RESEARCH COMPLETED ON POWER-DRIVEN TOOLS FOR TAKING LONG CORE-BORINGS

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Cores up to six feet long and approximately one-half inch in diameter can now be taken from the trunks of either hard or soft wood trees by power-driven coring tools recently developed expressly for this purpose in Atherton, California. The new tools differ from other corers in one important respect, namely, the cutting heads are detachable. This desirable feature is accomplished by a joint that cannot accidentally unscrew or loosen and thus leave the cutting head in the tree.

The problem of designing such a joint and other features for which there was no precedent so delayed progress that the development period extended over several years. The joint had to be able to transmit high torque, or twisting effect, in both directions (which eliminated most types of screwed joints) and it had to be as slim as possible to minimize friction. How great an improvement was made in decreasing joint diameter, even

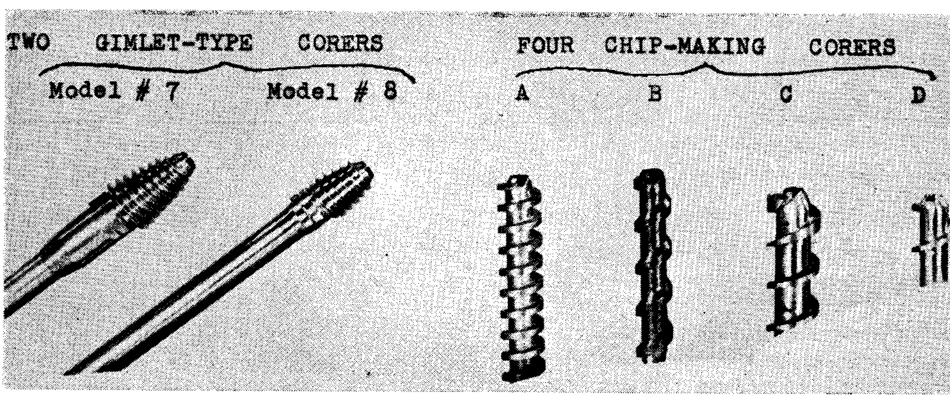

Fig. 1. Cutter-heads of original design. Two at left for cutting soft wood; four at right for cutting and removing chips in hard wood.

after the basic principle was developed, can be seen in Figure 1 which shows model 7 beside the much more efficient model 8. On both these models the diameter of the tube is the same.

Heretofore, in the manufacture of coring tools of shorter lengths, the difficult joint problem has been solved by eliminating the joint altogether, that is, constructing the tool by the "gun-barrel method" which drills the central hole out of a solid steel cylinder and thus produces the finished tool from a single piece of metal. But in corers six feet long this is impractical even if the same metal were equally suited to both tube and coring head.

By having a joint between these two parts it is possible to use a very high-strength steel in the cutting head tempered to meet exacting requirements, while still retaining in the long shaft the advantages of modern tube manufacture, which includes ready availability at a price low enough so that, at least for the gimlet-type corers, several extras can be kept on hand for emergency replacements.

The steel selected for the cutting-head is a carbon-manganese-silicon-molybdenum alloy with a breaking strength of 323,000 lb. per square inch and a hardness (Rockwell) of 59, despite which it will bend before it will break. After being worked to the exact form desired it is hardened by a process which subjects the metal to a temperature of 1600 deg. F. in an atmosphere of 1½% to 4% of oxygen; it is then quenched in oil and drawn at 290 deg. F. It is believed that these cutting heads will withstand any stresses to which they will be subjected in tree-cutting procedure.

The tubes, similarly, are of a material precisely suited to their special requirements. The alloy selected is a cold-drawn chrome-molybdenum, with normalized stress, which allows heat application to near critical temperatures and subsequent cooling in air without change in physical properties. This permits brazing or silver-soldering without loss of temper—an invaluable advantage where a re-heat treatment after finishing would be impractical.

With the joint problem solved, it is believed that this same type of joint can be used for one and perhaps two more 6 ft. tube lengths to be added as extensions. If this is successful the equipment then should be able to core to depths three times the present 6 ft. limit or about 18 ft. This would be enough to reach the center of even the largest *Sequoia gigantea* whose maximum diameter is 32 ft. Thus far, however, no extensions have been attempted and actual coring operations have been limited to the initial 6 ft. tube lengths.

