May 23, 1912.

there was hardly any vibration. The indicator cards explain this. The ram cards show an almost constant pressure during the acceleration and retardation periods. The pressure rises very abruptly at the closure of the waste valve, but drops more gradually at the end of the delivery. The rise in pressure is almost instantaneous and scales less than 0.01 of a second in some cases. The closing of the check valve and the opening of the waste valve seems to consume from one-tenth to one-twentieth of a second of time.

Due to the throw of the indicator arm it was impossible to get a reliable record of the actual maximum pressure attained in the ram and drive pipe. In order to secure this data a special device was later made and used. It consisted of a small chamber on which the pressure gauge was mounted, a drain cock was provided in its bottom, and its connection to the ram, or pipe, was through a check valve and stop cock. The chamber contained air so that when the stop cock was opened the pressure vibrations pumped water into the chamber, compressing the air, the check valve preventing the return of the water. When the maximum pressure was reached in the chamber the water no longer was forced in. The gauge then indicated the maximum pressure.

The maximum pressure in the ram was found to exceed that in the air chamber from 3 to 4 lbs. After correcting for difference in the static head, the maximum pressure near the head of the drive pipe was found to be only 10 per cent. to 20 per cent. less than in the ram. The indicator cards show about the same result.

This shows that the stress in the drive pipe does not decrease uniformly from bottom to top, but is nearly constant the whole length. Consequently, the drive pipe should be designed practically full strength its entire length.

Possibilities .- Judging from the results of a careful study of the conditions involved, and observations of the operation operation of the ram described, it is believed the limits of the name of the ram described, it is believed the limits of the name of the name described is the name of the nam the possibilities of operation and of capacity are beyond the ordinary requirements of practice.

Mr. Harza, at the conclusion of his paper, says: "If there is any reason whatever tending to limit the size and Canaci capacity of the hydraulic ram, it is the practical difficulties Which which might be encountered in the design of valves. It is believed believed that these are no more insurmountable than those encountered in the design of valves for other pumping engines of large size." It is believed that the proper valve required to solve the problem has been produced.

Head.-No difficulty should be encountered in operating these rams with supply heads from 1 ft. to 100 ft., and lifts from 1 ft. to 100 ft., and lifts from 5 ft. to 500 ft., the machines being designed to suit the suit the service required.

In addition to the automatic hydraulic ram there is a current ram manufactured by the Lester Duplex Hydraulic Ram Commanufactured by the Lester valve in this Ram Co., of Portland, Ore. The waste valve in this machine machine is operated mechanically by a separate current wheel The operating head for the ram is that produced by the velocity of the current of the ditch or stream in which the mach. the machine is set.

Capacity.-By the use of the multiple ring valve the size and capacity.—By the use of the multiple ring value more rings with of the ram may be increased by adding more rings without changing any essential operating conditions. If the court of valve ring, If the capacity is to be doubled, the length of valve ring, the unbol the unbalanced pressure on valves, the area of valve seats and the and the strength and resistance of the actuating spring are all increased that rams all increased in the same ratio. It is believed that rams having at least a 36-in. supply pipe can be built and operated successfully.

Uses.—The possible field of useful operation for the ram includes practically all those cases where water is to be

pumped and local water power is available to furnish the power.

Water Works .- The ram is sometimes well adapted for pumping water for domestic supplies and city waterworks, as it operates continuously and efficiently without cost of attendance or power. Hydraulic rams in the past have been used mainly for supplying isolated dwellings and small villages. Now, however, the advent of this new type of ram makes these machines available for use in large city waterworks.

Irrigation .- There has been a great need in irrigation work for a cheap pumping machine that would work automatically, economically, and efficiently under all conditions, and having sufficient capacity to make them practical for large installations. Under some conditions the hydraulic ram is an ideal machine for the purpose. The new design makes possible the use of large units.

It operates automatically, no attendant being required. There are no bearings to oil and no moving parts exposed in the new design. It can be set up and operated miles from an attendant without housing or fear of molestation. It furnishes its own power without cost. The cost of maintenance is practically nil and the first cost of installation small. The machines are very flexible as to their operating conditions, the same machine operating equally well under a high or low head. The delivery head can be changed at any time without touching the machine or interfering with its continuous action.

The hydraulic ram could be included in the design of many gravity projects to advantage. Why construct the main gravity supply canal to the level of the highest land with the great additional length of canal and expense involved, when it is possible to locate the supply canal at an intermediate level using the power of the water dropped from the canal to the lower levels to raise the water to the higher levels? In many cases a great saving in cost could be made in this way and much difficult construction avoided.

On existing irrigation projects there are numerous cases where drops in canals and laterals can be used to operate rams to lift water to cover additional lands above the canals. In many instances the cost of the machines for this purpose would not exceed \$3 to \$10 per acre thus irrigated.

Mining .- The hydraulic ram is very well adapted for pumping water for mining operations. If there is water power available to do the work the ram is the cheapest and most economical pumping installation for the purpose. No fuel or power is needed, no attendant is required and there is practically no cost of operation. The rams will pump direct to the giant for hydraulic mining. Benches above the river bed could be economically sluiced by the use of these pumps to furnish the water required. It is often cheaper to install a ram for pumping than to construct a long gravity ditch, and much cheaper to maintain.

NEW METHOD OF UTILIZING HEAT FROM GASES.

Prof. W. A. Bone, F.R.S., Professor of Coal Gas and Fuel Industries at Leeds University, in a lecture at Leeds, described a new method of gas heating without flame, which, he believes, may work a revolution in fuel economy and have very important industrial effects.

Prof. Bone is one of the greatest living authorities on the subject of combustion. The new process has already been put into practical operation at Leeds. Hot surfaces promote the combustion of gases in contact with them, and it is on this property that the process is based.