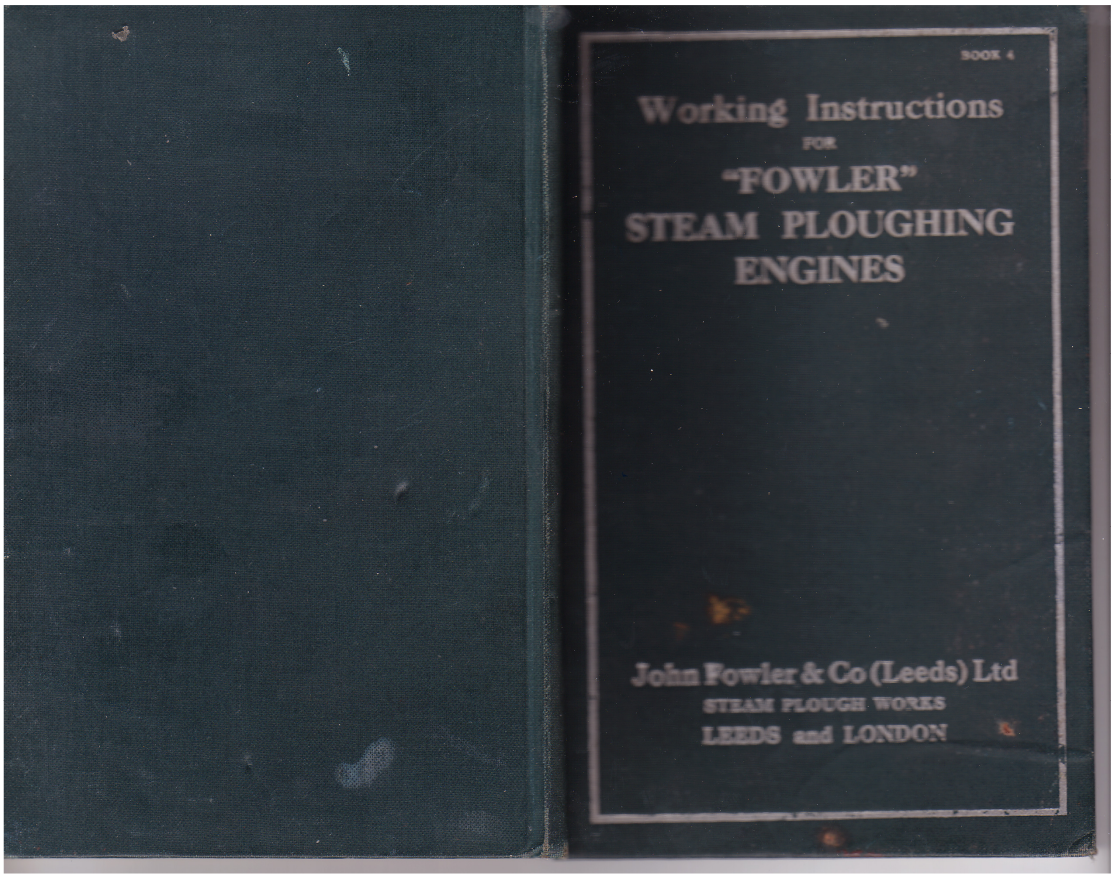

BOOK 4
Working Instructions
FOR
"FOWLER"
STEAM PLOUGHING
ENGINES
John Fowler & Co (Leeds) Ltd
STEAM PLOUGH WORKS
LEEDS and LONDON

BOOK 4

WORKING INSTRUCTIONS

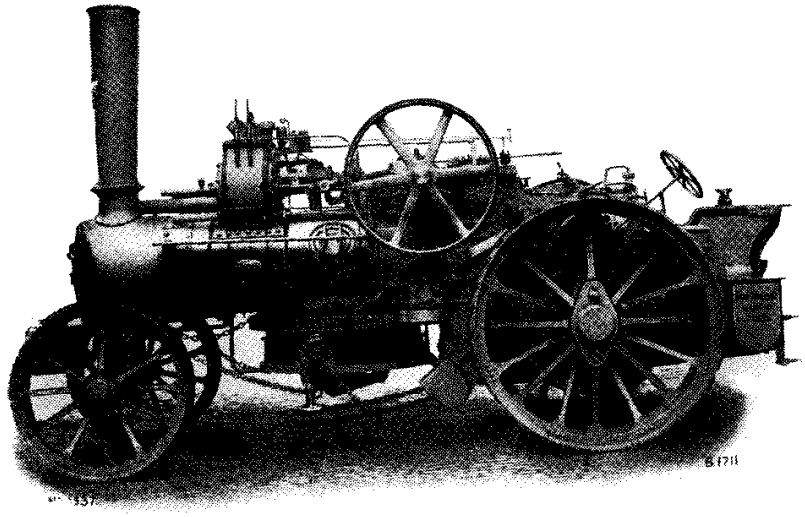
FOR

"FOWLER"

Steam Ploughing Engines

with general information on the management of Cable Ploughing Tackles.

Separate instruction books are published on the working of individual implements.



John Fowler & Co (Leeds) Ltd

Steam Plough Works, LEEDS *England*

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LONDON 113 Cannon Street E C 4

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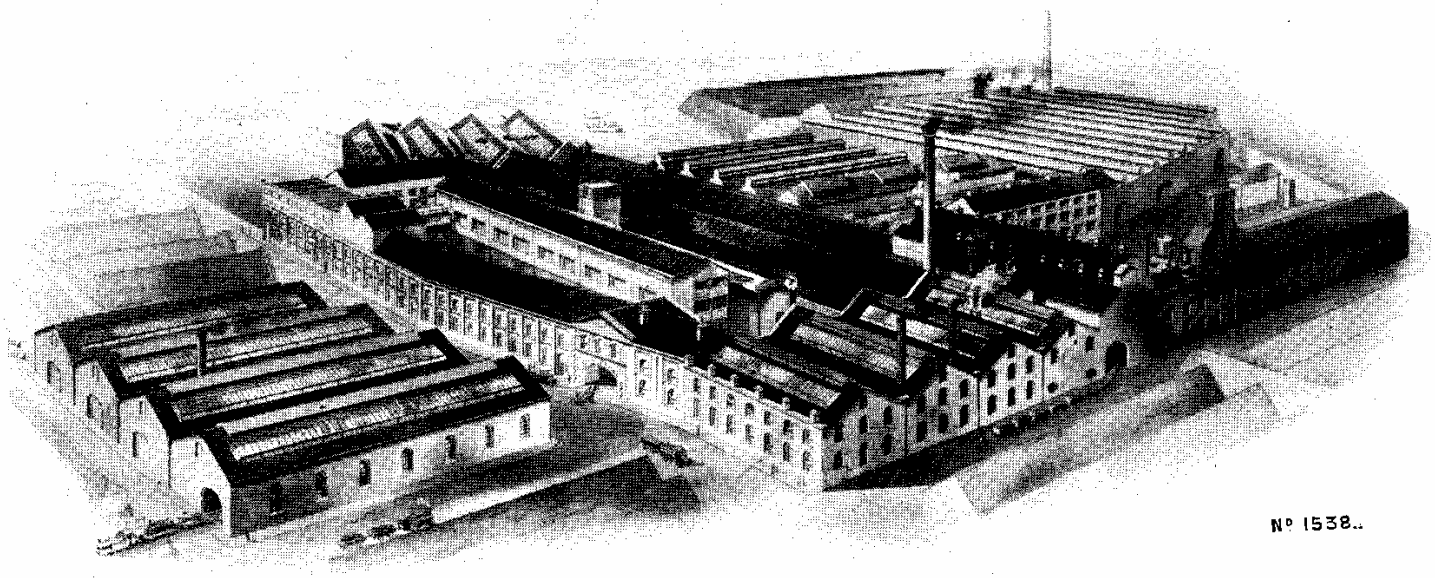


GENERAL VIEW OF THE STEAM PLOUGH WORKS, LEEDS

Introduction

IN compiling a book of working instructions it is impossible to provide for all eventualities or difficulties which may crop up.

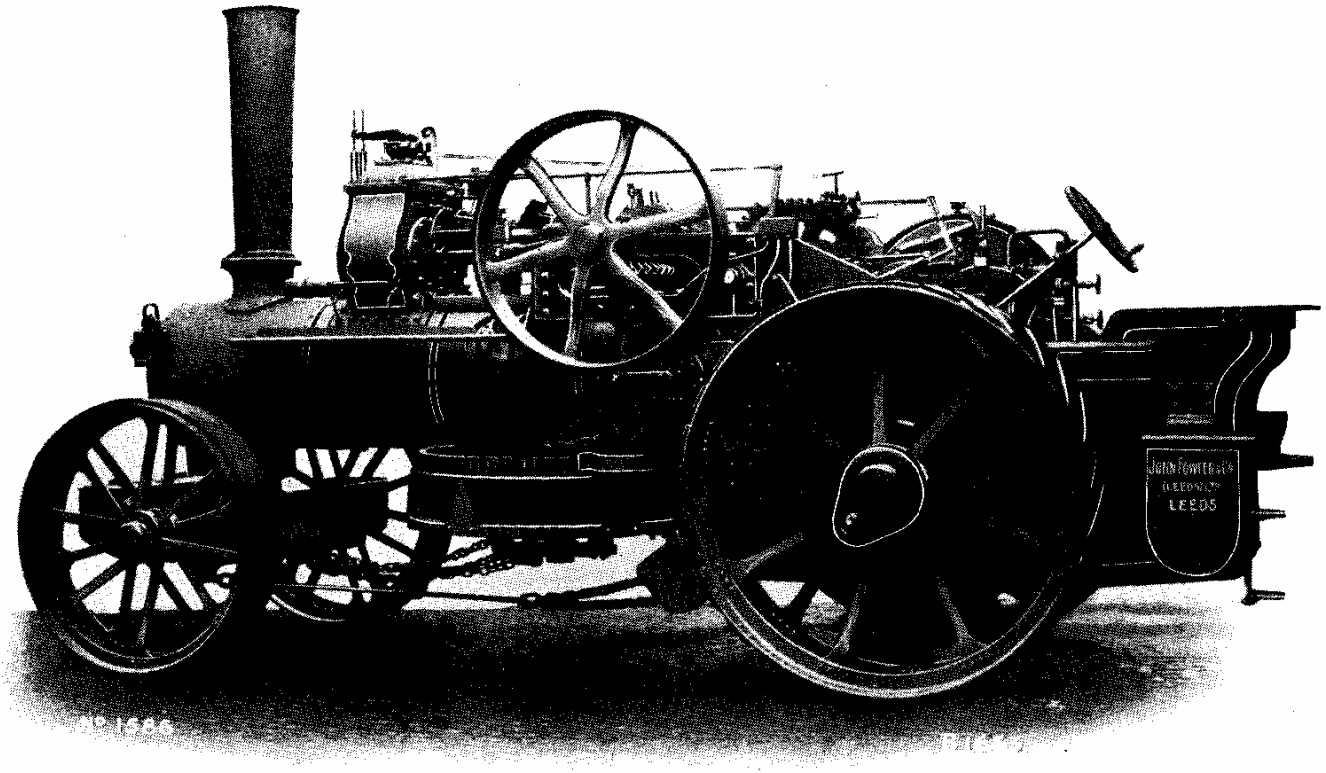
The instructions given in this book represent the combined experience of a number of expert steam ploughmen and others who have practical knowledge of the difficulties which may occur in the field, and of the methods which must be used if the best results are to be obtained.

