as the Haynes Company's leading model for the present year.

The machine on our front page which most resembles the automobile of to-day is that constructed more than ten years ago by Mr. Ransom E. Olds, of Lansing, Mich. The picture is reproduced from the SCIENTIFIC AMERICAN of November 21, 1896. Like almost all of the first machines, as above stated, Mr. Olds's early car had the engine and transmission mounted upon the running gear, while the body was supported on three full elliptic springs. The engine used was a single-cylinder one of 5 horse-power placed horizontally on the running gear, and arranged to drive a countershaft through three separate speed changes giving 4, 8, and 12 miles an hour normally, while by speeding up the engine, the car could be driven as high as 18 miles an hour. A single chain from the countershaft drove the rear axle, there being a considerable reduction, as can be seen. The rear axle was provided with a differential. Wood wheels provided with 1½-inch solid cushion tires were used on this car, the wheels being provided with ball bearings. A tiller steering device turned both front wheels on a simple design of steering knuckle. In our former description a great point is made of the fact that the fuel supply is located below the engine, and has no connection with the body. This was done in order to obviate any chance of explosion.

While the machine in question was one of Mr. Olds's first gasoline cars, it was by no means his first machine, as several years before he produced a three-wheeled steam automobile which had a huge boiler behind fired by liquid fuel. After turning his attention to the gasoline engine, however, as can be seen from the illustration, Mr. Olds produced a very creditable machine for that day, and he has since held his own in an industry that has become vast and in which improvements have been made more rapidly, perhaps, than in any other field.

THE CADILLAC 20-HORSE-POWER FOUR-CYLINDER ENGINE AND GOVERNOR.

(*Continued from page 24.*)

around a central vertical or inclined shaft, *A*, driven by gears from the camshaft and running upon ball bearings. Pivoted on a pin passing through this shaft, and held in the tilted position shown by the spiral spring, *C*, is the ring, *B*. As the revolutions of the shaft, *A*, and ring, *B*, increase, centrifugal force tends to make the ring assume the horizontal position shown by the dotted lines, and as it does so, it pushes upward on the link, *D*, and raises the collar, *E*. A shifting fork on this collar, as it is raised and lowered, rotates a shaft, *K*, and consequently moves back and forth the lever, *F*, which is connected by rod, *G*, to the throttle. In this manner the throttle valve is closed. By varying the tension on the spring, *C*, which the driver can do through the connections, *H J*, and their shifting fork, *M*, and collar, *L*, the governor can be set so that it will not close the throttle beyond a desired point. The placing of the commutator above the governor makes it very accessible. This type of governor is an exclusive feature of the Cadillac 4-cylinder cars.

ENGINE OF THE CAR DE LUXE.

(*Continued from page 24.*)

the ordinary force-feed oiler for lubricating the engine, there is a special plunger pump on the footboard, by which oil can be pumped into the crankcase. Should the oil overflow above the proper level, it runs into a special reservoir attached to the bottom of the crankcase. Should the latter overflow, the oil will run upon the ground. The crankpins are all hollow, and they are thoroughly lubricated by means of eccentric oil rings placed upon the crankshaft. The water pump is of the centrifugal type, and is made up of a bronze wheel that revolves in an aluminium casing. The radiator is of horizontal flat tubes indented, so as to allow for expansion in case of freezing. The water circulates back and forth from one side to the other, and from top to bottom through 20, 17, 15, 14, and finally 12 tubes, the idea being that as the water cools in descending from the top to the bottom of the radiator, it does not require so much room. Everything about this motor is of the finest, and it is undoubtedly one of the highest grade automobile engines constructed. The bore and stroke are 125 and 135 millimeters respectively, and the horse-power is 50 to 60. Besides the engine this car contains several other novel features, such as the rear axle, which is described on page 34.

THE AUTOCAR COMBINED ENGINE AND TRANSMISSION.

The engine and transmission shown on p. 24 is that of the type XIV Autocar tonneau, and it is noteworthy as being one of the few examples of the recent practice of combining engine and transmission in a single unit and giving this unit a three-point support. As can be readily seen, the transmission gear case and the crank case of the motor are bolted together, and the two cases are so shaped as to completely inclose the flywheel and clutch. The latter is of the three-ring metallic type, consisting of a bronze ring with cork or felt inserts that is clamped between two steel rings attached to the flywheel. As the bronze ring is rather light, it has but little momentum, and consequently both it and the gears come quickly to rest when the clutch is thrown out. This makes stripping of the gears improbable.

