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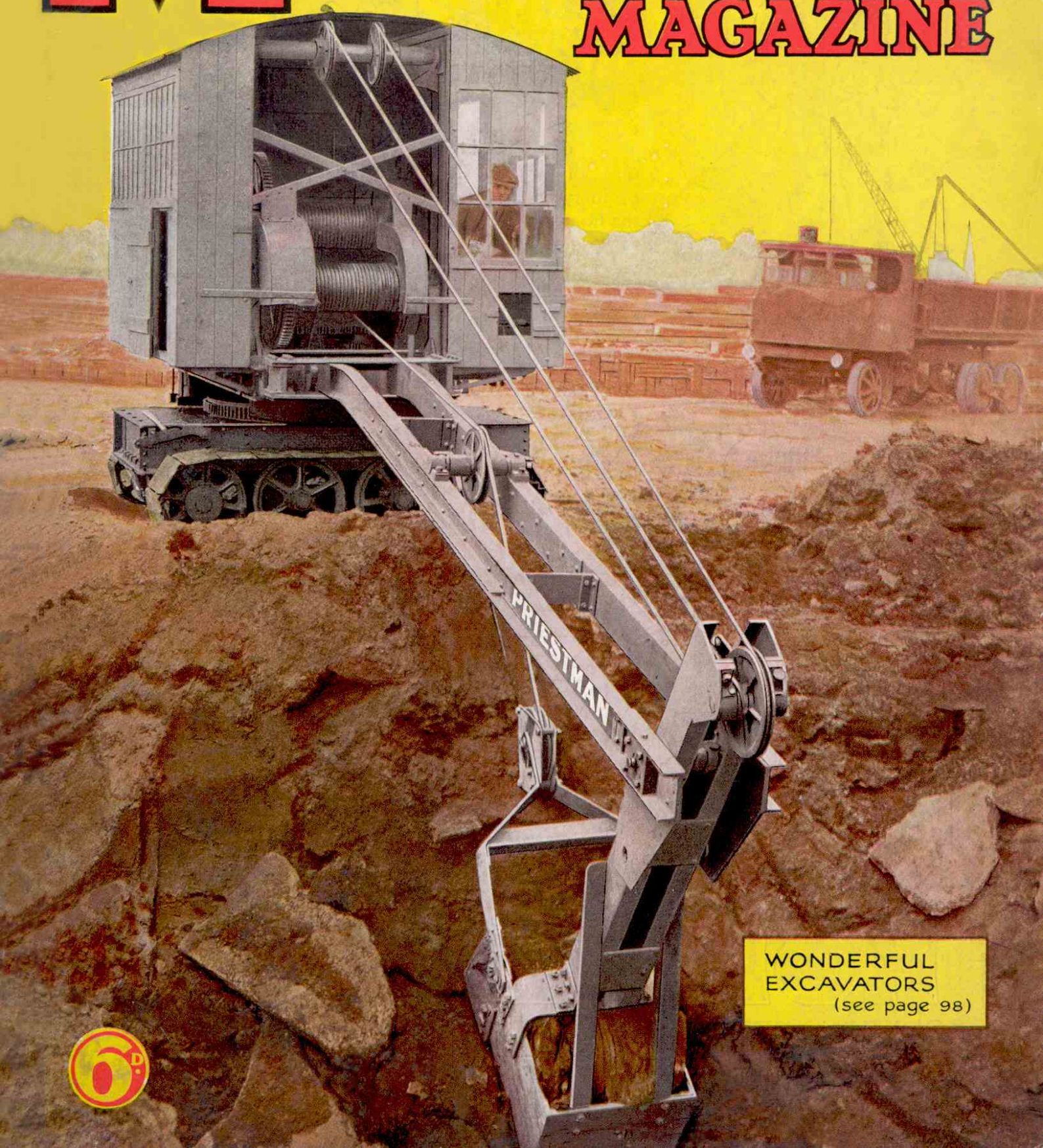

WONDERFUL EXCAVATORS
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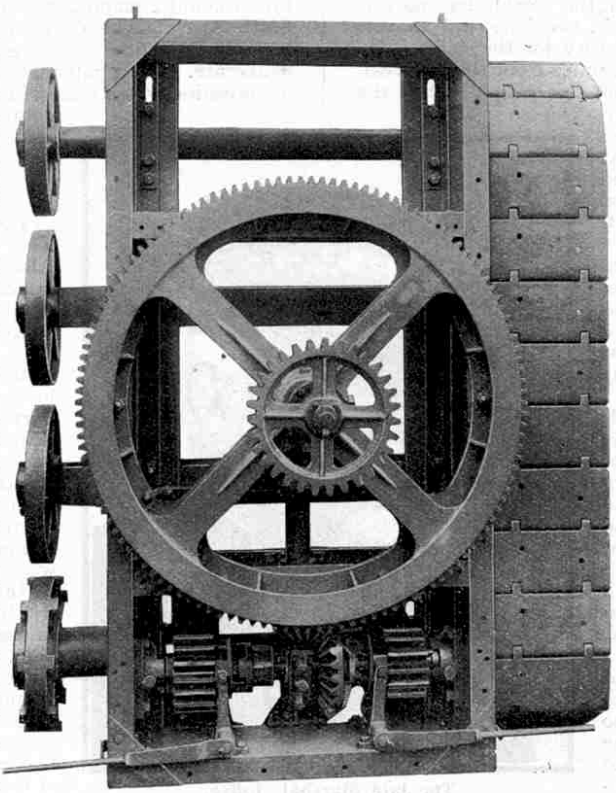
Modern Mechanical Excavators

