

that the trench has to be filled up as the work proceeds, either from the nature of the ground or the exigencies of the site. The architect should of course aim at getting the greatest amount of fall from the sewer to the junction with the branch drain of the house, keeping in view that these should themselves have quicker gradients than the main drain.

A fall of 1 in 48, or half an inch to a pipe, is a very good one for a main drain; but it sometimes happens that this cannot be obtained; nay, I have myself had to lay them nearly level, but in such cases special flushing arrangements are absolutely necessary. The usual system pursued by the "honest bricklayer" is to start from the main sewer, and lay each pipe to a fall by a straight-edge, with a piece of wood planted on each end. The size of this piece is determined by some rule, no doubt—probably the rule of thumb—a rule, I need scarcely say, of very wide and universal application.

By means of the above-named implements the drain gradually rises toward the house, but whether it hits the exact level, or falls below it, or is a foot or two higher, Providence alone can determine; at all events, I may say it is not so certain to work out right as were the two driftways through Mont Cenis.

It not seldom happens that if the workman finds that he has made a bungle, and has got too high, he either carries his drain on a level or actually dips it the wrong way. And what does the architect do? He sees the end of the pipe at the proper level, and all the rest carefully covered up, and probably assumes that all is right.

There is another internal defect arising from this way of laying pipes; they are laid by the flanges, and the inverts, which are of primary importance, are left to take care of themselves. I have never seen, outside of my own practice, house drains laid by their inverts; but I consider this should, where the fall is limited, always be done. It is readily done, but the drain layer has to be taught, and it is a good deal of trouble to teach him, but no more than I hope any architect interested in the perfection of his work would undertake.

The method of proceeding is by fixing slight rails at the

Calcium sulphate.....	79.56
Calcium carbonate.....	5.05
Ferric oxide.....	1.53
Aluminic oxide.....	1.02
Magnesium oxide.....	5.34
Water and organic matter.....	7.75
Sodium and potassium.....	trace
Phosphoric acid.....	absent
	100.25

3. An extremely hard residue, three-eighths of an inch thick, taken from a tubular boiler at Heeley, near Sheffield, the water used being pumped from a well. It was very difficult to powder, but was entirely soluble in aqua regia. The cake in places showed minute specks of metallic iron; these were afterwards dissolved out by iodine solution. A large percentage of ferric acid exist in this incrustation. The following is the complete analysis:

Calcium sulphate.....	37.06
Ferric oxide.....	38.98
Aluminic oxide.....	1.62
Organic matter and water.....	8.80
Magnesium oxide.....	10.36
Carbonic acid.....	2.58
Metallic iron.....	trace
Sodium and potassium.....	trace
	99.40

—Chemical News.

NEW IRISH MAIL STEAMERS.

For some years, says the *Engineer*, a large traffic has been carried on between England and the South of Ireland by way of Milford and Waterford, steamers being run between these ports by the Great Western Railway Company. Last year the London and Northwestern Railway Company put new and splendid express boats, the *Rose* and *Shamrock*, built by Messrs. Laird, of Birkenhead, to run between Holyhead and Dublin; and the Great Western Company, deter-