The motor shown is the four-cylinder, vertical, water-cooled one used on the tonneau. (The company also builds for its runabout a 12-horse-power double-opposed cylinder motor having the same arrangement.) The bore is 4¼ inches, stroke 4½, and the motor is said to develop 30 horse-power. The cylinders are cast separately with integral heads, water jackets, and exhaust valve chambers, and large mechanically-operated valves. The inlet valves are placed in the center of the cylinder heads, directly over the pistons, thus insuring complete filling of the cylinders at all speeds. All the valves are large and are mechanically operated from one camshaft, the lifts being provided with large rollers, which insure long life and little friction. The adjustment of the exhaust valve is by cap screws, which screw in the plunger and are held in the desired place by lock nuts. The inlet valve adjustment is by cap and lock nuts on top of the valve lift rod. The crankshaft is a weldless steel forging, oil tempered, with a large flange for bolting on the flywheel. This wheel can be easily removed and replaced with little trouble and no danger of becoming loose or running out of true. The crankshaft has three long split bearings which can be readily taken up should any wear occur. The crank case is made of aluminium alloy, of high tensile strength, and all the bearings are bolted to the upper half. The lower half can be removed without disturbing any other parts, and the crankshaft and pistons can be removed without removing the cylinders. The upper half of the crank case is provided with two large openings, through which all adjustments can be made without removing the bottom half. The camshaft and pump shaft gears are at the forward end of the crank case, where they are fully inclosed and run in oil. The centrifugal water pump is mounted on the crank case, and is directly driven from the camshaft by fiber gears. It circulates the water through a finned tubular radiator.

The timer also is mounted on the crank case and is driven by means of miter gears from the cam shaft. The ignition is of the high-tension type from current supplied by accumulators. Lubrication is effected by a force feed oiler, with an individual pump for each lead pipe. One pipe goes to each motor bearing and a separate pipe to the crank case to keep

up the oil level for the splash lubrication. The oiler is placed on the dash inside of the hood, the sight feeds only being on the rear of the dash and visible from the seat of the car.

The motor, flywheel, clutch, and transmission are contained and enveloped in a special aluminium case of high tensile strength, bolted together and supported as a unit at three points. Two points or legs extend from the motor to the frame and the third point is under the transmission, where it is seated on a stiff spring. This arrangement makes it possible to do away with the heavy sub-frame construction. One of the forward suspension points is seen at *A*, while the third point is shown at *B*.

The transmission is of the sliding gear type with three speeds forward and one reverse, and with direct drive on the high gear. The gears are solid drop forgings of high-carbon steel, oil tempered, with strong, broad faces. The shafts, also, are of high carbon steel and run on extra long Hyatt roller bearings, which insure perfect meshing of the gears, and eliminate any possible wear. A novel feature of the Autocar is the control of the throttle and spark, which is by means of grips forming part of the rim of the steering wheel, and which thus give the operator the use of both hands in case of an emergency. The gear shifting lever and the emergency brake lever are both on the right-hand side of the car. The foot brake consists of separate contracting bands on the hubs of the rear wheels, while the emergency brakes are of the expanding type in these hubs. Application of the emergency brakes first throws out the clutch. An irreversible worm and sector steering gear is fitted.

The rear axle is of the live type, and is of steel, incased in seamless tubing and ground to size. The wheel ends of the axles are squared, and fit the squared openings of the hub, doing away with the use of keys and eliminating any possibility of trouble at this vital point of the drive. Four sets of roller bearings, in connection with large ball thrust bearings, reduce friction to a minimum. The rear axle tube is securely fastened to the frame by two radius rods, which relieve the springs of the drive of the car. No torsion rod is needed. The bevel gears and differential gears are entirely housed and run in oil.

AN AUTOMOBILE MOTOR WITH ROTARY VALVE.

