power. We found that when starting up with a clear room the engine would pull very well; as the room became filled with burnt gases the beam of the dynamometer scale would begin to drop. During this 1-hr. run the engine had a gasoline consumption of 0.625 lb. per hp-hr. This same engine ran 500 miles on the Indianapolis speedway at an average speed of 88.7 m.p.h., with an average of 10 miles per gal. of gasoline for the whole race.

The water manifold, with a small pipe which leads to the thermometer, and the breather pipes, front and rear, is shown. It can also be seen how the covers come completely off the side of the crankcase. This opens up the whole side of the engine, making it very accessible besides being very light in weight. The whole engine, with exhaust-manifold complete, weighs 410 lb.; a large part of this weight is, of course, in the crankshaft, which weighs 165 lb.

THE DISCUSSION

A MEMBER:—At what engine speed was maximum horsepower obtained?

C. W. VAN RANST:—At maximum horsepower on the block the engine speed was 3200 r.p.m. On the track we continued up to 3500 and 3600 r.p.m.

MAX H. THOMS:—What is the axle ratio?

MR. VAN RANST:—It is 3 to 1.

MR. THOMS:—What sizes of tire were used?

MR. VAN RANST:—Three cars, the winner among them, used 32 x 4-in. front and 32 x 4½-in. rear tires. The others used 32 x 4½-in. front and 33 x 5-in. rear tires.

MR. THOMS:—What is the material in the flywheel? What is its diameter?

MR. VAN RANST:—The material is plain carbon-steel; the flywheel diameter is 13 in.

A MEMBER:—Please describe the breather system, from the radiator to the crankcase.

MR. VAN RANST:—The air comes through the radiator and there is enough draft to force it through the crankcase. The ideal condition would be to take it from outside, but the air comes through the radiator so fast that it does not heat up to a high degree and so it makes no difference.

A MEMBER:—Do you have trouble with accumulations of dirt in the oil?

MR. VAN RANST:—The greatest trouble in taking air into the crankcase is with dirt; it is serious and a thing we would like to get away from. We have to give the crankcase air or it will become too hot. There are means, I suppose, whereby we could get a less amount of dirt. I think it important to give all the air possible. That is one reason I mentioned that the crankcase should be fitted with a compartment where the dirt and carbon can filter out of the oil and not be carried through the engine.

GEORGE A. WEIDELY:—You obtained 10 miles per gal. of gasoline; how many miles did you obtain per gallon of oil?

MR. VAN RANST:—We prefer not to state that figure because this type of engine is not economical with oil. Due to the arrangement of the camshaft and because the valve mechanism is open, much oil is lost. The racing-car engine, unfortunately, seems to slobber a lot of oil, anyway; especially in this type, where the breather is large and the cam housing is overhead. The oil consumption was very high.

CHESTER S. RICKER:—What kind of oil was used?

MR. VAN RANST:—Straight castor oil. We tried mineral oil but found that the carbon deposit was too great and caused us to burn out three connecting-rods. After we used castor oil we never burned out a rod. The other oil would become foul and the jets would clog; immediately a rod would burn. With castor oil there was very little carbon and the oil had greater body. The temperature of the oil runs anywhere from 220 to 250 deg. fahr.

A MEMBER:—Do the fingers on the cams take all the thrust of the cams?

MR. VAN RANST:—Yes.

MR. THOMS:—What tappet clearances are there on the exhaust and inlet-valves?

MR. VAN RANST:—The exhaust has 0.030 in. and the inlet 0.025-in. clearance.

A. L. NELSON:—In regard to experiments with fuels and compression-ratios, what was done?

MR. VAN RANST:—We carried on a few experiments. Recently we tried a "dope" which Mr. Kettering prepared to retard the speed of combustion and prevent detonation. We found that in this type of engine it proved to be of no advantage. We experimented with compressions up to 135 lb., varying the percentage of dope to gasoline from 3 to 3½ per cent; but we lost power as compared to regular practice. The compression-ratio that we found to be best was 5 to 1, which gave about 105 lb. per sq. in. gage compression.

A MEMBER:—What is the comparison of an engine of the type described with the standard type, as far as quietness is concerned?