At the same time we are always pleased to hear from our customers and to do our best to help them with any difficulties they may meet with. Even when the work is apparently all going smoothly, if particulars of outputs and costs are sent to us, we are sometimes able to advise how the results can be improved.

With such machinery it is always worth while to leave no stone unturned in the effort to get the very best possible results.

In all correspondence referring to either Engines or Implements, and especially when ordering duplicate parts, the Engine or Implement number must be given. It prevents mistakes and avoids delay.

John Fowler & Co (Leeds) Limited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MANAGEMENT

The Cable Ploughing Tackle with its crew forms a self-contained unit capable of very large outputs, provided that it is kept constantly at work.

With this object it is highly important—

(1) That a competent man with previous experience in operating such machinery be found to take charge of the plant and teach the rest of the crew. If engine drivers and ploughmen can also be obtained with previous experience, so much the better, but this is not necessary, as the working of the machinery is easily learned in a few days, provided that proper supervision is available.

(2) That an efficient supply of fuel and water is maintained so that work is never held up through shortage.

(3) That payment of the men shall depend partly or wholly upon the area of work done, so that every man shall have a direct interest in increasing the output to the highest possible point.

(4) That the crew shall be accommodated close to the work so that time is not wasted each day in going to and returning from their homes. In the great majority of cases this is best arranged by the provision of a living van, which is hauled from place to place by the engines, and gives comfortable accommodation for five men. In foreign countries additional huts or living vans are also sometimes used to accommodate the native labourers apart from the Europeans.

(5) That the work be arranged to avoid unnecessary travelling from one field to another as much as possible.

(6) That the machinery be kept in as efficient a state as possible and every precaution taken to avoid stoppages through breakdowns.

Each time that the engines are washed out the engines and implements should be carefully examined to see that all working parts are in first-class running order. At the end of the season's work the whole plant should be carefully overhauled and made ready in every detail for the next year's work.

Duplicates of parts which might break or wear in use should be available at once, so that if breakdowns occur they may be remedied as quickly as possible. Far greater loss is involved if the plant has to stop work for a day or more waiting for new parts than by carrying a rather larger quantity of duplicates in stock against emergencies.

FOWLER SERVICE

To assist our clients in getting the best results out of their machinery, we are always ready to help them in securing the objects mentioned above or in any other way.

Among other things we can do for them may be mentioned—

(1) We can obtain the services of experienced men to take charge of new tackles and teach the drivers and ploughmen. Such men will either stay for a limited time until the crew have become thoroughly accustomed to working the plant and are able to operate it by themselves, or in the case of plants working abroad, arrangements are often made for them to go out under contract for six or twelve months, or even longer. In certain cases men can be found to take permanent charge of the machinery.

(2) We are always pleased to give particulars of piece-work or bonus systems of payment which have been found successful in practice, and which might be applied to any particular conditions of work.

(3) We can draw up suggested lists of spare parts which are most likely to be required and which we should recommend owners of ploughing tackle to keep in stock in case of need. The quantity of spare parts recommended depends, of course, on the distance from a spare part store where replacements can be obtained.

(4) We can, if required, supply experienced men, such as boiler makers, fitters &c. to overhaul tackles for our customers in cases where the service of such men cannot be obtained locally.

(5) If the work done by the implements is not exactly what is required, we can often arrange for some comparatively simple alteration which will produce the required effect.

STAFF REQUIRED

The number of attendants required for working a set of Steam Ploughing Tackle varies according to the country in which it is worked, and the nature of the work to be done.

In England the usual staff is—A chargeman who can drive an engine or steer the plough, two engine drivers, one ploughman, and if a van is supplied, one assistant who acts as cook, relieves one of the other men when required, and gets up steam before daylight. The men should come in to their meals by relays. If this arrangement is made, the tackle will not stop working for meal times.

A horse and cart will be required for coal once a day, and two horses for the watercart for the whole

day. If water cannot be got within a reasonable distance two watercarts may be required.

For tackles working abroad where native labour is available, the natives are nearly always used for handling the implements and often for driving the engines as well. In such cases, however, it is essential that an experienced European chargeman is present to see that the work is kept going and properly carried out.

LEGAL REGULATIONS

Driver and Steersman—One man can drive and steer a ploughing engine in the field, but when travelling on the road in England, and in most other countries, the regulations require that two men shall be present—one to drive and one to steer—and in addition that an assistant be available to help passing traffic on the road.

Registration and Boiler Inspection—In England and in other countries Steam Ploughing Engines must be registered in the County in which they are to be used. In most cases the boilers have also to be inspected and passed by the Boiler Inspector every year.

RECEIVING NEW TACKLES

Engines Sent by Rail—In Great Britain Ploughing Tackles are usually forwarded by rail completely erected, except that in some cases the chimney and flywheel have to be dismounted and refixed on arrival.

Unloading Engines—Where "end-on" platforms are available, the engines can be run off the railway trucks under their own steam. The truck buffers must be propped up with timber packings, and the wheels firmly wedged in position while unloading, to prevent the truck moving, or the railway locomotive can be used to hold the wagon in position. Wood planks or railway sleepers must be laid between the end of the truck and the dock, forming a platform for the engine to pass over.

Where no carriage dock or platform is available a temporary one can be built in the form of an incline composed of suitable wood beams, 12 to 14 inches square, and about 25 to 30 feet long, supported on cross timbers or railway sleepers. The beams must be firmly tied together, and so placed that the engine wheels can pass easily over them. The engine should be put into the slow gear and moved backwards slowly down the incline only a foot or two at a time, while a man should stand at each hind wheel ready to "scotch" it if necessary.

The implements can be pulled off the trucks by the engines either direct or with the help of the ploughing ropes.

Engines Packed for Shipment—Engines sent abroad are partially stripped and packed in special wood cases, each case being numbered and a list of contents forwarded to the customer or his agent.

Points to be borne in mind when Starting a New Plant—In addition to the instructions given under Starting and Running, the following points should receive attention—

(*a*) Check over the outfit supplied against the list and see that it is complete.

(*b*) Before letting any steam into the cylinders, turn the crankshaft and motion work round by hand to see that no accidental obstructions are present.

(*c*) See that all dust and dirt is cleaned out of the moving parts and that everything is thoroughly lubricated.

(*d*) Make arrangements for registering the engines and for insurance of the boiler and the driver.

INSTRUCTIONS FOR RE-ERECTING CABLE PLOUGHING TACKLE

which has been stripped and packed for export

The stripping and packing of engines after testing in our works is done with the greatest care under the supervision of men who have had personal experience of erecting such machinery in various parts of the world. All parts are marked for their respective positions as they are taken apart and carefully checked into the cases against the inventory, so that risk of mistakes is reduced to a minimum.

The cylinders, valves, and motion work are encased on the boiler itself, and all the adjustments are left exactly as they were when the engines were tested, so that no skilled knowledge is required in reassembling but only care and common-sense in handling the various shafts and gearing, and coupling them up in their correct positions.

The re-erection usually has to be carried out in a station yard, at the place where the trucks have to be unloaded, but in any case it should be done at a place where there is firm ground for jacking up and packing the various parts, and where there is enough room to unpack the cases without crowding. If a crane is available, so much the better, but if not a pulley block and shear legs can be used for lifting the various parts into position.

Only one engine should be erected at a time and cases should not be opened until they are actually required, so as to prevent parts from being lost or mislaid.

Even if a crane is available it is generally not strong enough to lift the boilers out of the truck, and

these have to be taken off with the help of jacks and levers. Old railway lines or strong wooden baulks can sometimes be used as slipways down which the boilers can be slid from the trucks on to the ground.

The boiler is then packed up on the ground in the working position, and first the fore-carriage pin, front axle, and front wheels are put on to it, so as to give it a more solid basis on which to stand.

The second motion shaft, upright shaft, and crank-shaft can then be put into position, as they have not to be lifted so high if put in at an early stage.

The hind tank and hind axle brackets are then bolted to the boiler. Then the third motion shaft can be put in position, and after that the hind axle and hind wheels.

Owing to the arrangement of the gearing, which is still keyed on to the shafts in the packing cases, the erection of the shafts must proceed in this order, i.e., second motion shaft, third motion shaft, hind axle, while the upright shaft must be put into position before the crankshaft.

All bushes and brasses are carefully adjusted before leaving the works, and there is nothing to do but put on the top halves of the brasses and the bearing caps after the shafts have been put in position to set everything in running order. At the same time, the greatest care must be observed throughout to clean all journals and bushes very carefully before putting them into position, and if any parts have become bumped or bruised in transit, they should be cleaned up by filing or scraping so that all bearings will run freely from the start.

The crankshaft is then coupled up to the pistons and valves, the flywheel keyed on to the end of it, and all subsidiary parts, such as injectors, clackboxes, steam and delivery pipes, coupled up, and the engine is ready for steaming.

The last part to be attached is the ploughing drum, which must be unpacked as close to the boiler as possible, and levered into position underneath on skids or rollers, before being jacked up into its place. The holes in the top of the drum stud are drilled eccentrically to give an adjustment for the drum gearing, and care must therefore be taken when the drum is jacked up to see that the stud is coupled up in the same position as it was before dismantling. The boiler and drum stud are painted to mark this position.