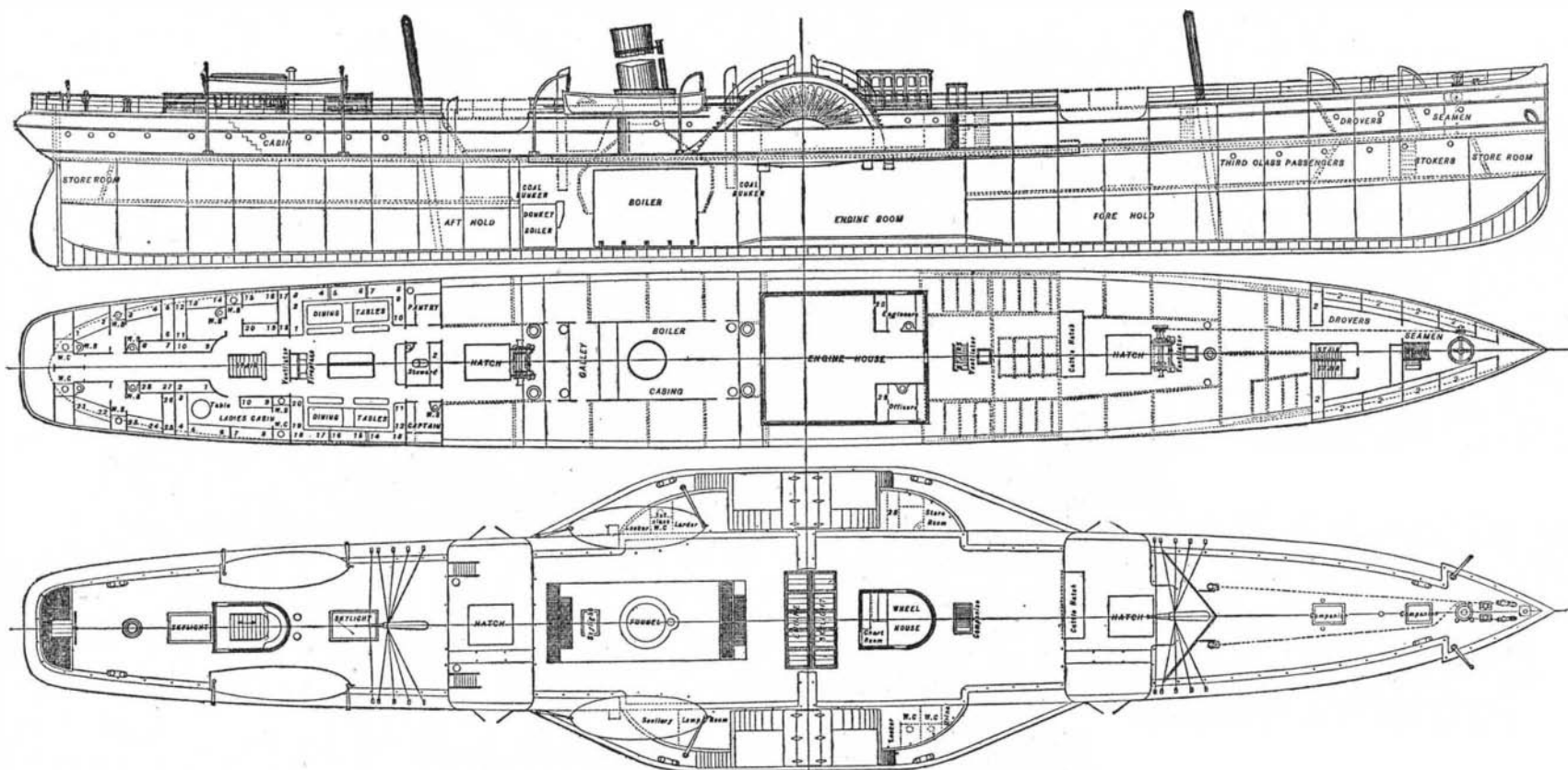
DISCONNECTING COMPOUND ENGINES.

WE give engravings showing engines for driving twin screws, the perspective view having been prepared from a photograph of engines lately made by Messrs. Rankin & Blackmore for the twin-screw tug-boat *Otter*, belonging to Messrs. John Laird & Sons, of Port-Glasgow.

The complication entailed by the ordinary arrangement of two cylinders to each shaft has hitherto deterred the owners of twin-screw tug steamers from adopting compound engines notwithstanding the advantages of these engines in other respects, but by Mr. Rankin's plan the compound system is rendered available without involving any more complication than the use of ordinary single-cylinder engines. As will be seen from our engravings there is in Mr. Rankin's engines but one cylinder to each screw shaft, the high-pressure cylinder being placed over one shaft and forming with its connections a purely non-condensing engine, having neither condenser nor pumps, while the low-pressure cylinder stands over the other shaft, from which the air, circulating, bilge, and feed pumps are worked. The surface condenser is situated between the two engines, but is of course connected to the low-pressure engine only.

In the engines of the *Otter* the cylinders are 13 in. and 24 in. in diameter respectively, the stroke in both engines being 20 in. Both cylinders are fitted with expansion valves which cut off at from $\frac{1}{4}$ to $\frac{1}{2}$ of the stroke to suit the variations of power required, an important point in a towing vessel. The valves are also useful for enabling the power developed in the two engines to be equalized and the two propellers to be thus driven at the same speed. The engines drive two propellers each 6 ft. in diameter, and to keep these propellers within the lines of the vessels they are slightly overlapped, working through a screw space formed in the ordinary way. This arrangement enables the tug to be brought alongside a wharf or other vessel without risk of the screw blades striking.

When the engines are connected and working in the ordinary course (that is placed in communication by their steam connections, the two shafts not being connected in any way)



DIAGRAMS OF THE NEW IRISH MAIL STEAMERS.

two ends of the drain, and sighting a boning rod, with a T piece at the top and a bent piece of iron or shoe to fit on to the invert at the bottom. This of course usually involves a correct system of levels and bench-marks, with the depths figured on the drawing.

The joints should in all cases be made in cement; half Portland cement and half sand is a good proportion, and special care should be taken to scrape out the cement on the inside of the joint so as to leave as perfect a tube as possible, free from lumps and obstructions. I need scarcely say half-bricks should not be left in the pipes, but I have not unfrequently found them there.

ANALYSIS OF BOILER INCRUSTATIONS.

By EDWARD FRANCIS.