MR. VAN RANST:—At ordinary traveling speed there is no reason it should not be as quiet as the average engine of today. I believe it would be more quiet than engines with the rocker-arm and lifter-rod valve actuation used in the cheaper classes of car. Also, at higher speeds I believe it would be more quiet; but there would be less tendency for the valves to flutter, due to the elimination of rocker-arms and lifter-rods, although at higher speeds there is a considerable hum anyway. I believe the noise would not be detrimental. I know of no engine that I would call quiet when running at high speed.

DANIEL C. TEETOR:—Is there anything special in regard to the design of the piston-rings?

MR. VAN RANST:—No; they are of cast iron, cast separately and machined to be ⅛ in. wide and ⅛ in. deep; two rings are used, with just an ordinary 60-deg. slot.

A MEMBER:—How much clearance is there beneath the rings?

MR. VAN RANST:—The clearance is 0.010 in. overall; that is, 0.005 in. on each side.

A MEMBER:—What material is used for the timing-gears?

MR. VAN RANST:—They are of chromium-vanadium steel containing 0.50 per cent of carbon and heat-treated.

A MEMBER:—How are the timing-gears kept quiet?

MR. VAN RANST:—We do not attempt to keep them quiet; they hum considerably when running. They could not be made quiet, because the webs are drilled, this tending to make them noisy.

A MEMBER:—How could that be corrected in a commercial car?

MR. VAN RANST:—I would recommend the use of helical bevel gears, having them drive a vertical shaft to the overhead camshaft.

ARTHUR HOLMES:—In what manner are the wristpins lubricated?

MR. VAN RANST:—By splash. Two small holes are drilled in the top of the wristpin boss and there are grooves the full length of the bearing inside. The oil coming from the connecting-rods is thrown upward into the cylinder and is picked up by these holes. Oil is also picked up from the cylinder wall by the wristpin hole.

LON R. SMITH:—What is the size of the crankshaft?

MR. VAN RANST:—The crankpin is 2⅛ in. in diameter. The main bearings are ball bearings 2¼ in. long and are very large.

A MEMBER:—Do you use shims in the connecting-rods?

MR. VAN RANST:—There are no shims and no grooves. We could not use shims, as this would cause a slot the entire length of the bearing which would allow the oil to pass through, because it is under such high pressure, and would probably cause a smoky engine. We have to keep the bearing as tight as possible, aside from the necessary clearance.

A MEMBER:—What is the pressure of the oil at the connecting-rods?

MR. VAN RANST:—It is calculated to be 40 lb. per sq. in.

A MEMBER:—Did you have any difficulty with the babbitt separating from the bronze bearings?

MR. VAN RANST:—There were only two or three instances that I know of the babbitt becoming loosened from the bronze.

MR. WEIDELY:—Those who have interested themselves in racing or other contests are familiar with the fact that many such events have been won by road ability rather than because of engine output; on the other hand, faults of the present-day motor-car often are found in parts other than the powerplants.

The limiting of displacement in our more important races has supplied an incentive to develop engines having abnormal torque at an abnormal compression and a still more abnormal speed, which has resulted in research along the line of engine improvement to the exclusion and detriment of improvement in other almost equally important parts of the car. It is doubtful whether the results gained in racing events help to improve the commercial article as much as they might and would if rules and conditions were added covering fuel and oil consumption, power losses, tire wear, acceleration, ability and durability of brakes and other things looked for in the modern car.

In view of the fact that probably all present-day cars, racing or otherwise, show a power loss at the wheels of over 20 per cent exclusive of slip, there seems to be food for thought in a direction other than toward the engine.

It is true that these matters might detract from the sporting side of a contest, but the results from such events would, no doubt, pay in a big way if these matters were considered. I have just learned that the part of the rules covering the bench and dynamometer tests of all cars entered in the Grand Prix Race, in France, has been dropped. This is really a misfortune for the industry as a whole, as otherwise no doubt much useful information could have been gained.

Mr. RICKER:—There was recently a very interesting contest in France in which the fuel-consumption was the criterion rather than the engine displacement. The question of a bench test for the French Grand Prix Race was largely, I understand, a matter of not desiring to put an engine to that test before it had to go into the race. A race is a question of a complete chassis rather than one of the engine alone. On a bench test the engine might break down or a good engine that did not fulfill the exact conditions might be eliminated; yet the engine and the chassis in which it was installed might make an ensemble that would win the race. Some of the suggestions that Mr. Weidely makes might well be considered by automotive engineers and especially by the automobile contest organizations of this country.