may be quickly changed to red as a warning to approaching trains.

Frequently a small light is provided at the rear of "A" units or on the ends of "B" units for use in backing or moving about terminals.

All switchers and road switchers have headlights at both ends.

All locomotives are provided with lighted numbers so that they may be identified at night. Operation outside yards on nearly all railroads requires the provision of classification lights. These may be changed from white, to indicate an extra train, to green, to indicate a train which is followed by another operating on the same time table schedule, or turned off entirely if the train is a regularly scheduled one without a following section. If the locomotive is used at the rear of a train to push it, marker lights must be provided. These show red to the rear and either green or yellow to the sides and usually to the front also. They are carried on the rear of every train to indicate that it is a complete train.

The locomotive must also have a compressed air supply system. This consists of a compressor, usually driven directly by an extension of the engine crankshaft and usually two main reservoirs in which the air is stored under pressure. A pressure governor is provided to stop the compressor or to hold open its intake valves so it can not compress air even though it continues to revolve when the reservoir pressure reaches a predetermined value. This is usually 140 pounds per square inch. Radiators are inserted in the compressed air lines to cool the air after compression. The compressed air is used to operate the brakes on the locomotive and train, to blow the air horn, ring a warning bell, operate windshield wipers and radiator shutters, to operate the large power contactors which connect the motors in various combinations as described later, and to blow sand under the wheels to increase traction.

GENERAL QUESTIONS

1. Give four (4) advantages the diesel-electric locomotive has over the steam locomotive.

   a._____ c._____

   b._____ d._____

2. Name four (4) general types of diesel-electric locomotives.

   a._____ c._____

   b._____ d._____

3. List the different types of ALCO diesel-electric locomotives and their horsepower.

   a._____ e._____

   b._____ f._____

   c._____ g._____

   d._____

4. The switcher locomotive has all weight on_____.

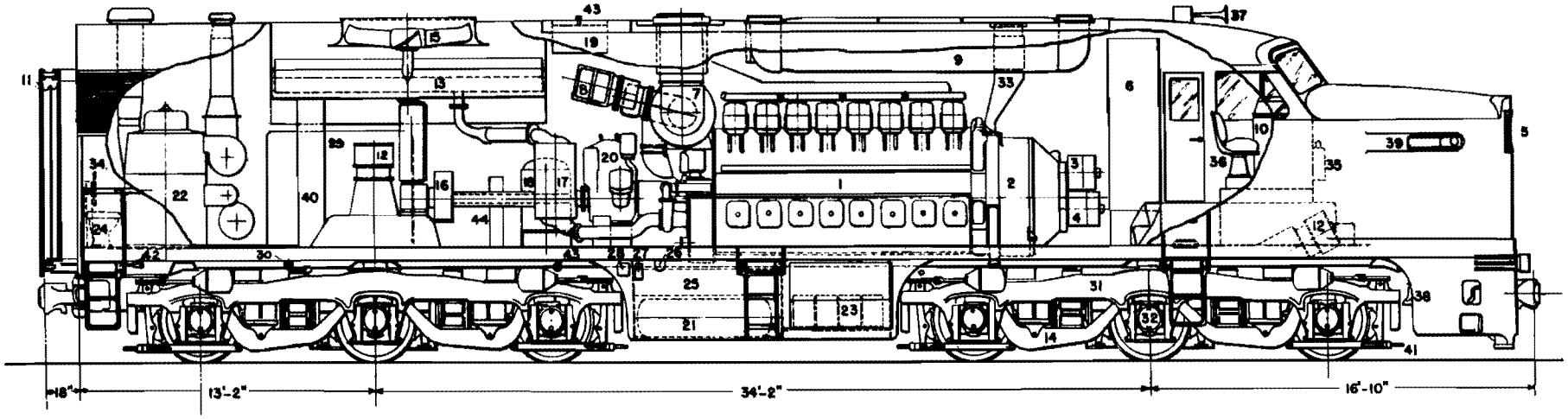
5. The construction of a road switcher locomotive provides space for a _____ _____ and/or_____.

6. The passenger locomotive has a two-motored three-axle truck that reduces the weight on drivers. Advantages derived from this type truck are:

   a._____ b._____

7. The "chain of power" in a diesel-electric locomotive consists of a _____ turning a _____ that supplies electricity through cables and contactors to the_____, _____.