STARTING AND RUNNING ENGINES

Before Lighting Fire—See that water is showing in the gauge glass and test the water gauge to make sure that this is showing the correct level. Sweep out tubes and smokebox. (This should be done regularly every day before starting work.) Attend to any leaky fittings.

Raising Steam—The steam jet in the chimney should be used with discretion. Its too frequent use may cause the boiler tubes to leak. See that the smokebox door is tightly shut.

Before Starting, see that all moving parts are properly lubricated and all oil cups and cylinder lubricator filled. Make a practice, while oiling up, of inspecting all bolts, nuts, and other parts which may shake loose. The early discovery of faults of this kind saves many breakdowns.

Feed Pump, Injector, and Water-gauge Cocks—These should all be tried before starting to see that they are in working order, the joints tight and valves working freely. (For further particulars see pages 17, 18, 26, 41, and 42.)

Starting—With **Compound Engines,** if the crank is not in the right position for starting either in forward or reverse gear, the auxiliary starting valve is used to admit steam to the low-pressure cylinder. Care should be taken not to keep this valve open longer than necessary, and it should only be used for starting purposes.

With **Single Cylinder Engines,** if the crank is on the dead centre and will not start in either forward

or reverse gear, the flywheel must be turned by hand to bring it into the correct position. This operation must be carried out with great care and with cylinder cocks open, as if there is any steam in the steam chest the engine is liable to start away quickly when moved off the dead centre.

Before putting in the road gear run the engine round slowly to see that everything is in working order and running freely.

Standing—When the engine is standing the reversing lever should always be left in the "mid" position.

Moving—When putting the road gear into mesh, see that the lever is moved right over so that the teeth are fully engaged, and always put the safety-pin into its place, so that the gear cannot disengage itself.

Water Level—The correct working level of the water in the gauge glass is shown by a plate on the firebox front. The water level must be carefully watched and kept approximately to this level by the use of the pump or injector.

Both top and bottom water-gauge cocks should be blown through from time to time, to see that they are quite free and register a true water level. This is done by opening the two cocks alternately and letting steam blow through the drain cock.

If the water-gauge glass breaks and cannot be immediately replaced, the water level can be ascertained by the use of the two try-cocks on the firebox front. The level of the water is obtained roughly by opening these for a moment to see whether steam or water is blown out.

If the water level falls below the gauge glass there is a risk that the top of the firebox will become uncovered and get overheated. If this occurs the plates are liable to become damaged through overheating, and the fusible safety plug in the firebox will melt and allow steam to blow out the fire.

Special attention should be given to the water level on hills. When **going up hill** the level rises above the top of the gauge glass, but, in spite ofthis, water should be fed into the boiler to replace that used up in steam, as it is advisable to keep the level up high enough to cover the front end of the boiler tubes and prevent them getting overheated.

When **going down hill** the boiler must be filled up sufficiently to keep the water level above the top of the firebox. The fire should be kept low to avoid blowing off. The engine must be kept in gear and the reversing lever used to control the speed of the engine.

Firing-up—A thin, bright fire should be kept for good steaming, and care taken to see that it is burning over the whole area of the grate—particularly round the sides. If any holes are left where the fire is not burning, it allows cold air to come in which interferes with steaming and is liable to make the tubes leak. Firing-up should be done in small quantities at a time and in accordance with the work the engine is doing. Too much smoke means bad firing and waste of fuel, and should be avoided.

Keep the fire thin by poking ashes through into the ashpan from time to time. After doing this, do not fail to rake the ashes out of the ashpan, as if left in they may go on burning and overheat the firebars.

The ashpan damper can be used to control the draught, and also if pressure gets too high the firehole door can be slightly opened, although this latter practice is not one to be employed while the engine is working, as it allows cold air to be drawn in directly on to the tubes and may cause leakage. The engine should not be allowed to blow off frequently nor should the pressure be allowed to drop too far below the working figures. Both of these effects give inefficient consumption and are signs of a poor driver.

Lubrication—Periodical attention should be given to all bearings and working parts while at work, to see that everything is properly lubricated and that nothing is getting overheated. (See page 31.)

Water Supply—The level of water in the tank should be watched and arrangements made for replenishment in plenty of time so that work is not stopped for lack of water.

Completion of Day's Work—When the engine is required for work on the following day, the fire may be banked up so as to keep the boiler warm and save time in getting up steam again in the morning. To do this the steam pressure should be brought right down and the boiler filled well up with water. The ashpan damper and firehole door should be closed and a plate put over the top of the chimney.

Frost—In frosty weather all pipes should be emptied of water to prevent freezing. If the engine has to stand in the open for some time, in winter, the boiler and tank should be emptied and all water emptied out of pipes, feed pumps &c.

MOVING TACKLES IN THE FIELD AND ON THE ROAD

The implements, van, and water cart are hauled from place to place by the ploughing engines. The usual practice is to couple the living van to one engine with the water cart behind it, and attach the plough to the other engine with cultivator or other implement (if any) coupled behind the plough. A special drawbar is fitted on all engines for hauling the plough, and a special pin hole is fitted on one of the plough bodies to which the cultivator drawbar can be attached.

The plough middle must be set level when travelling on the road, and the cultivator lifted as high as possible, and the catch lever firmly secured to the segment to prevent it slipping out.

The coiling levers on the engines must be fastened to the fore carriages to prevent them from fouling the hind wheels, and the drum fastened with the chain provided on the forecarriage to prevent it from rotating.

When passing stackyards or wooden buildings care must be taken not to emit sparks. The smokebox should be kept as free as possible from soot and ashes, the firehole door slightly opened, and some water put into the ashpan to extinguish any ashes falling through the firebars.

If the engine slips on hard ground, pavement, ice &c. some ashes, sand, sacking, or wood thrown under the driving wheels will probably help matters.

If the wheels slip on soft ground and the engine begins to bury itself, it must be stopped at once and the spuds put on the hind wheels. In some cases

the front wheels will refuse to steer the engine on soft ground, and then the angle irons must be attached to make them grip.

Sleepers or wooden bars should always be carried to assist in moving an engine over soft ground. If the engine has only partially sunk in, a wooden bar placed crossways in front of the driving wheel will often be enough to extricate it, as the next spud on the wheel will engage the wooden bar as it comes round and lift the engine out.

If the engine sinks so that it rests on the tank and ashpan, it will have to be jacked up and the wheels underbuilt with timber or large stones.

WORKING TACKLES IN THE FIELD

Setting Down for Work—Before the tackle arrives in the field to be ploughed the chargeman must decide on the best method of carrying out the work.

To secure good coiling of the ropes, it is advisable, if possible, when the field is not square, to start at the narrow end and work towards the wider portion.

It is always more economical to work a field in the way that will give the longest possible rope pulls, as less time is then spent in reversing at the ends.

Hilly fields should be worked, if possible, with the smokeboxes of the engines facing up hill, so as to leave plenty of water over the firebox and avoid priming.

It is also often necessary to choose the driest headlands for the engines to work on.

Apart from these considerations, the chargeman often has to work to instructions from the farmer as to the way in which the field is to be cultivated.

After it has been decided how the field is to be ploughed or cultivated, the engine nearest the gateway of the field is placed in its working position. A short length of rope is pulled out, sufficient to attach to the implement. The implement is then attached to the second engine, which hauls it across the field, at the same time unwinding the rope from the first engine. On arrival at the opposite headland the implement is uncoupled and the engine placed in working position. A length of rope is wound off the drum and attached to the implement, which is now ready for the first engine to pull back on its first working journey.

This is the quickest way of setting down, but in some land it is not always practicable. If this is so, and the second method is preferred, the leading engine in the train and the implement, turn into the field, and the implement is uncoupled. This engine takes up its position on the headland, and its rope is attached to the tank of the second engine, which travels across the field pulling out the rope. On arrival at the opposite headland the engine is placed in position and sufficient rope is unwound from its drum to couple to the end of the rope from the first engine. The ends of the two ropes are fastened together by a shackle, and the first engine winds up the rope belonging to it until the coupling shackle is fully up to the centre of the implement to be used. The rope ends are then unfastened and attached to the draft shackles of the implement.

Method of Working—After the plant is set into the field, work is started as follows.

The driver on the engine farthest from the implement runs his engine round slowly, and while it is in motion puts his ploughing clutch into gear. At the same time he must admit a little more steam to keep the engine moving under the heavier load. He continues to pull steadily, watching carefully all the time for signals from the ploughman, and opening the throttle gradually as the implement draws in to its work.

Some drivers prefer to run their engines in the reverse direction before putting in the ploughing clutch. They then bring over the reversing lever and engage the ploughing clutch just as the engine stops and starts to reverse in the opposite direction.

When ploughing, the whole of the first pull is usually taken steadily to allow the ploughman to cut a straight furrow. Afterwards higher speeds can be obtained.

When the implement comes up to the engine the driver slows down and pulls it gradually as close in to his engine as he can, so that the headland left is as narrow as possible. He then reverses immediately, drops out the ploughing clutch, engages the road gear, and runs forward.

This running of the engine forward is the signal for the driver on the opposite engine to start pulling, and the return bout begins at once.

The ploughman either swings the plough into a new width of work while holding it in the balance position, or else he pulls it straight down and steers it into the new work. In all cases the driver must pull very slowly and steadily until the implement is properly in work. The cultivator, for instance, has to be turned round, and if the driver pulls too fast he will easily upset it.

One reason why the driver, who has just finished pulling, runs his engine forward is to keep his rope out of the way of the implement. This is especially important in the case of ploughing where the rope may become caught between the skifes. As soon as the implement has started on its way he may have to move back again slightly to get into position for the next pull, and he then has time to attend to his engine, fill up with water, and fire up ready for the next pull. It is usually advisable to turn on the injector (or pump) directly after the engine has finished pulling, and so prevent it from blowing off, and to coal up shortly before beginning the next pull.

Care of Ropes—Before starting each pull the driver should make sure that his rope is properly coiled, as bad coiling at the bottom spoils the whole coiling of the rope on the drum and gives extra wear and tear both on the rope and on the engine.

Two brakes are provided to keep the tension on the rope.

The wooden brake on the drum should be adjusted to give just enough tension (and no more) to prevent the rope dropping out of position under ordinary conditions when it is running out.