With the present 6 ft. coring tools, cores can be brought to the laboratory for studying ring characteristics in continuous sequence from bark to central point in trees up to 12 ft. in diameter. Trunks in this size range comprise a large percentage of the trees important to the dendrochronologist.

In addition to the joint problem, another phase of this project which delayed progress was the absence of precedent or any reference literature whatsoever. Each advance had to be a cut-and-try process. A search in the patent office produced none of the hoped-for information about earlier designs of wood-coring tools. Apparently, none have been patented in this country. The years of slow progress can be dismissed here with the comment that the results are shown in the accompanying illustrations.

In the model 7 cutter-head the joint consists of a machined, tapered jaw-clutch in which separation of the two jaws during operation is prevented by an overlying, threaded sleeve which is advanced from the rear over threads cut in the jaws. The sleeve is advanced until it abuts against a shoulder at the forward end of the threads and then a snap-ring (an idea borrowed from the gasoline-engine piston) is fitted into a groove behind the sleeve. Such a joint cannot come unscrewed accidentally and has maximum strength for resisting torque in either direction.

Though model 7 was ideal in other respects, the sleeve construction made it considerably thicker than the tube. The cutting head, of course, had to be large enough to squeeze back the wood fibers so that the thick joint could pass. Despite the relatively large diameter, it did this successfully in soft woods, as coring in redwood proved. But friction was excessive and operating experience showed that a design with less difference between tube diameter and the overall diameter was necessary if frictional resistance was to be kept down. Based on experience in operating the model 7 head, modifications in joint design were worked out which resulted in production of model 8.

Model 8 has met all requirements for coring soft woods. The relatively small diameter of the cutting head exceeds the core diameter by no more than the necessary minimum to provide adequate strength. In striking contrast to its predecessor, this later model produces a 0.450 in. core with a cutting head diameter, at thread base, of only 0.889 in.

After proving the success of model 8 by trial, and believing there was no prospect for any further reduction of head diameter, it was realized that it would be impracticable if not impossible to force such a tool 6 ft. or more into a hard, close-grained wood. In other words, for long cores in the very hard woods, what is needed is some type of chip-making tool. Thus was born the decision to develop another and entirely different type of cutter-head that could bore its way into woods of any degree of hardness, friction being reduced by cutting out and removing chips as the cutting edge is advanced.

The series of experiments then begun was aimed at combining the screw-conveyor principle with a cutter design that would slowly advance a circular cutting-edge around a core while the encircling wood was cut away in chips which would be moved back out of the hole. This type, obviously, would require an overall diameter larger, in proportion to the core, than in the gimlet type, but with proper screw-conveyor design the friction developed should be very much less.

Development of this chip-making tool involved nothing unique as was the case with the novel-type joint. Rather, the process was a matter of cut-and-try in order to find (a) what modifications of standard wood-boring tools (notably the ship augur) would best suit this purpose and then (b) how such a design could be adapted to economical manufacture. Eventually both these requirements were met in a chip-making tool which, when tried out in the improved form shown in Figure 1, was an unqualified success.

Undoubtedly this success was, to a considerable extent, dependent upon a power plant, the development of which had been carried on concurrently with work on the coring tool design. The power required was much greater than had been anticipated because of the unexpectedly large amount of friction encountered in the long holes. Of the power plant as originally assembled only the two and three-quarter horsepower prime-mover remained when the final assembly was photographed (Figs. 2, 3).

