THE AMERICAN WALKING-BEAM ENGINE.

Looked at from the standpoint of the mechanical engineer, the most extraordinary fact in the story of the development of the Hudson River steamboat is the vitality of that early form of steam engine known as the walking-beam type. Although to-day its term of useful life lacks but a year or two of a century, and it is, therefore, actually as old as the Hudson River steamboat itself, and though it represents one of the earliest and crudest methods of changing the reciprocating movement of the piston into the rotary movement of the power shaft, the walking-beam engine is to-day the prevailing type of drive on the Hudson River. Most significant fact of all, when it came to the question of what type of engine to use on the "Robert Fulton," the latest of the Hudson River fliers, built this year, it was decided that, all things considered, the most suitable engine would be one of the kind which was first placed in a Hudson River boat in the year 1811.

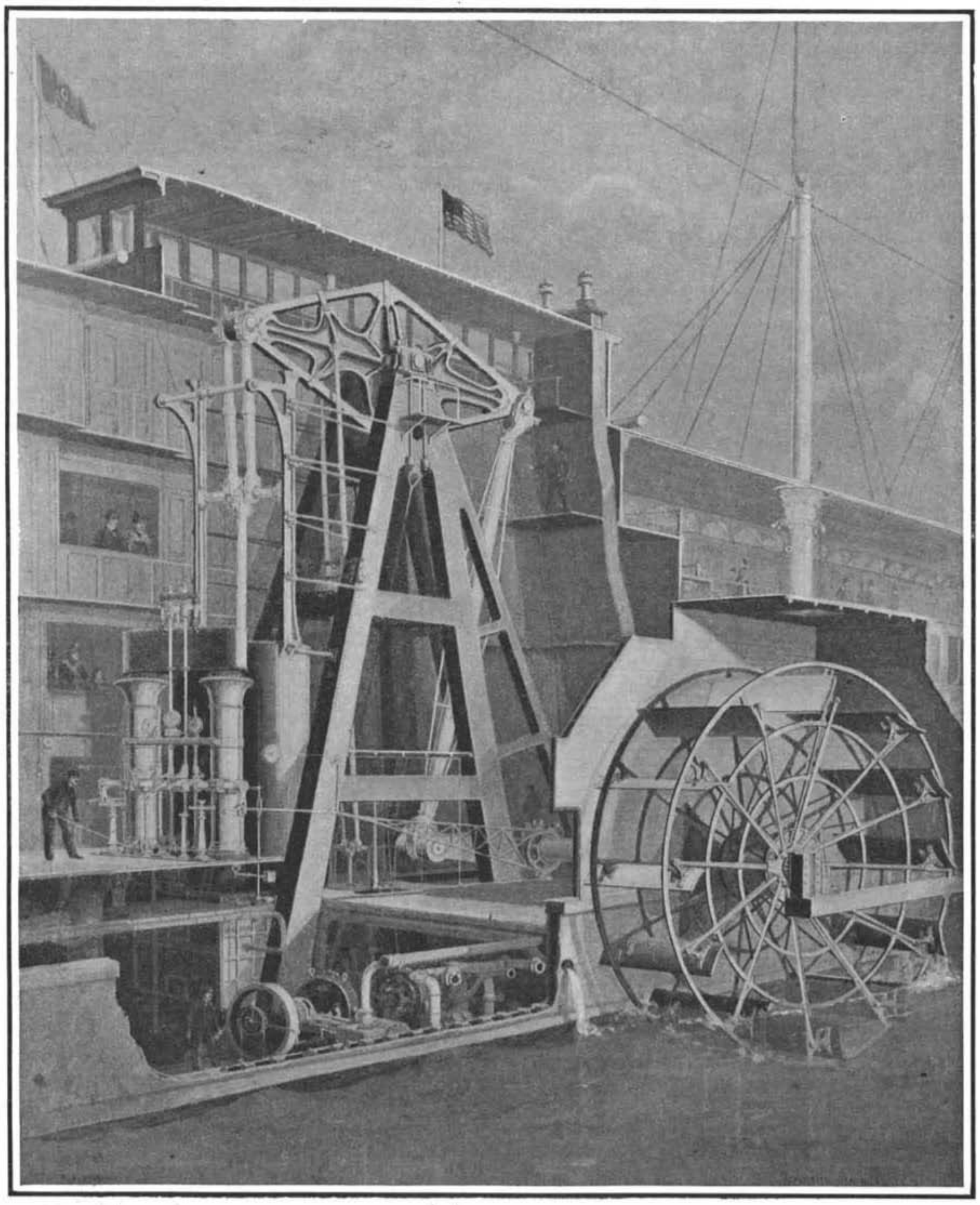
In steam engine practice, one hundred years ago, the rocking or walking beam was the favorite method of connection between the piston rod and connecting rod. We are all familiar with the engravings of early stationary engines, particularly those used for pumping in city waterworks, in which a vertical steam cylinder transmitted its power to a cast-iron overhead rocking beam, which was carried upon cast-iron girders supported on cast-iron pillars of elaborate classic design. By the middle of the nineteenth century, this type was being discarded for the simpler horizontal engine; and to-day the few remaining walking-beam stationary engines are regarded with a strictly antiquarian interest.