The hand brake on the ploughing clutch lever is used just at the end of a pull to give extra tension if the rope is likely to fall in the last yard or two through uneven pulling by the other driver or rough ground. Displaced coils of rope can be levered up into place again with the crowbar provided.

Working Signals—Before commencing work a system of signals should be arranged between the drivers and ploughmen, so that the plough or implement can be immediately stopped when required. The following are the usual signals adopted—

One sharp short blow of the engine whistle means "Stop."

Two sharp short blows mean "Go ahead."

A long continuous blowing means "Coal or water required."

The ploughman holding his arm horizontally means "Go slower."

Swinging his arm means "Go quicker."

Holding both arms up means "Stop."

COMMON TROUBLES EXPERIENCED WITH STEAM PLOUGHING ENGINES

Priming, or the drawing of water into the cylinders together with the steam, is caused generally by dirty water in the boiler, and means that it requires washing out. It also occurs sometimes if the water level in the boiler gets too high.

When the engine begins to prime, the regulator must be throttled down at once and the cylinder cocks opened to allow surplus water to get out of the cylinders. Failure to do this may cause the cylinder covers to be blown off.

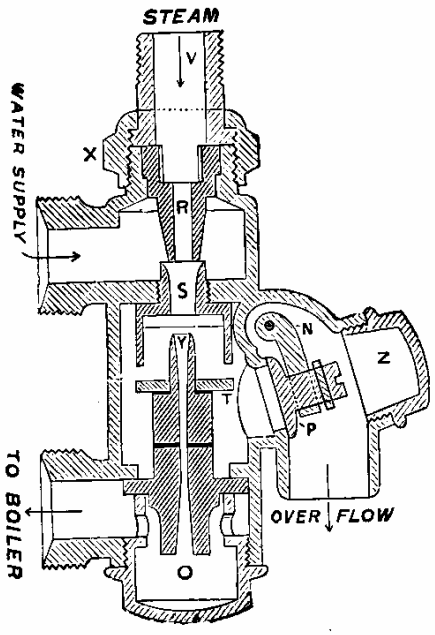
Overheated Bearings—Provided that bearings are properly lubricated there is no reason why they should run hot. It may be, however, that by the introduction of dirt or by too tight adjustment, a bearing will begin to run hot, and it then requires immediate and careful attention from the driver to prevent damage and further trouble. If adjusted too tight, the bearing should be at once slacked off, but not so much as to make it knock.

The use of heavy cylinder oil instead of ordinary oil, and the addition of some graphite or sulphur to the oil, all help to prevent overheating.

If the overheating is allowed to continue the brass in the bearing will begin to cut, destroying the surface of the bush, and once that has occurred satisfactory results will not be obtained until the bush is taken out and scraped up and refitted to the journal.

Injector fails to work—The driver should see to the following points, any of which may prevent it from operating—

(1) That there is water in the tank.



(2) That the tank strainer is not choked.

(3) That all joints and pipe couplings are tight, particularly on the suction pipe.

(4) That the injector cones are not partially blocked by grit and other foreign matter.

(5) That no steam leaks from the check valves in the boiler clackbox or the injector steam valve. A hot injector will not work.

(6) If the feed water is too hot the injector will not force it into the boiler.

Broken Gauge Glass—Shut off top and bottom water gauge cocks and fit a new glass. If no spare gauge glass is available, test water level from time to time with the try-cocks, until a new glass is available.

In renewing the gauge glass see that the rubber washers are not screwed down too tight. Should there be a slight leakage of steam at first, the rubber will soon expand with the heat and make a tight joint.

Warm the glass gradually by opening the top cock slightly and allowing the steam to blow through the glass, before allowing the full boiler pressure to come on to it, otherwise the glass will again break.

Boiler not Steaming properly or using too much Fuel—

(1) Boiler may be dirty and require washing out.

(2) Smokebox door may be drawing air, thus spoiling the draught.

(3) Exhaust nozzle may be furred up.

(4) Fire may be clinkered up or require cleaning.

(5) Ashpan may be full of ashes, and require clearing out.

Give these points careful attention, and if any fault is found, rectify immediately.

LUBRICATING OIL FOR FOWLER ENGINES

To get the best results from our engines it is essential that the right types of lubricating oils be used. Excessive wear and tear, and unnecessary expenditure in duplicate parts is the natural result from the use of inferior oil. We have come across so many cases in which our customers were being put to unnecessary expense on this account, that we decided to investigate the question of oils ourselves. After careful trial and extended tests under working conditions, we found a reliable series of oils which can be offered at a reasonable price, and arranged with the makers to put these brands on the market as **Special Fowler Lubricating Oils,** which we recommend our customers to use in our engines.

Fowler Special Quality Steam Cylinder Oil (Grade C) is a high-class cylinder oil suitable for use in engines working up to 180 and 200 lb. pressure (but not for Superheater Engines).

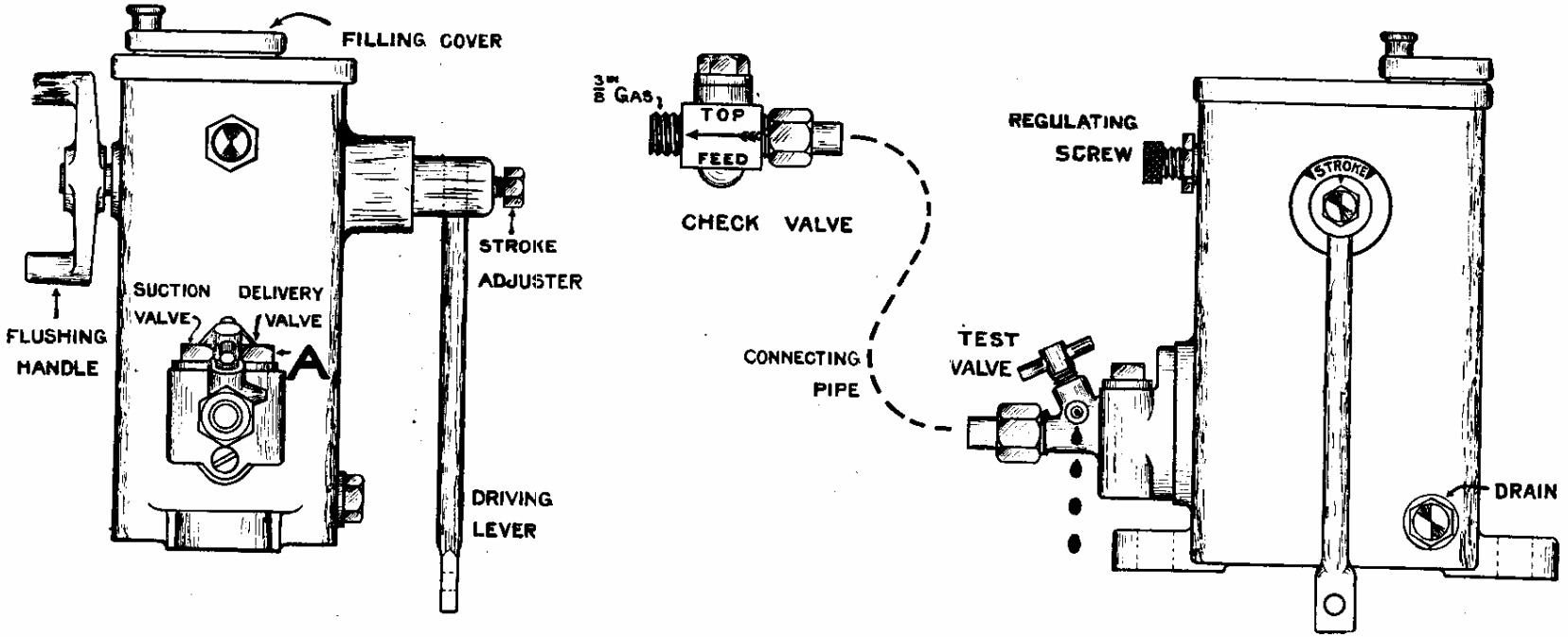
Fowler Special Quality Engine Oil (Grade S), for Summer Use, is an excellent all-round oil for engine bearings and all working parts; heavy enough to retain its viscosity in summer weather.

Fowler Special Quality Engine Oil (Grade W), for Winter Use, is a similar oil but rather lighter, for use in winter.

Fowler Special Quality Superheater Oil is a special cylinder oil suitable for maintaining efficient lubrication under the high temperatures obtained in Fowler Superheater Engines.

All the above oils are supplied in 40 gallon drums, delivered free to any station in Great Britain.

They can also be supplied in 5 or 10 gallon drums at an extra charge, carriage being paid on all orders of 40 gallons and upwards.



MECHANICAL CYLINDER LUBRICATOR

LUBRICATION

CYLINDER LUBRICATION

All new engines sent out from the Steam Plough Works now are fitted with mechanical cylinder lubricators, worked from the valve spindle, which pump oil continuously into the high pressure steam chest while the engine is working.

These lubricators give a more continuous supply of oil than the displacement type of lubricators, but as many engines are still working with displacement lubricators, a description of both types is given here.

From the valve face the oil is carried by the steam into the high-pressure cylinder, low-pressure valve chest, and low-pressure cylinder, so that all working parts are properly lubricated.

Mechanical Lubricator—In addition to the driving lever worked from the valve spindle, these lubricators are fitted with handles for hand-pumping the oil into the cylinder. It is advisable that, every morning before starting work, a certain amount of oil be pumped by hand into the cylinder to make sure that it doesn't start entirely unlubricated.

The amount of oil being delivered can be controlled by the regulating screw shown in the illustration and observed by opening the test valve.

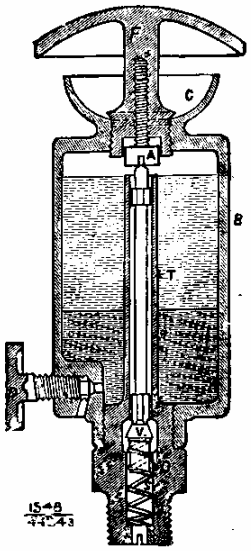
When first starting the lubricator, it should be worked by hand with the test valve open until oil comes out, and then the plug in the top of the check valve should be removed and pumping continued till oil comes out at this point.

In this way it is ensured that no air-lock or obstruction is preventing the delivery of oil.