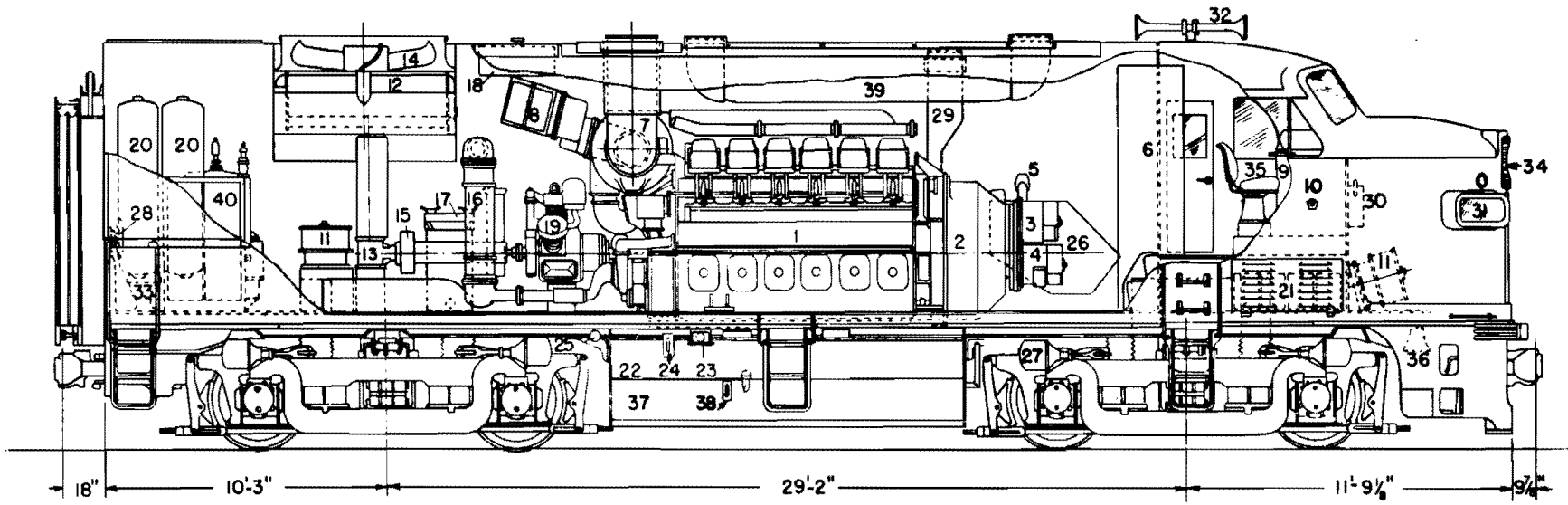
8. In all modern diesel-electric locomotives the engine is started by means of a_____.



2250 H.P. ALCO ROAD PASSENGER LOCOMOTIVE "A" UNIT

Identify the component parts of the road passenger locomotive by writing below the names that correspond to the numbers above.

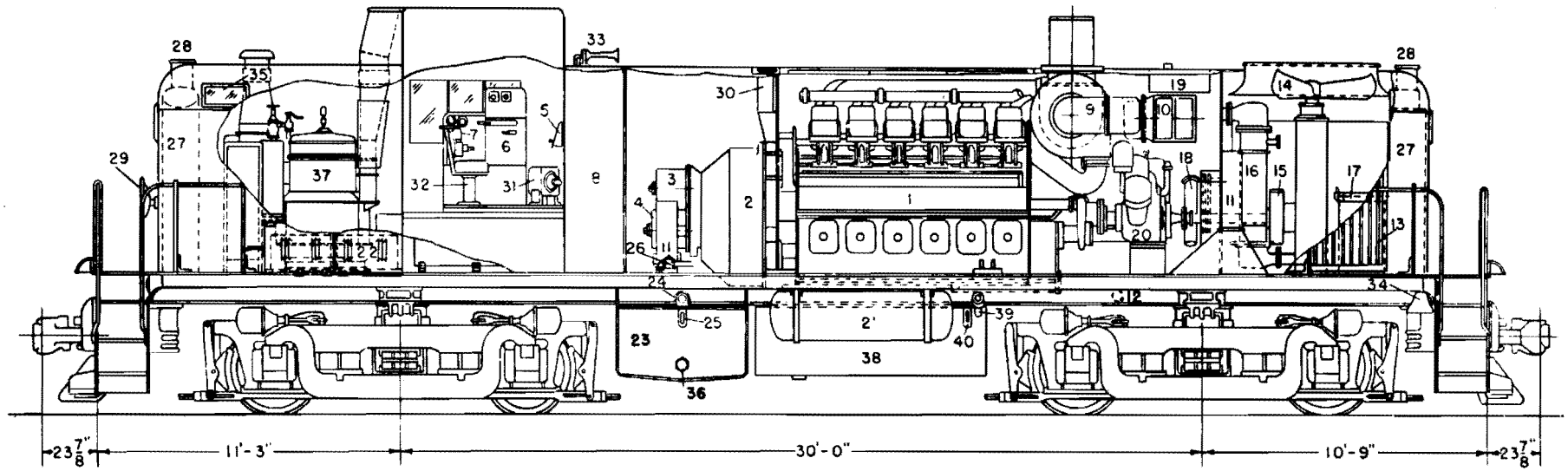
1. _____	12. _____	23. _____	34. _____
2. _____	13. _____	24. _____	35. _____
3. _____	14. _____	25. _____	36. _____
4. _____	15. _____	26. _____	37. _____
5. _____	16. _____	27. _____	38. _____
6. _____	17. _____	28. _____	39. _____
7. _____	18. _____	29. _____	40. _____
8. _____	19. _____	30. _____	41. _____
9. _____	20. _____	31. _____	42. _____
10. _____	21. _____	32. _____	43. _____
11. _____	22. _____	33. _____	44. _____



1600 H.P. ALCO ROAD FREIGHT-PASSENGER LOCOMOTIVE "A" UNIT

Identify the component parts of the road freight passenger locomotive by writing below the names that correspond to the numbers above.