In the development of the Hudson River steamboat, on the contrary, the beam engine proved to be so ideally adapted to the work, that it has held its place against the multi-cylinder, high-pressure, fast-running engine, with conspicuous success. In the first place, it was an easy engine to build; and, when once the foundries, machine shops, and forges had been built and a force of capable mechanics had become available, its first cost was low. The engine consisted essentially of a single cylinder, a walking beam, a connecting rod, the A-frame, which carried the main bearings of the walking beam, a jet condenser, a hot well whose piston was operated by connecting rods from the walking beam, and feed pumps operated from the same connecting rods as the hot well. Judging from early prints and descriptions, the engine was quickly developed to the identical form which it carries at the present time, the principal change being the substitution, in the past quarter of a century, of surface condensers for the early jet condenser.

The "Clermont," as we have shown elsewhere, transmitted the power from the cylinder to the crankshaft through a bell-crank lever. Subsequently, during the succeeding two decades, use was made of a steeple engine, in which a pair of rocking beams, carried low down in the boat, were used, or the crankshaft was placed immediately below the cylinder, with connecting rods coupled from the piston crosshead to the cranks. This type, however, soon gave way to the present form with an overhead walking beam mounted on a stout timber A-frame, whose footings were bolted to the keelsons of the floor of the boat. The A-frame was built of massive timbers very strongly braced and bolted, and carried at its apex the main bearings of the walking beam. The guides for the crossheads were held in line by rods extending from the guides to the A-frame.

The boiler of the "Clermont" was made of copper and carried the low pressure of four or five pounds to the square inch. Copper was used because iron plates were not available; but eventually, when reliable boiler plate became available, iron boilers were introduced, and immediately higher steam pressures began to be used. Tubular boilers were introduced in 1830 on the "Novelty," and about the year 1840 wood gave place to anthracite coal. Concurrently with the increase in boiler pressures, a great advance was made in the size and power of the engines. The single cylinder of the "Clermont" was 24 inches diameter by 4 feet stroke. The "Chancellor Livingston" of 1816 had engines 44 inches in diameter by 5 feet stroke. The "Constellation," 1825, used a cylinder 44 inches in diameter by 10 feet stroke, and these remained about the maximum dimensions until the appearance of the "South America," 1840, with cylinders 54 inches in diameter by 11 feet stroke. The keen contest for speed resulted in the construction of engines that were prodigious for those days, and have barely been exceeded at the present time. Thus in 1845 there was built for the "Hendrick Hudson," which was a fine vessel 320 feet long, an engine with a 72-inch cylinder and 11 feet stroke; and two years later T. F. Secor & Co. built for the "New World," one of the fliers of that day, an engine with a 76-inch cylinder and the enormous stroke of 15 feet. Thereafter the stroke was reduced to 12 feet, which was never again exceeded. The largest engine afloat on the Hudson is that of the "C. W. Morse," of 4,000 horse-power, built in 1904 by the W. & A. Fletcher Company, whose cyinder is 82 inches in diameter by 12 feet stroke.