Displacement Lubricator—To fill lubricator, first unscrew the drain screw "D" to allow condensed

water to be blown out. Then unscrew the cap "F" and fill with oil after replacing the drain screw "D."

When the cap is replaced it presses down the central spindle and reopens the valve "V," which admits steam to the top of the lubricator and drives the oil down the pipe by displacement. The oil-feed can be regulated by adjustment of the screw "A," which regulates the opening of the valve "V." The greater the opening of the valve, the more quickly does the oil run into the cylinder.



GENERAL LUBRICATION

When oiling up the engine it is advisable to have a regular sequence to keep to, as in this way there is no risk of anything being forgotten.

When the ploughing engine is at work in the field the most attention must be given to the ploughing mechanism, as this has the most work to do, but at the same time the travelling gear and shafts must not be forgotten, as bearings will cut if they are run when dry even if it is only to move for a few yards.

A common method of oiling is to start from the footplate and oil hind axle bearings, third motion, second motion, and crankshaft bearings, upright shaft bearings, ploughing drum bush and ploughing clutch strap, pump plunger, eccentric straps, and road gear change forks.

The crankshaft, big and little ends, crosshead guides, link motion, weighbar shaft, and valve spindle guides should be oiled and the cylinder lubricator filled up.

It is common practice to put a drop of oil on piston and valve rods and regulator spindle, to make them run easily in the glands.

The following have to be oiled from the ground—The hind road wheels (when travelling), coiling tappet die, rope guide pulleys, and front wheels.

Grease must be applied to all gearing from time to time to keep it well lubricated and prevent undue wear.

Worsted Trimmings—All oil cups should be fitted with worsted trimmings tied up with copper wire for syphoning the oil out of the cup into the bearing. The consumption of oil is regulated by the amount of worsted fitted, provided that it is not so tight as to choke the oil pipe.

To save oil, all trimmings should be taken out when the engine is stopped.

Big Ends—As the big ends are constantly rotating when at work, there is no need to syphon the oil into the pipe. For these oil cups, short worsted trimmings only are required in the oil pipe itself, leaving about $\frac{1}{4}$-inch of pipe clear above the top of the trimming. This ensures that oil passes through to the bearing only when the engine is running.

Running in New Engines—It is the greatest mistake to try and economise oil too much at the expense of the bearings of engines or implements. This is especially the case when the machinery is new and the bearings not properly run in.

POINTS REQUIRING PERIODICAL ATTENTION

Washing Out Boiler—It is advisable to wash out the boiler after every 100 hours of work more or less, but this depends upon the quality of water used. The life of the boiler and firebox, and freedom from leaking tube plates, depends largely on this being carried out thoroughly and regularly. To clean the water spaces round the firebox, mudholes are provided immediately above the foundation ring, and additional mudplugs are provided in the smokebox for cleaning out the boiler barrel, and above the firehole door for cleaning the top of the firebox. A strong force of water should be used from a force pump or hydrant, and a cleaning rod for loosening scale, care being taken not to damage the threads in the plug holes. Every possible care must be taken to remove all mud or deposit from the firebox plates, firebox crown, stays, and corners.

The boiler must not be blown off at a pressure of over 10 lb. or filled with cold water while hot. It is advisable when work finishes at night to allow the engines to cool down, so that they will be ready for cleaning in the morning.

Washing Out with Injectors—When the two engines are available, the injector from No 1 engine can be used for washing out No. 2 boiler, and vice versa. For this purpose a cock must be fitted on the injector delivery pipe and a short length of hose pipe with suitable nozzle attached.

The pressure of hot water supplied by the injector is very useful in washing out a boiler in this way, and under suitable conditions less time will be spent than if both engines are washed out together with cold water in the usual way.

Cleaning Inside of Boiler—The manhole in the side of the boiler barrel should have its cover removed twice a year, so that the inside of boiler can be examined and cleaned.

Fusible Plug—This should be examined when washing out to see that it is clean, so that the lead core is free to melt if the water level gets too low. Failure to attend to this introduces risk of boiler explosions.

The plug should be renewed every six months.

Washing Out Tank—If the water used is muddy a considerable amount of dirt will collect in the tank, causing stoppages in the feed-water pipe, injector &c. and making the boiler become dirty too quickly. This can be washed out when necessary by removing the handhole cover at the bottom of the tank.

Tubes—If tubes leak badly a tube expander must be used to expand them in the tube plate. When the tubes become old and have been expanded several times, further use of the expander does little good and ferrules are driven into them to keep them tight.

Exhaust Pipe—This must be kept clean and all carbon deposit cleaned out at intervals to avoid back-pressure in the cylinders.

Boiler Scale—If certain kinds of hard water are used in boilers, scale is formed on the plates, which injures the steaming capacity, and if allowed to get thick it is liable to cause overheating of the plates with serious results. Great care must be taken when washing out to remove scale, but if this cannot be done, a suitable boiler compound should be employed to remove it.

In cases of difficulty we are always pleased to advise users of our engines on the best boiler compounds to use for different conditions.

Packing Glands—There are many different packing materials on the market, all of which are satisfactory. On engines sent out from the Steam Plough Works, piston and valve rod glands are packed with "Silverite" metallic packing. On engines packed for export the packing is taken out of all the glands to avoid risk of rusting and pitting. A supply of "Silverite" is sent out with these engines for re-packing the glands on re-erection.

We keep supplies of "Silverite" packing in our Works, and are always ready to supply our customers with the least possible delay.

For regulator glands we prefer to use thick asbestos packing, while pump suction and delivery pipe glands are best packed with spun yarn.

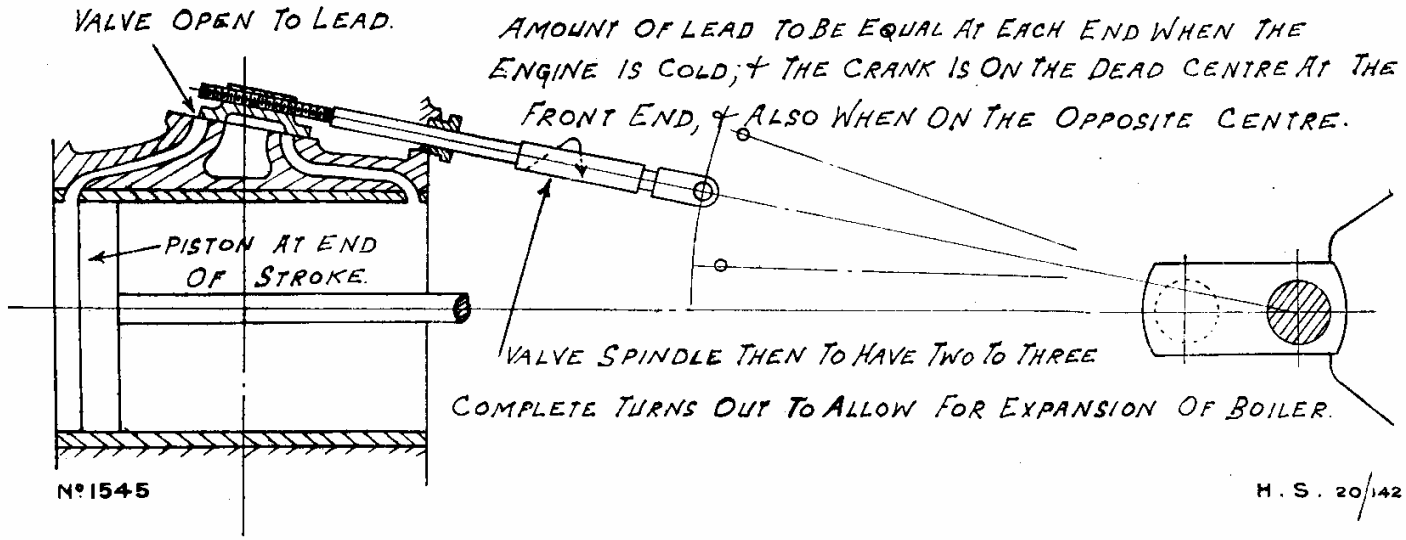
Setting Slide Valves—All engines leaving the Works have the slide valves correctly set. After the crankshaft brasses and eccentric straps have been adjusted for wear, the valves may require resetting.

Incorrect valve setting may easily be noticed by the uneven blast of the exhaust steam in the chimney.

To Correctly Set the Slide Valve when the Boiler is Cold—Put the reversing lever in the "full forward" gear and the corresponding crank on the "dead centre" at each end of the stroke, turning the crank in the running direction of the engine for that position of the reversing lever. Adjust the position of the slide valve on its spindle, so as to give an equal port opening at each "dead centre" of the crank.

Repeat these operations with the reversing lever in the "full back" gear, again turning the crank in the correct running direction for that position of the reversing lever.

Diagram For Setting Of Valves.



If the slide valve is correctly set, the port openings will be the same as in the "full forward gear."

If not, the eccentric rod must be lengthened or shortened to obtain this.

To allow for the expansion of the boiler when steam is up, screw the valve spindle outwards two complete turns—this will lengthen the distance between the valve and the crankshaft, and give correct valve openings under working conditions. (See diagram.)

How to Find Exact Dead Centre of Crank—A convenient way of doing this is as follows—

Shortly before the crank reaches its dead centre mark off on the slide bar the exact position of the crosshead, and at the same time mark the position of the flywheel to correspond with some convenient point on the boiler or flywheel bracket.

Then turn the crank forward until it is past the dead centre and the crosshead has reached exactly the same point on its return journey. Make a fresh mark on the flywheel to correspond with the same mark on the boiler. Divide the distance between the two marks on the flywheel equally and bring this central mark opposite the mark on the boiler. The crank will then be exactly on its dead centre.

Replacing Steam-Chest Cover—A spare joint ring cover should be available before the steam-chest cover is removed. Care must be taken in replacing the cover to tighten the nuts evenly all round. Start with the middle nuts on each side and tighten one by one towards the corners. When steam is up

again and the cylinder gets warm, these nuts will have to be tightened up again.

Cylinder Joints—To make a joint, proceed as follows. Clean the faces well and smear with a mixture of boiled oil and blacklead—this should be well mixed and spread thinly, care being taken that the whole faces are coated. On this lay the asbestos jointing material, which should also be smeared on both sides with the same mixture. The cover can now be replaced and secured, and the joints warmed through, and finally all the nuts well tightened. When removing the cover, care must be taken not to break the jointing sheet when inserting a tool—a thin chisel is best; the jointing sheet may be removed by inserting a knife between the face and the sheet, care being taken not to damage the material. The joint can thus be remade several times, using the same sheeting, it being only necessary to apply the blacklead and boiled oil each time on the faces and jointing material.