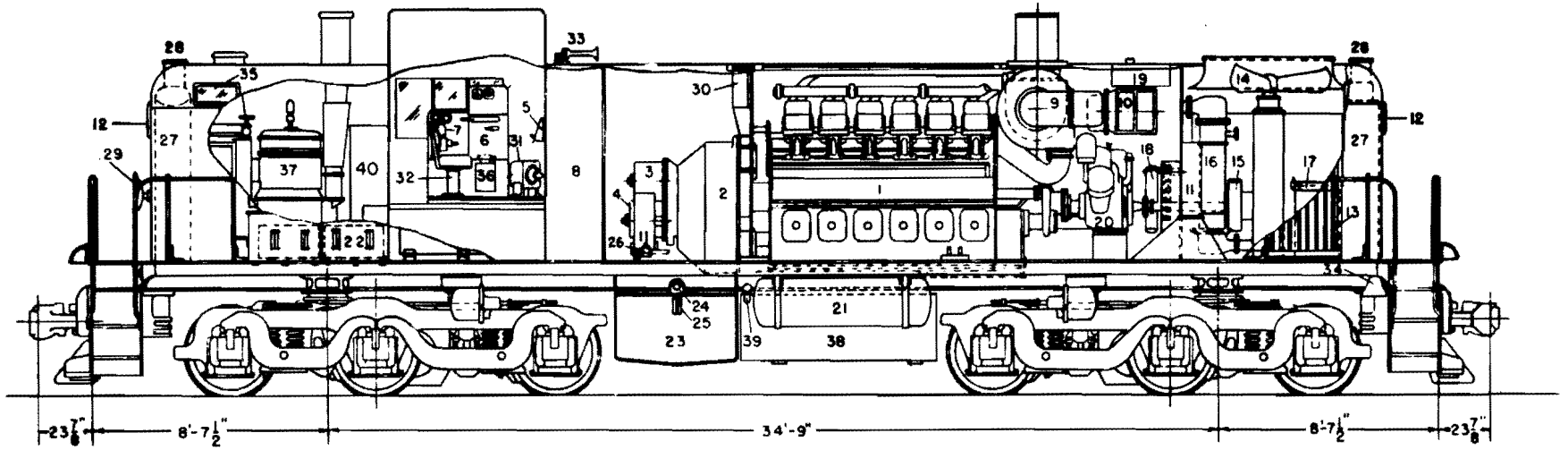
1. _____	11. _____	21. _____	31. _____
2. _____	12. _____	22. _____	32. _____
3. _____	13. _____	23. _____	33. _____
4. _____	14. _____	24. _____	34. _____
5. _____	15. _____	25. _____	35. _____
6. _____	16. _____	26. _____	36. _____
7. _____	17. _____	27. _____	37. _____
8. _____	18. _____	28. _____	38. _____
9. _____	19. _____	29. _____	39. _____
10. _____	20. _____	30. _____	40. _____



1600 H.P. ALCO ROAD SWITCHER LOCOMOTIVE - 4 TRACTION MOTORS

Identify the component parts of the road switcher locomotive
by writing below the names that correspond to the numbers above.

1. _____	11. _____	21. _____	31. _____
2. _____	12. _____	22. _____	32. _____
3. _____	13. _____	23. _____	33. _____
4. _____	14. _____	24. _____	34. _____
5. _____	15. _____	25. _____	35. _____
6. _____	16. _____	26. _____	36. _____
7. _____	17. _____	27. _____	37. _____
8. _____	18. _____	28. _____	38. _____
9. _____	19. _____	29. _____	39. _____
10. _____	20. _____	30. _____	40. _____



1600 H.P. ALCO ROAD SWITCHER LOCOMOTIVE - 6 TRACTION MOTORS

Identify the component parts of the road switcher locomotive
by writing below the names that correspond to the numbers above.

1._____	11._____	21._____	31._____
2._____	12._____	22._____	32._____
3._____	13._____	23._____	33._____
4._____	14._____	24._____	34._____
5._____	15._____	25._____	35._____
6._____	16._____	26._____	36._____
7._____	17._____	27._____	37._____
8._____	18._____	28._____	38._____
9._____	19._____	29._____	39._____
10._____	20._____	30._____	40._____

41._____