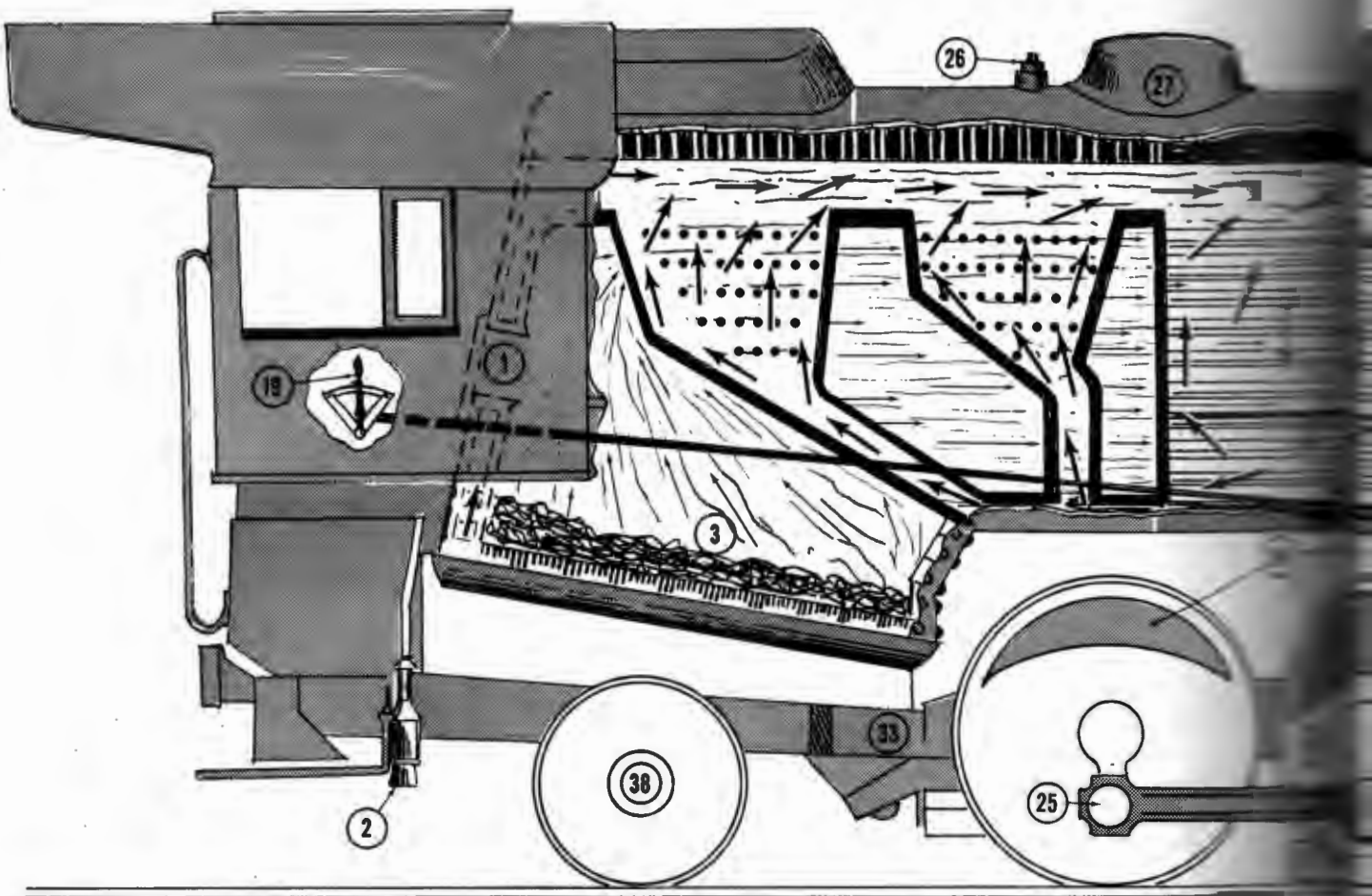
was geared to a center shaft leading to the trucks, was easier on track, but the least popular of the "big three" geared engines.

The Heisler, second in popularity only to the Shay, had two cylinders which were mounted vertically on either side of the boiler and canted inward, resulting in a "V" drive similar to an internal combustion engine. This arrangement turned a center shaft which was geared to one axle on each truck. A connecting rod from the primary wheels turned the secondary wheels. This resulted in less gearing, which the Heisler Company contended meant less maintenance, since the gearing was the most vulnerable mechanism in all three types. There are still a few Heislers in service, and at least two Climaxes.

The modern steam engine was an aggregation of complex mechanisms, whose operation is illustrated below. The drawing is of a hypothetical locomotive, but typical of steam power constructed in the 1920's and '30's.

The operation is as follows: The fuel (in this case, coal) enters the firebox through an automatic stoker, or by hand, through the fire doors (1). Water is fed into the boiler by means of an injector (2). After being burned in the firebox (3), the hot gases travel at tremendous speed through the boiler tubing (4), heating the water en route to the smokebox (5). The heavy arrows indicate the direction the water takes as it flows around the tubes and over the firebox. The light arrows indicate the route of the gases from combustion to the stack (6). Arrow (7) indicates the live steam line to the valve chest and (8) the exhaust steam outlet. The valve (9) regulates the flow of steam to the cylinder. Steam exerting pressure moves the piston (10) and piston rod (11) which is attached to the crosshead (12). The mass of steel is held in place by the crosshead guides (13). The locomotive is reversed by admitting steam to the opposite side of the piston through the manipulation of the power reverse mechanism and the valve gear (in this case Walschaerts). The parts of the valve gear are as follows: valve stem (14), combination lever (15), radius bar (16), link (17), reverse gear (18), and the reverse lever (19) in the cab. The main rod (20) is the connection between the crosshead and the driving wheels. Connecting rods (21) extend from the main driver (22) to the other drivers. The eccentric crank and eccentric rod (23) also join the main driver and are attached to the main pin along with the connecting rod and main rod. Large counterbalancing weights (24) serve to neutralize the unequal weight of the rods which are attached to the wheels by means of connecting



pins (25). The safety valves (26), steam dome (27), sand box (28) and bell (29) are located on top of the boiler. The generator (30) is steam operated and supplies electricity to the headlight (31), marker lights (32) and cab and tender lights. The frame (33) is a major sub-assembly which runs the entire length of the engine. The smokebox door (34) provides ready access into the front end for maintenance purposes. The pilot coupler (35) is mounted above the pilot, or cowcatcher (36). The pilot wheel assembly (37) is also called the pony truck or engine truck. The trailing truck (38) is sometimes referred to as the firebox truck.

LOCOMOTIVE INJECTOR

In addition to the running gear, there were other complex mechanisms inherent in the modern steam locomotive, such as airpumps, automatic stokers, feedwater heaters and various exhaust systems. At *right* is a diagram of the relatively small (No. (2) *below*) but vital injector; the mechanism by which cold water from the tender is admitted to the boiler which contains steam which may be as hot as 700 degrees Fahrenheit. If the water were sent into the locomotive cold, it could cause a geyser-like eruption back in the tender from the pressure. This particular injector is a Sellers Type S, and through the valves illustrated, mixed live steam with the incoming water, propelling both into the boiler.

DRAWING BY DAVE STRASSMAN.