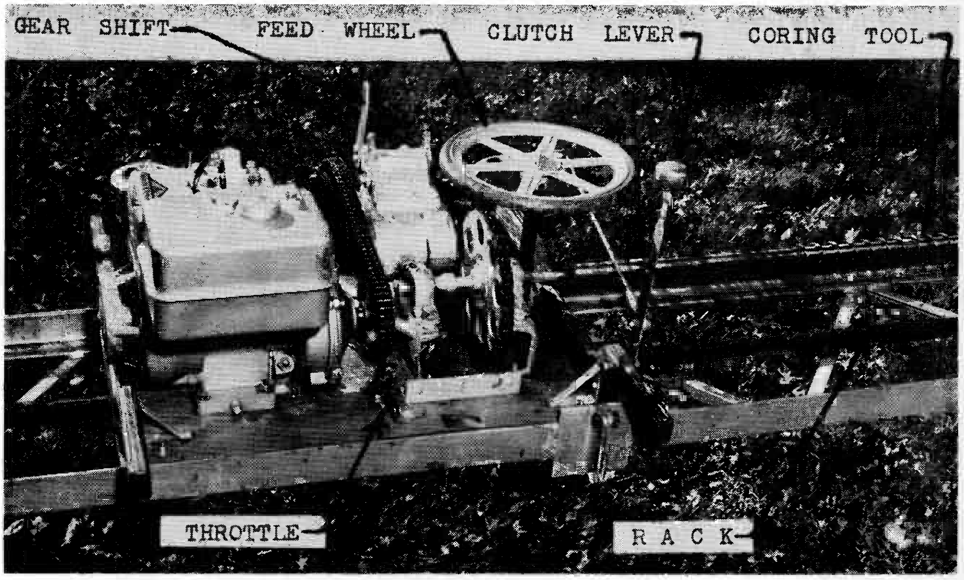

FIG. 2. Close-up of power unit from operator's side. Vertical shaft of feed-wheel has a pinion on lower end which engages a mid-track rack.

Some of the parts had been rebuilt several times to meet unexpected requirements. Because of the heat developed by friction, it was found best not to attempt a driving-rate faster than a safe maximum which an experienced operator can determine by the "feel" of the feed wheel. However,

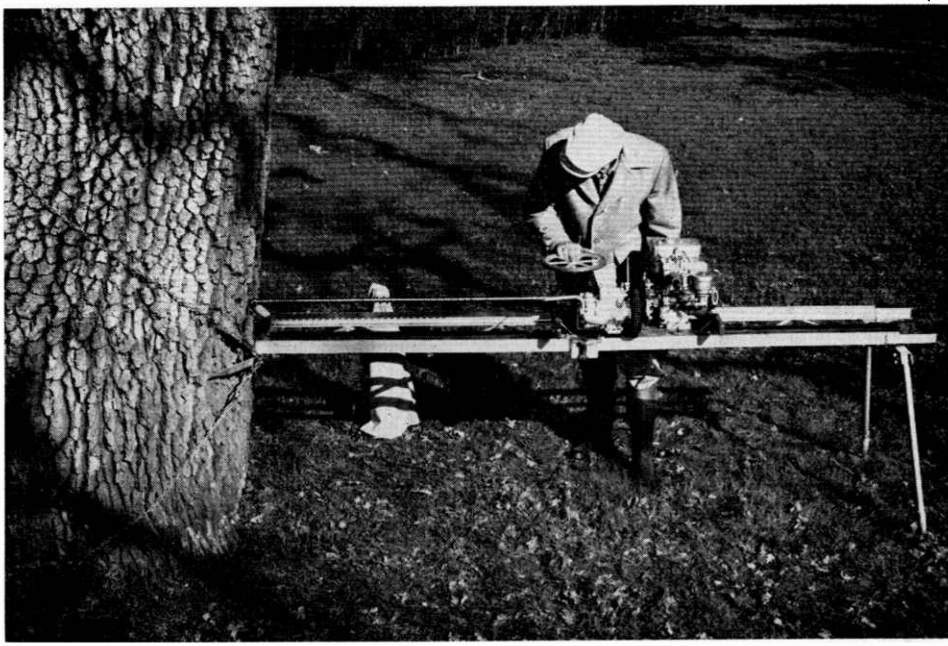

FIG. 3. Power-unit rides an 8 ft. steel track braced against the tree with chains and turnbuckles. Central joint makes shipping length 4 ft. Telescoping legs at track end adjust for sloping ground.

for speedy withdrawal motion the gear ratio in the transmission was stepped up to about 165 r.p.m. The clutch is a necessity in careful control of speed, especially in starting a new hole. Operation will be understood from the control labels on the several parts shown in Figure 2. General appearance of the outfit, assembled and in operation, is shown in Figure 3.

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