A Wonderful Convertible Machine

BEFORE the introduction of excavating machinery, tasks such as cutting canals, digging reservoirs boring tunnels, and sinking the deep foundations of large buildings, were carried out slowly and laboriously by the combined efforts of large numbers of men. During comparatively recent years this manual labour has been replaced gradually by mechanical power, and though some spade work is still necessary, the greater part of the excavation in these great undertakings is now done by huge machines of various types, operated by steam or by electric power. These giant digging machines are each capable of doing the work of hundreds of men and of continuing for unlimited periods.

The most familiar of mechanical excavators are the steam shovel, sometimes called the steam navvy, and the dragline excavator. The steam shovel consists of a huge steel shovel mounted on an arm that is pivoted on a jib. This jib is of heavy design, for it not only takes the stress from the digging rope, but also bears the whole of the excavating stresses from the shovel arm, together with their attendant slewing and digging stresses. It is operated from a steam engine situated in a cab placed in a convenient central position, and the entire mechanism is generally mounted on caterpillar tracks. The steam shovel excavates above the level of the ground on which it stands, and moves forward into the excavation as it proceeds. Such shovels are often to be seen at work in open mines and quarries, or engaged in the excavation of railway cuttings, canals and docks. Under favourable conditions they are capable of performing an enormous amount of work, but they cannot operate on wet or marshy ground, or excavate material below their own level.



The undercarriage of a Priestman "Universal" Excavator mounted on the four steel axles that carry the caterpillar tracks. For this and the other illustrations to this article we are indebted to the courtesy of Priestman Brothers Limited, Hull.

Where conditions are unsuitable for a steam shovel to operate, a dragline excavator is usually employed. This machine also has a massive steel arm and a shovel or bucket, but instead of the bucket being mounted on a pivoted jib, it is slung from the outer end of the arm and is manipulated by a flexible rope. It operates in the opposite manner to a steam shovel, for it excavates below the level on which it stands, and retreats when it has removed all material within reach. The jib is of lighter design and may be of greater length than the jib of a steam shovel, which gives the dragline a wider range of action and enables the bucket to dig a wider cut. The greater length of the jib is made possible by the stresses at its head being less than in the case of the steam shovel.

The dragline has two winding drums as against the single drum of the steam shovel. One drum carries the digging rope, which is connected to a cross-bar above the front of the bucket. The other drum accommodates the hoisting rope that allows the bucket to swing out to the excavation, controls the depth of cut, and raises the loaded bucket. The hoisting rope is attached to the body of the bucket on the side farthest away from the machine.

When the dragline is at work the bucket is lowered to the foot of the excavation, the digging drum is placed in gear, and the rope is then hauled in, drawing the bucket toward the machine and dragging it into the material to be removed. Immediately the bucket has collected a full load the clutch of the digging drum is disengaged and the hoisting drum is thrown into gear. While the hoisting rope is lifting the bucket the digging rope is allowed to run freely, causing the bucket to swing toward the front of the jib. The excavator is then slewed over to the dumping point and the bucket is tilted forward so that its contents are discharged by way of the open mouth.

The dragline and the steam shovel are similar in general construction, and a steam shovel may be designed in such a manner that it can be converted into a dragline if required by fitting a different jib and special bucket and adding another winding drum to the machinery. Even greater adaptability is shown by the "Universal" excavator built by Priestman Brothers Ltd., of Hull. With slight alterations to equipment this machine can be converted into a dragline, a navvy, a trench shovel, a grab, or a skimmer scoop, an attachment for effecting shallow excavation where a level surface is required. The change-over from one attachment to the other can be carried out by unskilled labour in about a couple of hours.

The largest excavator of this type is 15 tons in weight, and its overall dimensions are such that it can be transported easily by rail or motor vehicle, while short journeys can be made under its own power. The machine is provided with caterpillar tracks of ample

bearing surface for travelling over roads without damaging their surface, and for traversing grass land without sinking into it. The undercarriage is built of large steel channel girders, rigidly cleated and gusseted, and is mounted on four steel axles carrying at their ends the driving sprockets for the caterpillar tracks.

Each track consists of a series of cast steel plates connected together by nickel steel pins. These pins have square heads that prevent turning, and are designed so that they can be removed easily for replacement. The track plates are specially designed to prevent the entry of mud and stones, and the inside portions of the plates are shaped to form a smooth path for the rollers, and also to act as driving dogs, engaging with corresponding dogs on the driving sprockets. The sprockets and rollers are of cast steel and are of large dimensions. Efficient adjustment is provided to take up wear in the joints of the track plates, and the arrangement is such that the adjustment screws are in tension.

A 15-ton "Universal" Navvy Shovel at work in Australia.