The permanence of the walking-beam engine as the favorite drive for Hudson River steamboats, and its undoubted popularity among the directors of the companies and in the pilot house and the engine room, is largely due to the especial conditions under which the Hudson River service is operated. In the first place, the upper reaches of the Hudson are very shallow during several months of the summer, and it is desirable to keep the draft of the boats as small as possible; conditions to which the broad and shallow but sweetly-modeled river boats lend themselves admirably. The largest vessels for the night service are of over 4,000 tons displacement, and are driven by engines of 4,000 horse-power; yet they draw only about 8 feet of water. It would be a difficult proposition to drive such vessels with screw propellers. Furthermore, the large number of landings which must be made call for a boat with good maneuvering qualities, able to stop and start quickly, and make quick landings at the piers. The paddle-wheel beam-engine boat has proved to be ideal for this purpose. While it is well understood by the engine builders and shipping men of the Hudson River that high boiler pressures, multi-cylinder expansion, and rapidly-running engines are conducive to fuel economy, it is also realized that these economies can be secured only when the engines are continuously in service. Otherwise, the heavy extra capital cost of the more expensive installation is liable to exceed the saving due to coal economy. The Hudson River boats are out of service for about five months of the year; and although a multi-cylinder engine will run under a consumption of from 1.5 to 1.75 pounds of coal per horse-power per hour as against 2.3 pounds for a low-pressure single-cylinder beam engine, the greater first cost of the plant will go far to offset the saving in the coal bill. The cost of upkeep, moreover, of the beam engine is relatively far less. The boilers, built for 50 to 55 pounds pressure, generally carry from 30 to 35 pounds under an easy fire. This means a lessening of boiler repairs, since it is easier on steam pipes, joints, and packings. Moreover, the engine-room force is reduced to a minimum, an engineer and an oiler generally being sufficient to take care of the average Hudson River engine.



Cylinder, 81-inch diameter by 12-foot stroke. Horse-power, 3,800. Boiler pressure, 55 pounds. The two vertical pipes in front of the cylinder are the "side pipes," one the steam pipe, the other the exhaust. They communicate with transverse steam chests at top and bottom in which are the poppet valves. The latter are operated by two vertical rods, which are lifted by cams on rock shafts, driven by the eccentrics.

ENGINE OF THE "ADIRONDACK."

The accompanying illustrations of the 3,800-horse-power engines of the "Adirondack" of the night line, the last of the large river steamers to be built of wood, will serve admirably as a reference in connection with the foregoing description of the typical river-boat engine. The "Adirondack," which is 412 feet long, 50 feet beam, and 90 feet over the guards, with four decks above the waterline, and over 400 separate berths for the passengers and crew, was built in 1896. The vessel serves to show the point of size to which these stately river boats have been developed. In the engraving the side of the hull and superstructure has been broken away to show the full height of the engine, which was built by the W. & A. Fletcher Company. The engine foundation consists of heavy steel keelsons. The A-shaped gallows frames are built up of steel plates, the legs, which are of box section, being strongly braced together with struts, which are also of plate steel and box section. The walking beam consists of a strongly-ribbed cast-iron web, belted with a heavy wrought-iron strap; the whole being firmly strapped and keyed together. The cylinder is 81 inches in diameter by 12 feet stroke. The two large vertical pipes seen in front of the cylinder are known as the side pipes; the one on the star-

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3,800 maximum horse-power, can drive her at a speed of 20½ miles an hour. The maximum in size and accommodations is reached in the "C. W. Morse," of the People's Line, which is 427 feet over all, 90 feet over the guards, and contains 450 staterooms. The dining room will accommodate at one time 300 people. She is driven by a walking-beam engine with a cylinder 81 inches in diameter by 12 feet stroke, and her maxium speed is 20½ miles per hour.

In the above necessarily brief story of the development of the Hudson River steamboat, we have endeavored to bring out the salient points of the increase in size, speed, and accommodation of one of the most remarkable and successful types of vessel in the world to-day. It would be well in closing to refer to the phenomenal speeds which were achieved by these vessels over half a century ago, and draw attention to the fact that their record passages were usually made when wind and tide were favorable. The swiftest of the present-day boats would undoubtedly exceed the earlier speeds, though by no very great margin; and it must be remembered that, under existing conditions, they are run under a fixed schedule, generally under a reduced steam pressure, and are operated at several miles less speed than the maximum of which they are capable.

THE AMERICAN WALKING-BEAM ENGINE.

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board side being the steam pipe, and the other the exhaust. Each of these pipes carries a separate rocking shaft, which is operated by its own eccentric. The motion of each rocking shaft is communicated to two vertical lifting rods, which operate the valves by means of two cams called "wipers." The eccentric rods are formed with hooks at their outer ends, which engage a pin in the arms of the rocking shafts. They are thrown out of gear by means of the slotted vertical rods through which the eccentric rods work, one of which will be seen in the engraving. These vertical rods are known as strippers, and they are operated by the levers which will be noticed attached to the rocking shaft on the steam pipe. When it is desired to start or reverse the engine, the eccentrics are thrown out of gear, and the valves are worked by a steam starting and reversing engine, which is controlled by the vertical lever seen near the steam pipe. If it is desired, the valves can be operated by the vertical starting bar shown in the engraving.

