



PRACTICAL TALKS TO THRESHERMEN



LESSON CX.

WHAT should be the weight of a light tractor? Should it be as light as it is possible to make it or is there a certain minimum under which it is not safe to go? What are the deciding factors in regard to weight? These are questions the designer must answer when he takes up the problem of designing a tractor.

The fashion this year calls for tractors weighing not more than five thousand pounds and as much less as possible and still make the machine sturdy enough for the work it has to do. The reason for this demand for a light weight machine is easy to understand when one reviews the history of the tractor development.

The first tractors were designed for breaking new land primarily and were necessarily made very strong and heavy. The manufacturer was not strictly limited as to cost of production because there was an active demand for such machines and the purchaser was willing to pay a good price. When the slump came in the heavy tractor trade, manufacturers turned their attention to developing the old land market and for this a lighter and cheaper machine was needed if it was to displace horses.

The first problem in order to develop a market was and still is low price. This requires light weight. Another thing the farmer wants is a nimble machine, one that he can handle easily and without much effort. Then there is to be considered the matter of weight as related to packing the soil. Most farmers object to running a heavy machine over soft cultivated ground, claiming that it will pack the ground so solidly that it will not grow a crop. All of these reasons seem to require a light weight machine.

The problem involved in designing a tractor to meet all the conditions enumerated are engineering problems. First, the designer is limited as regards cost. If a tractor must sell for six hundred or eight hundred dollars there is not a very large margin for him to work on considering that out of this price he must pay for raw material, labor, all overhead charges, pay dividends and pay the cost of marketing.

After doing all this, he is required to construct a machine that

possesses all the necessary qualities of strength, durability, reliability, power, light weight and low cost of manufacture. The first four of these items call for good materials, fine workmanship, and considerable weight. The last two call for the minimum of materials and the cheapest possible construction consistent with the requirements. These conflicting requirements make the problem exceedingly difficult. They are the reason for the curious features of design that have appeared during the past couple of years and represent the various designer's idea of solving a difficult problem.

The value of the deciding factors of tractor design are as yet not very well understood even by those who have had the most experience and are not appreciated at all by many of the newer designers who have had their engineering experience in other lines. Take for example the matters of strength and durability; how many men know how to design a tractor that has just the right strength in all its various members? Very few. This is very apparent when reports of users show such serious breakages as gears, connecting rods, frames and other major parts. Then there is the problem of vibration. Many tractors shake themselves to pieces in a short time. Tractor requirements are very severe. The amplitude of vibration is short, and the entire machine is subjected to a constant shiver unlike the long undulatory vibration in an automobile. Frames with even riveted joints have been known to shake to pieces in a comparatively short time. These vibrations are caused by having a rigid machine with rigid wheels, provided with rigid lugs, traveling over hard and uneven ground. In an automobile or a truck, with which a tractor is often compared, there are soft tires on the wheels and springs underneath the frame. Conditions are very different. The truck or automobile can not be compared with the tractor because working conditions are so entirely different. In addition to this, the tractor drags a dead weight behind while the other vehicles carry the loads on their backs.

Strength and durability require

the best of materials and enough metal to withstand all the maximum stresses of vibration, torsion, bending tension, etc. None of these stresses can be figured by the usual engineering formulas and the result is that every tractor is the best guess of the designer who made it, considering the fact that he was held under the rigid restrictions of low cost and light weight. It is not at all remarkable that many of the light weight machines show structural weaknesses. Neither is it remarkable that the light weight machines of last year show great improvement over those of the year before. It merely shows that the designers are learning from experience.

One of the things that a farmer wants above almost anything else after strength, power and reliability are satisfied, is handiness or nimbleness. He wants a machine that will get around easily, that handles without much effort. It is very much of a question if the prejudice against the heavy machines was not due more to their awkwardness than to a fear that they would injure the soil through packing. When the soil contains a certain amount of moisture almost any tractor will pack the soil injuriously, but if it is in a condition to be worked even by horses even the heavy machines do not do much damage. It is still a question if after all nimbleness is not what is required even more than light weight. The light weight machines possess those qualities of nimbleness and that is one reason why they are in demand.

The question of power is another one about which there is still considerable difference of opinion. In plowing, the resistance of the soil varies through such wide values that it is difficult to make a universal tractor. It may easily haul four plows in some soils and only one in others. This difference in soil resistance leads to overloading, which is one of the most difficult things the tractor manufacturer has to contend with. If a machine is overloaded it soon wears out or breaks. The average farmer gets a tractor to crowd the work along and he wants to make it do all it can. If it will go at all with the load, he will not drop a plow or two to make the work easier for

the machine. He would do so if he were driving a team but he has not yet been educated to adapt the load to his tractor.

On this account fault is found with most tractors that they haven't enough power. If they are provided with stronger engines then there is danger of overloading the framework and other parts. A powerful engine requires a strong frame and that means a heavy machine. Obviously the only thing that can be done is to make the engine only powerful enough for the safety of the framework that supports it.

In order to meet the requirements of light weight and low cost of production mentioned in the beginning, designers and manufacturers have brought out many rather startling looking machines in the last two years. This endeavor has been the reason for all of the three wheeled designs. Take, for instance, those with the triangular frames; obviously such designs call for the minimum weight of material in the frames; when only one driver is employed there is no necessity for a differential gear and the transmission is simplified. All of these reduce cost and weight. They adapt themselves very well to satisfying the last two of the considerations named, but they lead to obvious defects. Under certain conditions they are not easy to steer. There is generally, though not always, considerable side draft while plowing.

The three wheel machines with a single driver in the rear also gets away from the differential gear and some troublesome transmission problems, but unless it is designed with the center of gravity low there is danger of upsetting. This difficulty may be overcome to a great extent, but in turning corners the tendency is always present. All of the three wheel machines lend themselves peculiarly well to chain drive, which is a most excellent method of transmitting power so long as the chain does not stretch, but if it gets too long, it is inefficient and there is more or less liability to breakage of the chain. Up to the present there has not been enough attention paid to tractor requirements by the chain manufacturers, but there is an indica-

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