The cylinder joints should be made with asbestos sheeting, and the joints should be warmed through before the nuts are finally tightened up.

Safety Valves—These are carefully adjusted to blow off at the correct pressure before leaving the Works. For compound engines they are now set to blow off at 200 lb. per sq. inch. As the engines become old the working pressure must be reduced.

They should be examined frequently to see that they are working properly. On the Ramsbottom type this can be done by gently raising and lowering

the lever whilst the engine is under steam. This will allow the steam to blow past the two valves alternately and prevent them from getting furred up. It will also show that the valves return properly to their seats and do not allow steam to escape before the full blowing-off pressure is reached.

The same effect can be obtained on spring balance safety valves by tapping underneath the levers to allow the steam to escape momentarily.

On no account should safety valves be screwed down or weighted to allow a greater pressure in the boiler than its normal working pressure, or serious accidents may result.

It is advisable to insure all boilers and they are then periodically inspected by the insurance companies, and safety valves and pressure gauge are tested and adjusted.

Adjusting Brasses—Any wear of brasses should be taken up at the earliest opportunity to avoid knocking, but after adjustment special care should be taken to avoid overheating. Connecting rod brasses should be fitted to bear on the centre of the brass only and to clear at the top and bottom. The brasses should be let up solid, brass to brass, but to avoid risk of heating they should then be slightly opened, leaving a gap about the thickness of a piece of tin, but not to allow any knocking. This adjustment can be made after the brasses have been fitted up again by gently tapping back the cotter pin with a hammer. Care should be taken to see that oil holes are free and not stopped up.

When packings are fitted behind brasses to take up wear they must be put on both sides of the brasses to avoid altering the alignment of the shaft.

Pistons—Steam blowing past the piston rings is indicated by an irregular exhaust. The piston rings should be taken out and cleaned from time to time, and, if worn, replaced by new ones.

To Test for Steam Leaking Past the Pistons—The cylinder cocks must be disconnected, and, if the engine is a single-cylinder one, the crank must be put on the "dead centre" nearest to the driver, the reversing lever put in the "forward gear," and the front cylinder cock opened. On gently opening the regulator, if the piston rings are leaking, steam will come out of the open cylinder cock. If the piston rings are tight, little or no steam will appear.

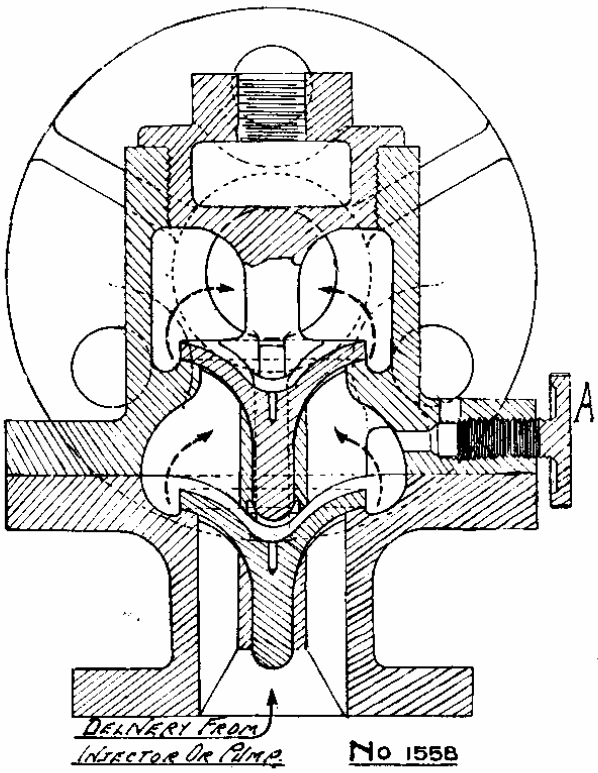
The operation should then be repeated for the opposite end of the cylinder as a check.

With a compound engine the procedure is similar, but for the low-pressure cylinder the starting cock is used to introduce the steam instead of the regulator.

Injector—The standard type of injector fitted is the Penberthy. With hard water a deposit is sometimes formed on the cones of the injector, and it will not work properly until these are taken out and cleaned.

When injector cones get worn with use they cause a continuous dribble from the overflow while working. They should then be renewed to avoid further trouble.

Boiler Clackboxes—The design of the Fowler twin-valve clackbox is shown in the accompanying illustration. When any signs of leaking past the valves are evident, the first opportunity should be



taken of regrinding the seatings. The bottom valve can be uncoupled and re-ground while the boiler is under steam, provided that the top valve is tight. The milled head screw "A" is fitted to test whether the top valve is tight before uncoupling the joint at any time.

Feed Pump—See that the strainer is free from dirt, and that all pipes, joints, and couplings are tight. Take out the valves occasionally and clean them. Always tighten gland nuts up equally to ensure plunger working freely; keep the pump plunger well oiled, as the pump is always running. If there is an air lock in the pump, open and close the pet cock repeatedly to allow the air to escape. Opening of this cock will also show if the pump is working. Keep pump barrel cool, as if it is too hot the pump will not work.

Steerage—Do not allow the steerage chains to get too slack, as this is liable to cause breakages on rough roads.

Water Lifter—These are fitted on engines when required for filling the tanks from rivers or tanks on the ground. When using these care should be

taken to regulate the steam so that as little as possible is used to do the work efficiently. The object is to keep the water in the tank as cool as possible, as if it gets too hot the injectors will not deliver it satisfactorily into the boiler.

The action of a steam water lifter is on the same principle as an injector. A jet of steam is used to cause a partial vacuum in the lifter and suction pipe and draw the water up into the tank.

Care should be taken to prevent sand and dirt being drawn up into the pipe with the water. When taking water from a stream or ditch the strainer on the end of the suction pipe may be placed on the firing shovel to keep the mud away from it.

Likely causes of failure to lift—

(*a*) Suction pipe blocked with sand or dirt.

(*b*) Air drawn into the suction pipe, either through a worn pipe or through a bad connection between water-lifter coupling and suction pipe.

(*c*) The use of too much steam causing the water lifter to become overheated.

(*d*) Water too far away from the engine or at too low a level. The vertical lift possible with a steam water lifter is not more than 20 or 25 feet.

The water lifter may be easily started by placing the suction rose in a bucket of water and lifting the bucket up to about the height of the water lifter.

INSTRUCTIONS FOR WORKING FOWLER'S LIQUID FUEL APPARATUS

The general arrangement of the Oil Burning Apparatus is shown by the accompanying diagram.

The following information should be carefully studied and followed by drivers and others in charge of the engines.

Filling Oil Tank—Before filling the oil tank, be sure that the strainer "K" is in its proper position, and if for any reason this strainer is taken out, it should be replaced at once, as any grit or sediment in the tank is likely to block up the injector. Another reason for keeping the strainer in position is to avoid any explosion which might be caused by holding a light too near the oil tank and igniting the accumulated gas; the explosion would then be confined within the strainer, but if the strainer is not in its proper place, all the gas in the tank would be ignited and a dangerous explosion might ensue.

Working—The fire must be lighted in the usual way with wood or coal, and fired until a steam pressure is generated of about 20 lb. per sq. inch; the remaining fire should then be pushed well back on the grate bars away from the firehole door, and the bars completely covered with a thin layer of broken firebricks or lump limestone broken into about 2-inch pieces, keeping the base thus formed thinnest about the centre of the grate. Spread these pieces over the firebars so that no large openings are left through which an excessive supply of air would pass; at the same time, however, they must be spread so that sufficient air is allowed to pass through to ensure proper combustion. Black patches over the grate denote the access of too much air. To start the

oil fuel injector, the cock "A" nearest the tank must be turned on, the valve "B" closed; the steam valve "C" for the injector must then be opened and the oil supply regulated by the valve "B." In a few seconds the oil will be injected into the firebox and it will be ignited by the remaining fire at the back of the firebox. Should, however, the fire have completely burnt out, and nothing is left in the firebox to ignite the oil, a piece of greasy waste or any such inflammable material can be thrown in for this purpose. In regulating the oil supply, the regulating valve "B" should be opened sufficiently to burn the oil without emitting much smoke from the chimney. When there is no exhaust blast in the chimney, the jet cock may be turned on a little so as to create a current of air through the firebars to ensure proper combustion.

Oil and Steam Regulation—The arrangement of the parts for regulating the steam and oil supply is also shown.

The steam and oil are controlled by the one hand lever "D" which works on a quadrant (a half turn giving a full opening), and the driver can readily see how much the oil valve is open.

Coupled to the regulating valve "B" by the rod "L" is the steam valve "M"; this steam valve supplies the necessary steam to the burner, and the amount of opening can be regulated by the adjustment on the rod "L," and also by the position of the pin "N" in the lever on the valve. Sufficient steam to throw the oil in a partially sprayed form over the grate is all that is necessary. By this arrangement the driver can easily make his adjustments for the necessary amount of oil and steam, and can then go on the whole day ploughing by the simple movement of the one lever "D."

Cleaning—If the oil has a tendency to run into the ashpan, this will probably arise from two reasons—

First, the injector "E" may be stopped up, thus allowing any drippings from the injector to run down the firebox front instead of being injected into the firebox; this can be remedied by cleaning out. The other cause would be some obstruction in the path of the oil jet, i.e. a piece of broken stone projecting too high above the firebars on which the oil impinges before being properly vaporised and ignited. Should the oil be not injected freely into the firebox (there being a sufficient supply of oil in the tank, and the injector "E" in proper working order), this may arise from the oil being too thick, in which case the warming coil "J" in the tank must be used. This can be started by opening the valve "F," and also the cock "O," allowing steam to enter the warming coil. The small cock "H" at the end of this warming pipe is provided to allow the condensed water to escape, and this must be left slightly open to allow the water to drain out freely. It may be necessary from time to time to clean out the injector, and to do this the "Cleaning Out Cock" "G" must be used. First close the cock "A" and open the valve "B," then blow steam at full pressure through the oil pipe and injector "E." By opening the valve "F," and the cock "G," any sediment &c. will be blown through into firebox, thus clearing the passages thoroughly. Next turn off the regulating valve "B," and turn on the cock "A" next to the oil tank, and repeat the operation; this will blow through the remainder of the pipe back into the oil tank. A drain cock "P" is provided for emptying any water out of the oil tank which may collect.

