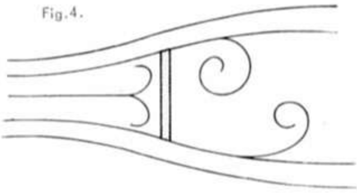
Fig. 3.

Fig. 4.



girders, 27 feet 6 inches in depth, were used for stiffening and in all some 16,000 tons of steel went into the construction.

The Verrazano Narrows bridge, carrying 12 traffic lanes between Brooklyn and Staten Island, was built between 1959 and 1965 with a span of 4,260 feet, at present the longest span in the world.

Britain's Severn Bridge, 7th in the world, was begun in 1961 and finished in 1966 at a cost of £8 million. It is the lightest for its length and load ever built but what makes it more important is its revolutionary design. Spanning a mile of river, the bridge has a main span of 3,240 feet and side spans of 1,000 feet. Choice of site was difficult and mainly governed by the lack of solid foundations in the area where the bridge was needed—to link up the motorways planned for the area. At the final choice of site the tides are faster than anywhere else in Britain, with a rise and fall of more than 40 feet.

Foundations for the western pier had to be sunk 45 feet below water level but the eastern pier was built on solid rock, only four feet down. The story was repeated with the cable anchorages: on the west shore the anchorage was built on sand after going down 60 feet, while on the east side rock was found after only ten feet. *Fig.* 1 shows the eastern anchorage in cross section.

The piers for the towers stand 45 feet above high water mark, the towers being another 400 feet high. 18,000 miles of high tensile steel wire went into the cables and the 8,320 wires making up each cable have a diameter of 20 inches after compression. *Fig.* 2 is a cross section of the saddle which receives the cable at each tower top.

The break with conventional design came with the bridge deck, and the magic word here is aerodynamics. If wind strikes a bridge horizontally then the deck can be made to act like an aerofoil. The flow across such a deck would be of a streamlined character—*Fig.* 3—and the deck would have a lateral drag effect together with a small vertical lift. Even more important are the effects of the wind against the stiffening girders. *Fig.* 4 shows how these present a vertical barrier to lateral winds and cause eddies. Large eddies leave the top and bottom edges of the plate alternately and so produce regular pulsations in the air forces on the plate. The Severn bridge deck was therefore designed as a continuous shallow welded steel box girder, carefully proportioned to take care of these aerodynamic problems. To help create stability even the steel wires connecting the deck to the cables were not placed vertically as is normal, but inclined to form a series of triangles. This application of aerodynamics to bridge building constitutes as important a step forward as Roebling's invention of the steel wire cable. The deck of the Severn Bridge was assembled on shore in watertight sections, which were then floated out to the required position. Width of the box section is 75 feet, with 105 feet between the outer edges of the cycle and foot ways, which are cantilevered out from this main box.

Suspension bridges of the near future seem well on the way towards that figure of 7,000 feet mentioned earlier. Amongst the bridges lined up for the future are one with a 4,580 foot span over the Humber Estuary, one of 4,600 feet in Tokyo Bay, and one of 5,000 feet in the Messina Straits.

West Country Inventor

by Edyth Harper

DEVONSHIRE is famous for fishermen, cream and beautiful scenery, among other things. Few people connect it with the use of steam, yet it was a Devonshire inventor who employed steam in a type of engine known as the atmospheric engine.

When steam-engines were first used they were called fire-engines because fires were needed for heat to raise steam to atmospheric pressure. Once inside an engine, cold water jets condensed the steam. This condensation caused a partial vacuum. Excess atmospheric pressure above the pressure in the partial vacuum, caused the engine to work.

There had been many attempts to harness steam before Thomas Newcomen of Dartmouth put his ideas into practise. A mathematician called Nye had a theory for making steam propel an engine in 1647. By 1665 the Marquis of Worcester invented a system known as "Fire-Waterworks" which could cause a column of water to be pushed 40 ft. into the air by using steam. At the turn of the 17th century a Capt. Savery produced a form of steam engine that was used in Cornwall in the tin mines. Denis Papin of France is said to be the first designer to incorporate a piston into his engine.

All these men's inventions were known to Newcomen who knew Capt. Savery personally. A native of the West Country, Newcomen was well aware of the problems mining involved. Savory was the manager of a Cornish mine. He, Newcomen and another man called Cawley, a glazier, decided to patent Newcomen's invention—the atmospheric engine.

It proved popular and for 70 years was the most effective device for pumping water out of the mines. In Newcomen's engine a "beam" was used and condensation became instantaneous. The beam moved on an axis. At one end the pump's rod was attached and the other end was fixed to the piston rod. The piston worked in a cylinder over a boiler. A connecting pipe had a stop-cock in it to regulate the steam.

Many things that have benefited mankind have come about by accident. A boy called Humphrey Potter had the task of opening and closing the stop cocks. Humphrey however disliked work. To save himself effort, he thought up an idea by which, with the help of levers and strings, the valves were controlled by the engine.

Newcomen lived until 1729 when he died in London. It is in his own town, however, that a statue was erected. A diagram is carved on a block of stone showing how his atmospheric engine worked and in some old mines, the pumping mechanism can still be seen.

It is a far cry from such a simple invention to the machinery used in mining today but men like Newcomen paved the way for modern techniques. They deserve our thanks for their practical ingenuity.