The caterpillar tracks are steered by means of hand levers on the undercarriage, which actuate clutches on the main clutch shaft. The shafts can be driven separately in a forward or a reverse direction, or locked singly or together. To turn the excavator gradually in any direction the inside track is allowed to run free while the outside track is driven; and to make a sharp turn to right or left the inside track is de-clutched and locked and the outside track is driven.

The motive power of the excavator may be supplied by a four-cylinder engine designed for starting on petrol and running on paraffin; by a high-speed Diesel engine, or by an electric continuous running motor. In each case all the motions are controlled by the same arrangement of clutches. Power for travelling is transmitted from the main engine to the first power shaft and through the centre pin to the tracks by means of spur bevel gearing, no chains being used. A double set of gears is mounted on the top side of the bedplate and operated by a hand lever on the driver's platform. This gearing gives a traction speed of $1\frac{1}{2}$ m.p.h. for road travelling, and $\frac{5}{8}$ m.p.h. for working conditions.

The reduction and transmission gear from the engine to the main clutch shaft is enclosed in a specially-designed gear box that forms an oil bath and ensures silent running. The gear box is designed so that the top half can be easily removed for inspection without disturbing the shaft bearings or removing the oil. The friction clutches transmitting the power of the engine to the slewing, travelling and lifting motions are of ample size to transmit the full power of the engine and to accelerate quickly. When the swing clutches are disengaged the machine is free to centre itself over the load. The normal rate of slewing is six circles per minute, so that with quick acceleration of the clutches the operator can work at a rate of three cycles per minute.

The excavator is equipped with two winding drums mounted on separate shafts, one behind the other. Each drum is deeply grooved to prevent rope slip, and is free running and fitted with its own clutch and brake. The drums are operated by Priestman patent relay clutches, which are so designed that the engine provides the power for their engagement. When the machine is being used as a grab excavator the front winding drum is utilised for the holding or opening rope, and the rear drum is used for closing and hoisting the grab.

Cutting a trench through hard gravel with the aid of a "Universal" Trench Shovel.

The ordinary operations of the machine, travelling, lifting and slewing, are controlled by four hand levers operating the clutches and two foot pedals governing the brakes. This control mechanism is grouped at one side of the machinery in a position that ensures the driver having a full view of the work in progress. Two of the four levers are fitted with patent load easing gear which, by the movement of one of the pedals, simultaneously releases the main clutches when their respective brakes are applied. This operation eliminates all shock on the

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superstructure during the transfer of a load from the hoisting motion to the brake, and is of great assistance to the driver. An adjustable seat is provided for the driver, within easy reach of all controls. The engine, winding drum and gearing are enclosed in a corrugated cabin that gives ample protection to the machinery.

The entire superstructure is carried on a wide bedplate that is accurately bored to receive a massive centre pin around which it rotates. This bedplate is supported by four brass-bushed cast steel rollers that follow a circular path on a large cast steel race bolted to the top of the chassis and giving ample stability under all working conditions. In the centre of the race is a boss carrying the steel centre pin.

Three jibs of slightly different design are used in connection with the various kinds of work performed by the excavator. The jib that is fitted when the machine is used as a dragline also serves when the machine is converted to a grab excavator. It is supported on a four-part hoist rope attached to the lifting gear at the rear of the machine. A jib of greater strength is employed when the machine is operated as a navvy. It is connected to the revolving frame by large cast jib feet, and is supported on a four-part jib hoist rope attached to one of the main clutch operating drums. Racking motion is obtained by lifting and lowering the jib.

The jib attached when the excavator is required to work as a skimmer scoop is used also for the trench shovel. As stated earlier in the article, the skimmer scoop is used to effect shallow excavations such as are required in the making of roads. The trench shovel, as its name indicates, is used to excavate a deep trench, and this machine has been employed on many important contracts in connection with the laying of long distance pipe-lines. The skimmer scoop is converted to a trench shovel by removing the scoop, turning over the jib, and attaching the arm of the trench shovel to the head of the jib. The jib of the skimmer scoop or the trench shovel is of ample strength to withstand heavy digging loads, and the top end is fitted with triangular plates that carry the drag rope sheave and the jib hoisting sheave. A mild steel guard fitted round the jib head protects the drag rope and sheave if they come in contact with the material. The scoop is fitted with a mild steel cutting lip to which the usual teeth are bolted, and is attached to a steel runner that moves forward upon eight rollers.

In addition to its many land uses, the "Universal" excavator can be easily converted into a floating grab dredger by removing the undercarriage and the caterpillar track and bolting the superstructure to the deck of a suitable pontoon or barge. In this form the excavator has performed useful work in deepening waterways that are too wide for an ordinary dragline to operate successfully. As a grab dredger the machine makes two complete operations per minute, and can dredge 60 tons of gravel per hour.

Mechanical excavators have been employed on many great engineering works, including the Panama Canal and, more recently, the River Shannon Hydro-Electric scheme in the Irish Free State. Powerful electrically-operated excavators have been employed on the recently completed Welland Canal scheme, and huge dragline excavators are at work on extensive irrigation schemes in India.