Note—In no case must the liquid fuel apparatus be worked without the firebrick arch in the firebox, as such a proceeding would damage the firebox plates.

ROPES AND COILING GEAR

Correct rope coiling is most essential both to prolong the life of the rope and prevent shocks and vibration, which damage the engine and gearing. Serious accidents can also be caused by bad rope coiling.

To Set the Coiling Lever when putting on a New Rope—The drum must first be set with the rope hole opposite the front axle; the tappet wheel must then be set with the die or tappet at the lowest part of the tappet wheel, and the coiling lever at right angles with the rope hole, that is, the coiling lever must be between the front and hind road wheels, which then gives the drum a quarter of a revolution lead of the coiling lever. The coiling lever must be set with the top of the bottom pulley level with the top face of the bottom flange, care being taken that the stop lever is about the centre of the quadrant, where it must be made fast. The drum must then be turned a quarter of a revolution until the rope hole is opposite the lever, and the rope must be taken through the hole and over the spoke, following the hole in the direction in which the drum has to work, where it must be made fast (this avoids the bend of the rope being too sharp). Care must be taken that the rope is started at the bottom of the drum. The rope must then be carefully coiled tightly on for the first lap, with the coils close together, leaving a clearance above the top coil, because the first coil of the second lap has to lie above the last coil of the first lap. If this is carefully done the rope will coil automatically and without trouble.

Irregular Coiling—Should the rope coil badly when ploughing, it should be pulled off the drum by

the other engine and re-coiled, the engine being drawn back across the field in order to give the necessary resistance.

Putting On New Ropes—The greater the strain with which a new rope is wound on to the drum the better.

If the innermost coils are wound on slack they will spoil the coiling of the layers above them, and also the rope itself will become damaged.

New ropes are usually delivered wound on steel reels. The other engine is used to pull out the new rope off the reel until the whole length is laid out straight across a field or along a road. The near end is then fastened on to the drum of the engine in the manner described above, and the engine starts to wind the rope in under tension, the second engine being used as the load to keep it tight, great care being taken meanwhile to see that it coils correctly. Two laps should be wound on to the drum before the tension is applied to prevent the rope from being pulled off the hook bolt inside the drum. Should the lead of the rope from the pulley box on to the drum be too high or too low, the level of the pulley box can be adjusted to make it right.

Should the coiling gear be set too early or too late, so that the rope does not start naturally to coil each new lap, at the top and the bottom, at the right time, adjustment can be made by altering the position of attachment of the stop lever on the quadrant on the side opposite to the coiling lever.

Ropes sent abroad are not wound on reels, and when this is the case care must be taken in handling to prevent the rope springing out when it is unfastened and becoming tangled. A good method is to get a plank of wood and make a 2-inch hole in the middle

of it. Place the plank on the ground and lay a water-cart wheel or ordinary cart wheel on it; with the axle hole over the hole in the plank. Then put the coil of rope on the wheel and put another wheel on top of the rope. Drive a strong iron bar through the axle holes well into the ground, and in this way the two wheels act as an extemporised reel from which the rope can be unwound.

Drum Brake—This should be oiled and correctly adjusted, so that the tension is not too great when the rope is being unwound, and yet it must be sufficient to prevent the rope coils from falling slack before they leave the drum.

Drum Bush— If this becomes worn it must be replaced or irregular wear on the drum gearing will result.

Instructions for Splicing Lang's Twist or Ordinary Twist Steel Wire Ropes—The difference between Lang's and Ordinary Twist Ropes is in the direction of twist of the wires forming each strand, the strands themselves are twisted in the same direction in each case. A length of each kind can be spliced together as easily as two lengths of the same rope. Ropes usually employed in steam ploughing have six strands, but a five-strand rope is sometimes used, and can be spliced quite as well as a six-strand one.

There are two or three ways of commencing to make a splice. The simplest method is described.

(1) The strands of each rope are unlaid for about ten feet. The rope should be bound with twine to prevent unlaying any further, and the core of the rope that has been unlayed cut off and the strands laced, as shown in Fig. 1. To do this one man

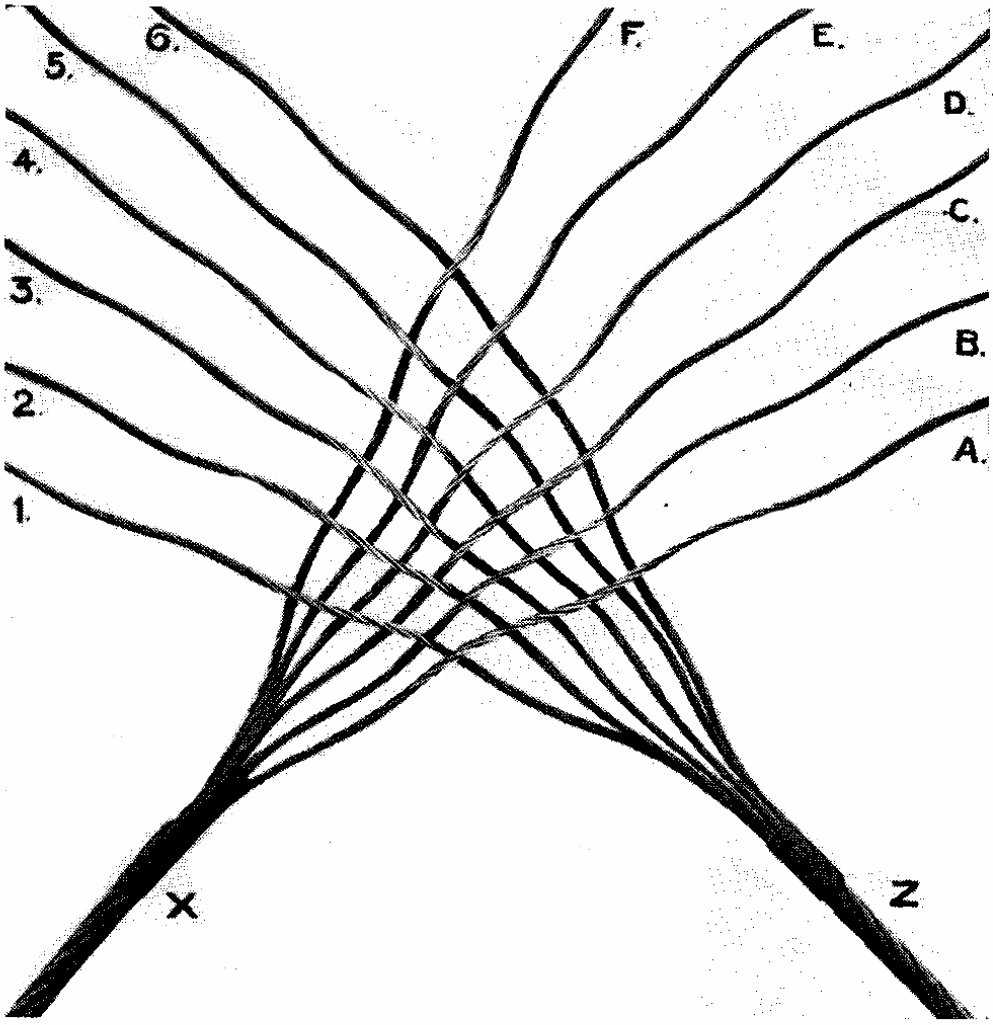


FIG. 1

holds rope "X," with the strands spread out flat, taking great care that they are in proper order. Another man now takes rope "Z," and puts strand 1 between strands "A" and "B," strand 2 between strands "B" and "C," and so on with the remaining strands. The putting of the strands together is exactly the same as the locking of the fingers of a man's hands.

(2) When the strands of each rope are properly interlocked, the two ropes must be pulled together tight and kept so until a strand on each side has been laid in. The process of laying in consists in

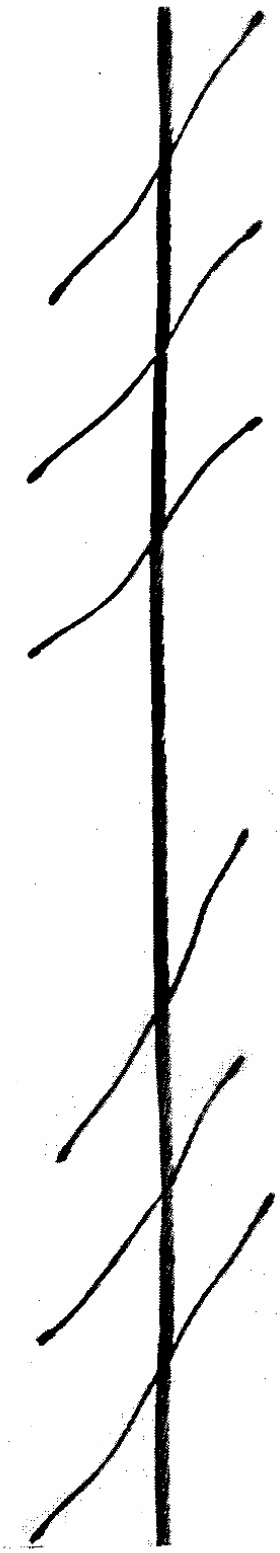


FIG. 2

laying one strand from one of the ropes into the opposite rope in place of the corresponding strand of the opposite rope which is unwound for the purpose. Thus if the strands "Z1" and "XA" in the illustration are taken, the two ropes are pulled up together and held there, then the twine binding is taken off rope "X" and the strand "XA" unwound, the strand "Z1" being brought forward to lie in the groove that it leaves. The next strand is laid in the opposite direction, i.e. strand "XB" would be laid into rope "Z," strand "Z2" being unwound for the purpose.

(3) The first strand laid in in this way is carried on for about 8 feet from the joint, the second for about 6 feet, and the third about 4 feet. All the protruding ends are then cut off to about 12 inches long and bound with twine, and the joined rope will then appear as in Fig. 2. The proper length to cut off each strand will be found by laying it along the rope and making sure that when it is turned in to the centre it will not quite meet the succeeding strand, which has to be turned in from the opposite direction.