(*Continued from page 25.*)

approximately flat cuts, such as *B*, which form the port spaces 120 deg. apart, there being one for each cylinder. This cutting of the ports in a single shaft insures absolute timing of the valve action, while the single cut serves both for the exhaust and the inlet ports. The three cylinders are cast in one piece with a single port, *P*, at one side of each cylinder. The three ports are surrounded by water, which insures perfect cooling; besides this they are of short length and small surface, which makes for greatest efficiency. The diagrams make plain the arrangement of the ports, as well as the various positions of the valve for admission, ignition, and exhaust. The large diagram shows plainly the practically straight passage of the gas into the engine, the short cylinder port with consequent small area, and the sweep of the incoming cool charge against the hot cylinder head and spark plug, which makes it certain that the mixture at the point of ignition will be little, if any, diluted by the residue of the preceding charge.

In the second diagram, showing ignition position, the cylinder port is closed. Its wall area and contents are both very small, while the surfaces of the valve and valve bushing in contact are very large, thus insuring freedom from leakage. Furthermore, the position of the motor, which is inclined at an angle of 30 deg., as in all Duryea vehicles, is such that the piston movement throws any oil that may be above the piston head into this port, thus perfectly and copiously lubricating the valve, particularly at the compression dead center, where the pressure is highest and the need for a tight joint most imperative. The sketches do not show an ignition method, but both the jump spark and the make-and-break have been fitted to this style of engine with equal satisfaction, although Mr. Duryea prefers the larger spark secured by the make-and-break system.

The third diagram shows the valve in the exhaust position, and makes quite plain the straight passage for the escape of the heated charge. These ports are 3 inches long by about ¾ inch wide. They open more suddenly than most poppet valves. Their large size, quick action, and perfect shape contribute to superior results. It is readily seen that with a poppet valve the gases conflict with each other, coming, as they do, from opposite sides of the valve toward a common center, and that they are further retarded by this center being occupied by the valve stem and valve stem guide used in the ordinary construction. Further, the ordinary poppet valve can neither be cooled nor water-jacketed, and frequently gets red hot. It is always much hotter than is compatible with proper wearing, so exhaust valves, as is well known, give users considerable trouble. They frequently need regrinding as well as renewing, while the wear of the tappets and cams, breaking and loss of temper of the springs, wearing of the guides, pitting of the valve surfaces and valve seat surfaces, and similar destructive effects, all contribute to make the ordinary exhaust valve a thing to be avoided if possible. With this type of valve, too, there is no chance of a valve breaking and slipping into the cylinder, with the result that the cylinder is cracked and has to be replaced—a matter of considerable expense if the cylinders are cast in pairs. In fact, these troubles have made engine users look toward the two-cycle engine as a possible better device. The Duryea rotary valve avoids these troubles. There are no springs, cams, or tappets. The motion is a smooth rotary motion, perfectly balanced, instead of a clatter and multiplicity of varied strains. There are no springs, slides, cams, or gears. The valve is ground accurately to size, although the packing surfaces are so large and the lubrication so perfect that a slight variation in size produces no perceptible loss. Both the valve and the lubricating oil on its surface are kept cool by water all around the cylinder ports, as well as water through the center of the valve. This double water cooling absolutely prevents overheating of any part or burning off of the lubricating oil, and so perfectly insures long life to both the valve and its bushing. The valve bushings are removable, so that in case of damage, such as might occur by some foreign substance passing through the valve and scoring the surface, both valve and bushing can be removed without detriment to the cylinder casting. The expense of upkeep is extremely slight, for the bushings are not of great cost and the valve, after a long period of use, can be reground if necessary, and a slightly smaller bushing fitted at little expense.

The valve is driven by a silent, self-adjusting chain, which is long-lived and needs no attention. This chain is free from the noises that accompany gears, particularly after they have been in use long enough to wear slightly, for gears under the intermittent action of the valves become quite noisy as soon as they get slightly loose. The spark timer is attached to the valve shaft on the outer side of the sprocket, while the water enters and leaves the valve at the opposite end.

In general this design of engine is the most simple yet seen for a four-cycle, and avoids the objectionable features of the two-cycle, such as leaks around the sides of the piston from the transfer port to the exhaust port, the loss of crankcase compression because of the wearing of the piston and cylinder, and the mixture of the lubricating oil with the explosive