MODERN EXCAVATING EQUIPMENT

By DONALD T. JOHNSTONE, '29

AT the present time, the great tendency of man is to do bigger things in less time at the lowest possible cost. We marvel at the rapidity of construction of our large buildings, sewers, canals, tunnels and highways. We must have large quantities of stone, gravel, clays, coal, iron and raw materials that are extracted from the earth to supply our increasing demands, and one of the principal contributing factors toward this rapid quantity production is our present power excavating equipment. By means of this equipment excavations are made for basements, foundations, and sewers; highways are cut and graded, and open pit mining operations are carried on. This variety of uses demands excavators of many types and sizes, and for these purposes manufacturers have developed and placed standard power shovels on the market ranging from one-half cubic yard to eight cubic yards dipper capacity.

For the usual small excavation job, probably the most generally used machine is one of approximately one cubic yard capacity. This will vary from those of one-half cubic yard to two cubic yards, but we may consider the one cubic yard machine as applicable for a large variety of uses. Practically every job on which the small machine is used is carried on under different conditions, so that it is not possible to state an exact handling cost per cubic yard that will apply to all excavation projects. The principal factors that govern excavation costs are: the power used to operate the machine; the kind of material to be moved; the facilities for removing the material from the machine; the height at which the material must be dumped from the dipper; and delays due to necessary repairs.

The present machine may be driven by steam, electricity, gasoline, or oil, consequently the practicability of any particular power is established by conditions peculiar to the localities in which the machine is to be used. The following table of comparative operating costs is based on data of actual experience covering a wide range of working conditions in many localities. Also, the figures are for a particular make of three-fourths cubic yard machine but they will show the differences due to the source of power.

	Steam	*Electric*	*Gasoline-Electric*
Operator	$8.00	$8.00	$8.00
Fireman	6.00	none	none
Pitman	4.00	4.00	4.00
Coal, one ton	8.00	none	none
Gasoline, 35 gallons	none	none	8.75
Power, 225 K.W.H.	none	6.75	none
Water supply	1.25	none	none
Oil and minor supplies	1.25	.50	1.00
Operating cost	$28.50	$19.25	$21.75
Interest at 6%	2.90	3.60	4.10
Depreciation and maintenance	4.80	4.50	5.50
Total cost per day	$36.20	$27.35	$31.35

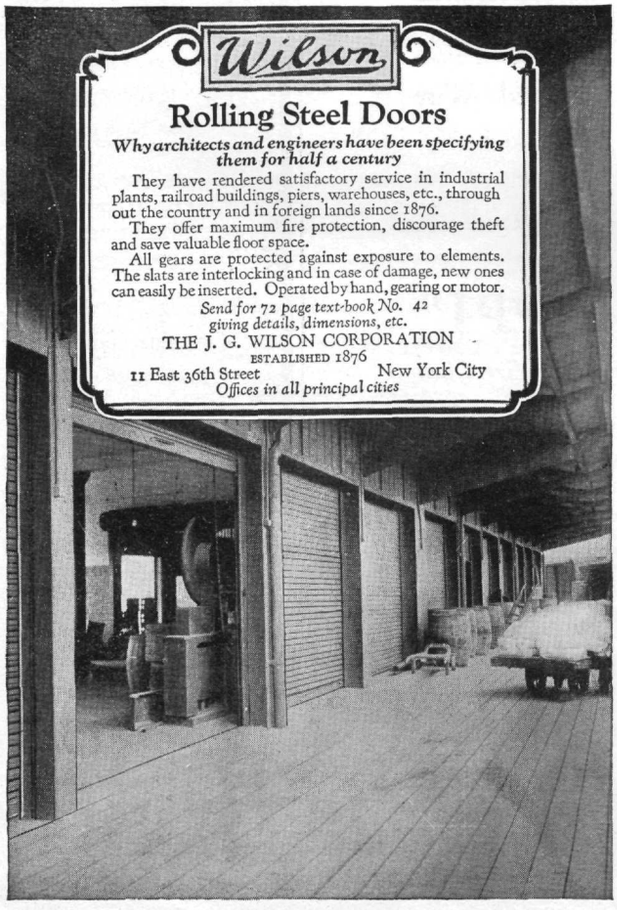
This machine will move, under average working conditions, approximately 450 cubic yards of earth per 10-hour day. In some cases this figure will be greatly exceeded, if working conditions are favorable, while in other cases it will not be reached. In general, operating costs on steam machines may be considered on a basis of one ton of coal per 10-hour day to each cubic yard of dipper size, and on electric machines approximately .3 to .6 K.W.H. per ton of material excavated. Depreciation is usually figured at 10 per cent and maintenance from three to five per cent of first cost per year.