(4) The ends must now be turned in to the middle of the rope,

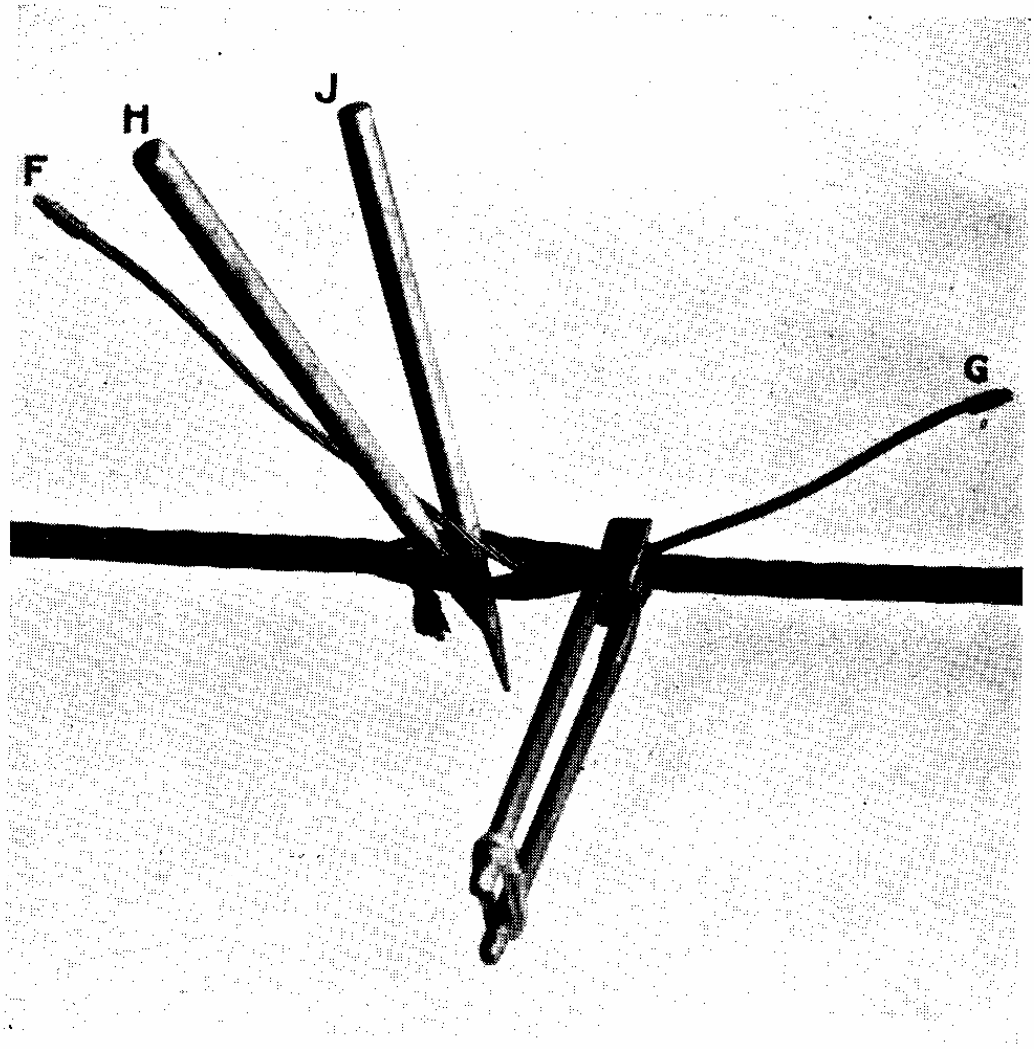


FIG. 3

the hemp core being forced out of its place to make room for them as the work proceeds. Take two marlin spikes, which are supplied with the outfit, and drive one of them through the centre of the rope as in Fig. 3. Then put the other spike "J" into the opening, but not driven so far in, and place the end to be turned in between the spikes. Cut the hemp core of the rope and pull the end out below the opening as shown. Then stand astride the rope on the side away from the end to be turned in, hold the spikes in the two hands, and bring the tops together until the strand slips

down into the centre of the rope. Now withdraw the spike "J" and work the other round so as to force the strand progressively into the centre of the rope, pulling out the hemp core on the other side as the work proceeds. The same operation is performed on the remaining strands. A pair of tongs, if available, can be used as shown, otherwise the strand "G" is laid across the right leg, which will serve the same purpose.

If a wire is broken in a strand you are running in, it must be bound with twine so that it cannot work out, or trouble will soon arise.

Should the rope require hammering into shape, care must be taken if a steel hammer is used. A wood mallet is a much better tool.

APPROXIMATE CALCULATION OF ACREAGE

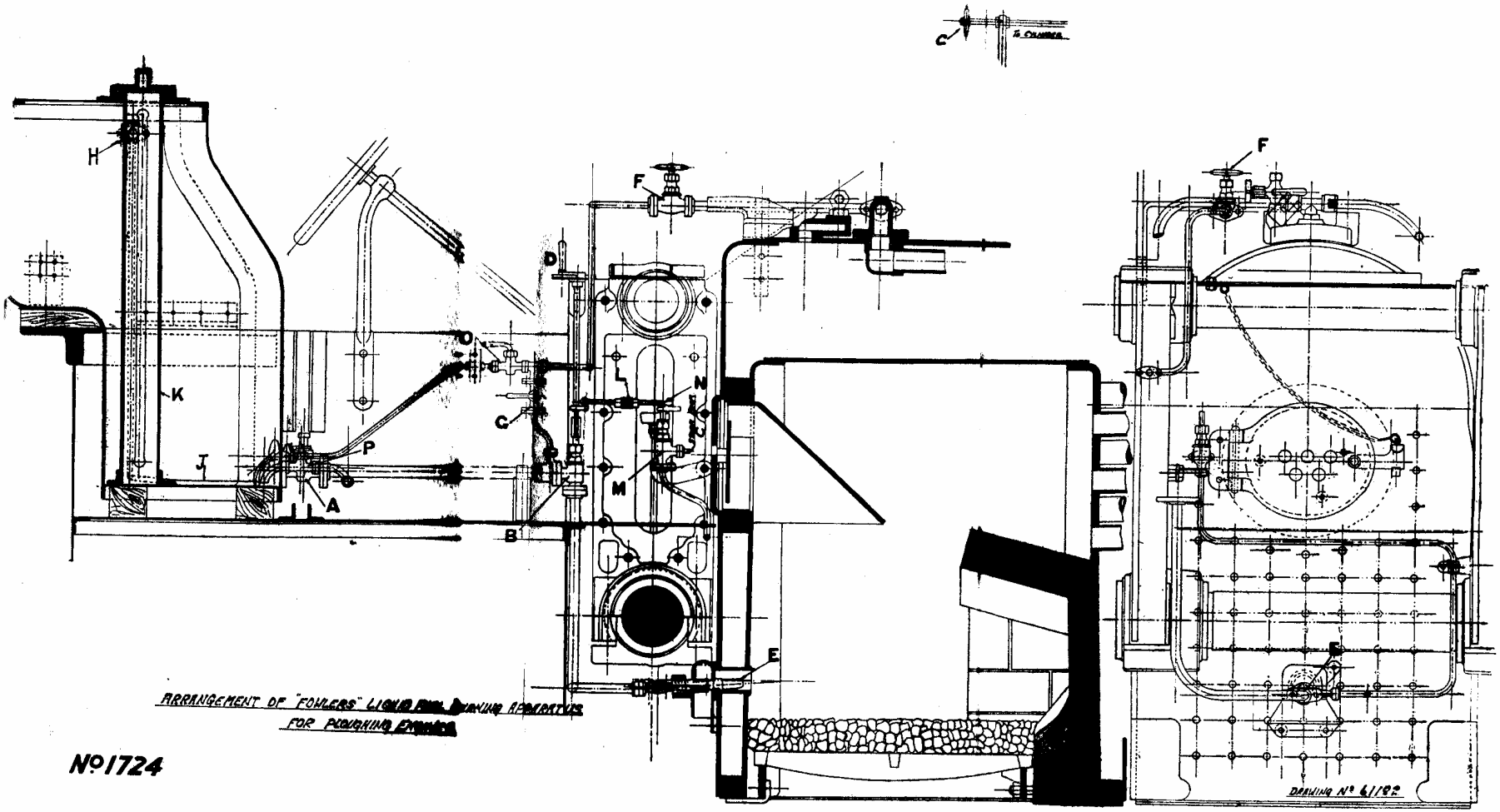
Length in Yards	Width in Yards											
	50 Yards			60 Yards			70 Yards			80 Yards			90 Yards			100 Yards		
	A.	R.	P.	A.	R.	P.	A.	R.	P.	A.	R.	P.	A.	R.	P.	A.	R.	P.
100	1	0	5	1	0	38	1	1	31	1	2	24	1	3	18	2	0	11
150	1	2	8	1	3	18	2	0	27	2	1	37	2	3	6	3	0	16
200	2	0	11	2	1	37	2	3	23	3	1	9	3	2	35	4	0	21
250	2	2	13	3	0	16	3	2	19	4	0	21	4	2	24	5	0	26
300	3	0	16	3	2	25	4	1	14	4	3	33	5	2	13	6	0	32
350	3	2	19	4	1	14	5	0	10	5	3	6	6	2	1	7	0	37
400	4	0	21	4	3	33	5	3	6	6	2	18	7	1	13	8	1	2
450	4	2	24	5	2	13	6	2	1	7	1	30	8	1	19	9	1	8
500	5	0	26	6	0	32	7	0	37	8	1	2	9	1	8	10	1	13
550	5	2	29	6	3	11	7	3	33	9	0	14	10	0	36	11	1	18
600	6	0	32	7	1	30	8	2	28	9	3	27	11	0	25	12	1	23

USEFUL FIGURES

144 sq. inches = 1 sq. foot
9 sq. feet = 1 sq. yard
$30\frac{1}{4}$ sq. yards = 1 sq. rod, pole, or perch
10 chains × 1 chain = 1 acre

40 perches = 1 rood
4 roods = 1 acre
640 acres = 1 sq. mile
220 yards × 22 yards = 1 acre

10 sq. chains = 1 acre
4840 sq. yards = 1 acre
1 chain = 22 yards



ARRANGEMENT OF "FOWLERS" LIGHT [illegible] DRAWING APPARATUS
FOR PLOUGHING ENGINES

No 1724