1. A BROWN cake, half an inch thick, from a small egg-end boiler, using water drawn from the southwest face of the Anticlinal of Brimington in the middle coal measures. The incrustation was hard, only partially soluble in HCl (the solution being red), and nearly completely soluble in aqua regia.

The complete analysis shows—

Calcium sulphate.....	75.65
Silica.....	5.64
Ferric oxide.....	4.71
Magnesium oxide.....	4.85
Loss on ignition (water and organic matter).....	8.61
Phosphoric acid.....	trace
Sodium and potassium.....	trace
	99.46

2. A very gray cake, about three-eighths of an inch thick, readily pulverized, a portion taken up by water. This was obtained from a boiler fed by water from the Sheffield Water Company's mains. The aqueous solution contained CaMg and H₂SO₄. It was not entirely soluble in HCl, the solution being of a pale yellow color. The subjoined analysis leads to the inference that the water was permanently hard, and that it had little action upon the iron of the boiler.

mined that the rival company should not get more than their fair share of the traffic, have now put on improved boats between Milford and Waterford. These boats have been built and engined by Messrs. Simons, of Renfrew. They are three in number, and identical in all respects, except their names, which are *Milford*, *Waterford*, and *Limerick*. They are 1,000 tons burden, and fitted with compound inclined engines, 400 horse power nominal.

The quickest passage on record was made on May 27th, between Waterford and Milford, by the *Limerick*, Captain William Pearn. The *Limerick* left the Waterford quay at 5 P.M., and arrived at the pontoon, New Milford, at 11:45 P.M., thus accomplishing the distance in 6 hours and 45 minutes, which is less time than was ever known before.

BERLIN PNEUMATIC DESPATCH.—The proposed pneumatic despatch line in Berlin will have 26 kilometers of tube, and 15 initial stations. The wrought iron tubes have a clear breadth of 65 millimeters, and lie about one meter below the surface of the ground. The letters and cards which are to be forwarded have a prescribed size, and are enclosed in iron boxes, or cartridges, each of which can hold 20 letters or cards. In order that they may pack closely, they are covered with leather. From 10 to 15 cartridges are packed and forwarded at a time; behind the last cartridge is placed a box with a leather ruffle, in order to secure the best possible closure of the tube. At four of the stations are the machines and apparatus needed for the business. The forwarding of the boxes is effected either through compressed or rarefied air, or through a combination of the two. Steam engines of about 12 horse power are used for the condensation or exhaustion of the air. Each main station has two engines, which drive a compressing and an exhausting apparatus, the steam for each engine being furnished by two boilers. Large reservoirs are employed both for the condensed and for the rarefied air. The former has a tension of about three atmospheres; the latter, of about 35 millimeters of mercury. The air, which is heated to 45° C. by the compression, is cooled again in double-walled cylinders which are surrounded by water. The boxes travel at 1,000 meters per minute; a train is despatched every 15 minutes. Each circuit is traversed in 20 minutes, including stoppages. The cost of the enterprise will be about \$300,000.

the high-pressure engine exhausts into the low-pressure engine, which in its turn exhausts into the surface condenser in the usual manner. But when the engines are disconnected and working separately for the purpose of manœuvring the vessel in harbors, &c., the high-pressure cylinder exhausts through the receiver safety valve—which is loaded to 15 lb. per square inch—direct into the waste-steam pipe. On the other hand, when the low-pressure engine is used alone, the steam is admitted to its valve casing through a reducing valve which is loaded to 16 lb. per square inch, the exhaust steam passing into the surface condenser as usual.

In the case of the *Otter*, to prevent the engine from sticking on the center, the makers fitted each screw shaft with balanced flywheels, as shown, these flywheels being provided with suitable tripping gear. In practice, however, this has been found almost unnecessary, and we believe that further experience will fully confirm this. The great secret in handling single engines is never to use the throttle valve, but to stop and start them by the reversing lever alone; if this plan be followed it is but very rarely that an engine will stick on the centre, and it will be found that it can be stopped, started, or reversed promptly and easily.

The engines of the *Otter* have we hear proved perfectly successful, and Messrs. Rankin & Blackmore have now other pairs in hand for other boats, one pair being of double the power of those supplied to the *Otter*. Although so far these engines have been applied only to tug-boats, yet they are undoubtedly applicable to larger vessels, and they possess advantages which recommend them for adoption on board trading steamers, one of the chief of these advantages being that either engine can be conveniently worked independently in case of a breakdown.—*Engineering*.

IMPROVED TUG STEAMERS.—Messrs. Howden & Co., Glasgow, now supply improved tug steamers, having two propellers, one at bow and one at stern; immersion to which is given by a novel and suitable formation of the hull, both propellers being larger than could be fitted in the stern of an ordinary screw steamer of same displacement. The effect of this arrangement is to give two large and independent columns of water for resistance, and a hauling power double that obtained from a paddle, single, or twin screw steamer with the same expenditure of engine power.