The handwheel on the small vertical standard in front of the exhaust pipe opens the steam valve for the starting engine, and the wheels which are seen on the other two standards are for operating the injection valve and for turning the surface condenser into a jet condenser, if at any time it should be desired to do so. The surface condenser is located in front of the steam cylinder and below the main deck. Behind the steam cylinder and also below the main deck is the air pump, which is operated by connecting rods from the walking beam. The gear shown attached to the front face of the gallows frame, above the cylinder, is a hand winch, for lifting the cylinder head.

The paddle wheels are of what is known as the vertical or feathering type, in which the buckets are made to enter and leave the water in a nearly perpendicular position. The old type, with fixed radial buckets, is extravagant and uncomfortable; extravagant because it wastes power in forcing water downward when the buckets strike, and lifting it when they leave the water; and uncomfortable because it sets up a violent vibration throughout the whole vessel. The feathering paddle wheel is smoother and more efficient in its action, and its efficiency is from 12 to 15 per cent greater than the older type. Its construction is as follows: Bolted to heavy timbers just above the guards is a large pin carrying a loose flanged ring, to which are pivotally attached a set of connecting rods. At their outer ends these rods are pivotally connected to rocking arms fastened to the back of the buckets, the buckets themselves being pivotally attached to the rigid spokes of the paddle wheel. The pin and loose ring are placed eccentrically to the crankshaft, and the ring is rotated in its proper relation to the paddle wheel by attaching one of the connecting rods rigidly to it. The eccentricity of the ring is so adjusted that the buckets shall always enter and leave the water in a perpendicular position, thus securing a true feathering action. The wheels are 30 feet in diameter.

Steam is supplied by four steam boilers, of the lobster-return flue type, each 11 feet wide, 9 feet 3 inches diameter of shell, and 33 feet long, with steam domes 87 inches diameter and 10 feet 6 inches high. Forced draft is supplied by two large Dimpfel blowers, driven by independent engines. The steam pressure is 55 pounds to the square inch, and the total horse-power is 3,800.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

ADJUSTABLE PATTERN.—M. Bogushefsky, New York, N. Y. This invention consists in the construction and combination of parts, whereby the different edges of the pattern may be moved outwardly or inwardly substantially in parallelism, without varying the relative proportions or the general shape of the pattern. Attachments are employed for varying the style of the garment, rendering one pattern useful for cutting different forms of garments.

PNEUMATIC HEEL-CUSHION.—W. L. Gordon, Deal, N. J. The cushion is such as worn at the heel of the shoe on the inside in order to cushion the heel in walking. The cushion has an improved form which increases its elasticity in action, and a further object is to provide improved means for holding the cushion in position.

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TELPHER SYSTEM.—B. T. Hitch, Allen, Md. In this case the invention relates to telpher systems and is particularly applicable to rural mail delivering routes in which the delivery points are relatively far apart. It may be used also as a parcel delivering system or for any purpose in which the rapid transportation of light matter is desirable.

HEAD-GEAR FOR SUPPORTING LIGHTS.—D. E. Taylor, Willimantic, Conn. The gear is for use by surgeons, dentists, and opticians, and supports an electric light and delivers the rays directly upon the object under inspection. The main feature involves a spring metal band, adapted to extend over the head from the front to the back, and be retained in position by resilient engagement with the forehead and back of the head.

Of Interest to Farmers.

BEEHIVE.—P. Weaver, Fort Worth, Texas. The object among others here is to provide a hive of concrete or cement whose walls will be thick enough to exclude heat and cold, and whose interior will be large enough to receive any desired form of honey frames and which will afford at its entrance ventilating means, cleaning out means, and means for the passage of the bees into and out of the hive.

PEA-HULLER.—W. L. Hay, Franklin, Tenn. The intention of this inventor is to provide a device of comparatively simple construction in which the hulling of picked peas or of peas on the vines may be accomplished by merely shifting the concave and feeding the peas through the device in the direction most suitable for their proper treatment.

DEVICE FOR TEACHING MILKING.—P. J. DeVries, Hull, Iowa. The purpose of the improvement is to provide a device that simulates the udder and teats of a cow pendent therefrom, together with other details that afford means for practising the removal of water from the artificial udder by a proper compression of the teats, and thus acquire the art of milking quickly and safely.

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