tity of water unless it is also cooled by radiation. Now, as you have no radiator, all the cooling that can take place is the radiation from the sides of the hopper and as this is quite small, it will not cool much. Therefore, the heat that is constantly being delivered to the water will cause it to rapidly boil away and as the hopper capacity is small, this will mean frequent fillings which will be unsatisfactory to the farmer, expecially so if he is plowing about a mile or so from the nearest stream. Make that hopper five or six times the capacity and you will improve it in more ways than one. It will have a greater radiating or cooling surface, and, therefore, save water because every heat unit that is radiated from its walls means just that much less steaming. The larger quantity of water will take a longer time to get to the boiling point and during the stops and at noon it will radiate considerable heat, this also increasing the time before it needs refilling. This large hopper will run possibly six hours, in fact it should be made to run six hours, so that it will only need filling in the morning and at noon, the two times when a tractor gets 'the once over.' Here is another point you want to look out for. Notice you only left 3/8-in. clearance between cylinder and hopper in the lower part; this is plenty, as long as only water is there, but what do you suppose is going to happen when scale, mud, sand and dead leaves accumulate there? It won't take long to overheat the lower part of the cylinder and distort it. Better leave an inch or an inch and one-half and also be sure to make your hopper so it can be easily scraped all around inside so when scale-forming water is used, which can not be avoided in some localities, there is plenty of room to scrape off all scale as often as necessary."

"My, but there is a lot more to a hopper than I had any notion," remarked Harry.

"Your rack and quadrant system of steering has the advantage of being novel, but it is wrong in principle. It turns each wheel through exactly the same angle, which will not do. When you go round a curve the inside front wheel must turn through a greater angle than the outside one; in fact, they must turn so that if lines are drawn as prolongations of the axles of the front wheels and the rear ones, these lines must all meet at one point, and this point will be the center of the circle upon which the tractor is turning. You must design your steering mechanism so that at all positions, right hand or left, the front wheels will automatically turn through different angles, so that each axle is practically a true radial line from the center the tractor is turning upon. The further you get from this design, the harder will it be for the tractor to turn, and power that is consumed dragging a wheel in a different way to which it is headed, means just that much power less at the draw bar. You had better spend a few days on another steering device or accept some of the well-thought out designs that are somewhat standard on automobiles and trucks."

"There is a great deal more to designing a tractor than you thought, isn't there, Harry?" remarked his father. The expert smiled and continued:

"Your method of taking the exhaust away from the engine is neat, but I notice you have the exhaust pipe passing under the carbureter. This you will find is very unsatisfactory, because once in a while the carbureter will leak a little and as soon as the fuel drops upon the exhaust pipe, it will catch fire and possibly set the fuel in the carbureter on fire. Your intention to get the exhaust pipe out of the way and incidently warm the carbureter was very good, but in this case the risk is too great and so you had better change this part."

"Well, I am certainly learning things fast," acknowledged Harry. "There is one thing I want to ask you, and that is: What is the objection to running the engine 'left hand?' If the engine were to turn that way it would save a pair of gears and simplify things some. If there is no serious objection, I suggest it be changed."

Harry and his father talked over the Tractor Situation

"There is no reason why an engine can not be designed to run one way as well as another, but there is a very serious objection to putting a 'left hand' engine in your tractor, and that is because everyone is used to 'right hand' engines and it would be as awkward as a left hand thread on a machine bolt, so even if it does complicate the transmission a little, you had far better do that than try to force a 'left hand' engine upon the public.

"Here is another thing you want to look out for. You are running your clutch in oil, which is satisfactory providing it is properly designed, but you have made no provision to stop it rotating when in neutral where it has to be every time you start the tractor. Possibly you think that when you open the clutch and it is disconnected, that it will immediately stop rotating, but such is not the case. The drag caused by the oil revolving with the flywheel is amply sufficient to keep the clutch spinning and as soon as you attempt to shift gears the result will be to wear the gear teeth tips and burr them all up; also it will be very difficult to engage the gears at all. To cure this you will have to put some kind of a brake on the clutch or clutch shaft, so that when the clutch is opened it will press against the brake and stop revolving, allowing the gears to be shifted smoothly and quietly just as it is stopping. There are quite a number of things you should change or improve before you think of building your tractor.

"Your valve mechanism is too much exposed and will rapidly wear on account of grit and fine dust working in. These parts should be well protected with a dust proof cover of some kind. Your exhaust pipe is discharging just underneath the engine and towards the ground; on dry days it will kick up such a dust that the operator will be scarcely able to see or breathe and will use up his energy cussing the tractor and its designer.

"The magneto is in a very poor place, sticking out in front there. Why every time you run into anything, you will be very liable to damage it and put the tractor out of commission for a week or so. Your engine is mounted too high and it would be very awkward to crank unless the man stood on a box, better arrange to lower it about twelve inches. That rigid seat would jar a man almost to death when running over a hard road, and you have not provided any comfortable place for him to put his feet. If he were at all tall his legs would be all doubled up and he would probably have the cramp in a few hours.

"You have given him no protection against the sun or a sudden shower; add at least an umbrella holder for one of those large canvas umbrellas. It seems as though you have tried to hide every oil hole, for they are in odd places where no one would think of looking for them. If you expect the tractor operator to properly oil everywhere, you must help him to the extent of putting the oil holes in prominent places and then running tubes to where you want them to go. Also be sure and put good practical dust caps over every one.

"You have forgotten to put a good brake on the tractor. How do you expect to stop a tractor on a hill? As soon as you pull your clutch out, the tractor will start down the hill, and if you hap-

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This will means frequent fillings— especially if he is plowing about a mile away from the nearest stream