It is obvious that in order to attain the highest operating efficiency a machine must be adapted to the particular work at hand. The small machines can be used on many kinds of jobs such as excavations for basements and sewers, loading of sand, gravel, etc., and general contracting work where the available working space is comparatively small. Quarry work, stripping, and open-pit mining require more rugged machines of greater capacity. If a machine is to be selected for any particular kind of work, all or part of the following points will govern the selection. What capacity per hour is necessary? What digging radius, height, and depth are necessary? At what height above the ground line and distance way from the centerline of revolution will it be necessary to dump? Any of the above considerations may be the important factor and the machine chosen to suit, but all the conditions are usually satisfied.

Shovel capacities may be figured, under ordinary working conditions, according to dipper size. A one-yard machine will move, on an average, one cubic yard per minute and the capacities increase as the dipper sizes so that the 8-cubic-yard machine will move 8 cubic yards per minute. This gives a range for a 10-hour day of approximately 600 cubic yards to 5,000 cubic yards. An 8-cubic-yard machine is capable of making one complete cycle of operation in 45 seconds when swinging through a 90-degree angle. There are intervals of time consumed in moving the shovel and for oiling and other mechanical attentions. Accessory equipment also has a bearing on the amount of work available from the shovel per day. Average conditions usually result in approximately 65 to 80 per cent actual digging hours, based on total time employed.

All machines are designed for working ranges suitable to the type of machine. The ranges of small revolving machines commonly known as "whirlies," increase as the dipper capacities. The small revolving machine of one yard dipper capacity will give maximum dumping radius of 26 feet and a maximum dumping height of 15 feet. These figures increase as the dipper sizes within the small revolving shovel group. On the heavier type of machines that are used to a great extent in railroad extension work, rock quarries, and ore mines, the ranges are small when compared with dipper capacities. This is due to a demand for a powerful machine of large capacity

(Continued on Page 24)



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(Continued from Page 4)

for loading cars. A machine that can dump over our railroad gondola cars is all that is usually required, but it must have a large dipper for rapid production. The large revolving machines were primarily designed for stripping overburden from mineral deposits, consequently they must be able to dig through deep banks and dump correspondingly. The largest machine now on the market is the 8-cubic-yard full-revolving shovel, which has a maximum dumping radius of 97 feet and a maximum dumping height of 67 feet.

The working range figures given above will vary slightly with different makes of shovels, but they are representative of the types. Also, these figures are for so-called standard equipment, but special equipment can be placed on the small revolving type which will change the ranges to suit special work such as deep sewer or trench work or work requiring a higher lift than the standard equipment will give.

Originally, the only machines built were operated by steam power and if local conditions made operating costs prohibitive the labor saved was not worth the cost. In some localities the handling of fuel for the steam machine is an arduous and expensive operation, and good feed water is not obtainable without the installation of water softening devices, filters, and purifiers. Smoke ordinances are now enforced in many cities and regulations controlling the use of steam boilers are becoming more severe each year. The electric and gasoline-electric machines have been developed to take care of these difficulties. The first shovels of this type, though lacking in the finer details, proved conclusively that there existed a new and very promising field for motor application in earth and material handling equipment. Cheap hydro-electric power is now available in many localities and new projects are continually under construction. Where electric current is not available from an outside source a design has been provided whereby the electric current can be generated on the machine.

In selecting power shovel equipment many factors should be taken into consideration. Steam has certain inherent characteristics and advantages that should not be overlooked. In proposing a change from steam to electric operation we have to deal with steam equipment which has not only proved its worth in power shovel construction, but has probably reached its highest state of development. At the present time, however, similar operating characteristics are obtained with the electric motor drive, even to that important feature of having high starting torque with quick acceleration of motor and machinery. These new shovels have many features which make them equal, and, under many conditions of operation, superior to the steam shovel. The saving in operating expense of the electric or gasoline-electric shovel over the steam shovel will depend somewhat upon the comparative cost of fuel and electric power and will vary for different localities. The electrically operated machine eliminates the fireman, the watchman, the handling and hauling of fuel, the use of water, and otherwise avoids considerable waste, but local conditions taken collectively should govern in all cases the type of machine chosen.