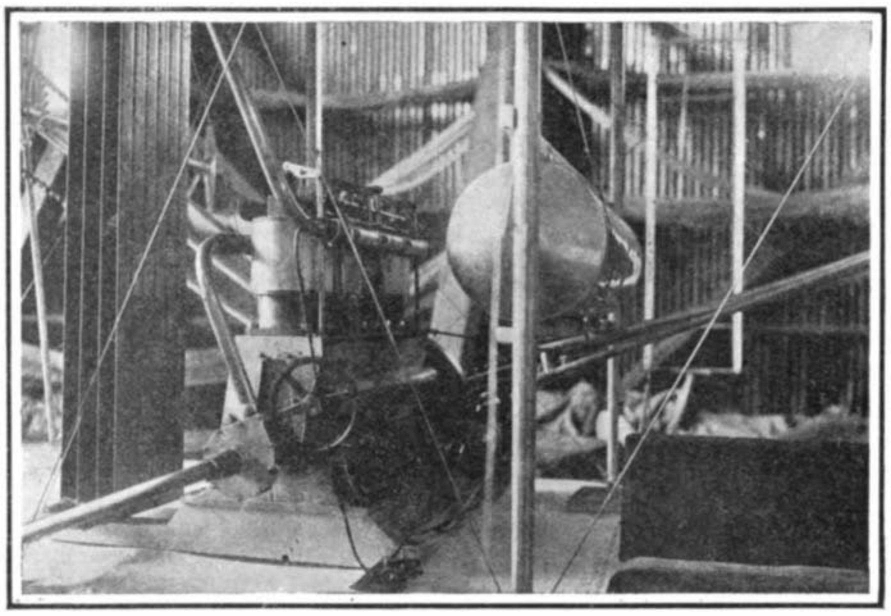
THE WRIGHT AEROPLANE—ITS CONSTRUCTION.*

IT HAS FLOWN FOR OVER AN HOUR IN A 10-MILE BREEZE, HAS ATTAINED A HEIGHT OF 300 FEET, AND A SPEED OF OVER 40 MILES PER HOUR.

BY L. P. ALFORD.

The results of the aeroplane trials that were conducted from September 3 to 17, inclusive, by Orville Wright at Fort Myer, Virginia, in the presence of officers of the Signal Corps of the United States army, aroused great interest throughout the civilized world. They were surely epoch-making, and it is lamentable that they were brought to an end by disaster. A characterization of the machine as the greatest purely mechanical invention of this generation is none too strong.

* The text of this article is reprinted from the American Machinist and Western Electrician. The illustrations are republished from the Scientific American.



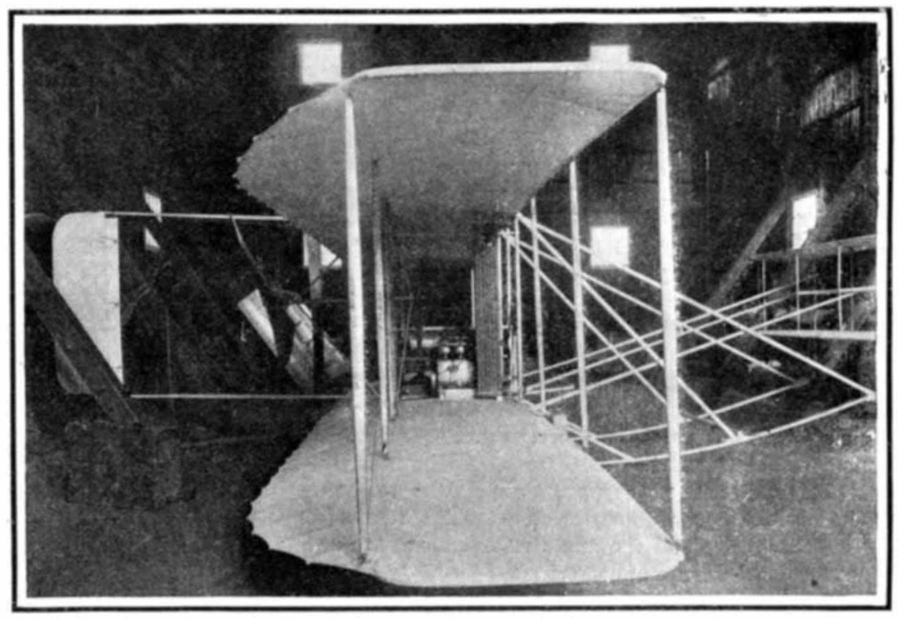


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FIG. 1.—DETAIL FRONT VIEW OF CENTER OF AEROPLANE, SHOWING THE MOTOR, RADIATOR, GASOLINE TANK, AND SEAT.

The driving chain and sprocket of one propeller are visible at upper left-hand corner, and the crossed tubes carrying the other propeller chain can be seen on the right. The twin vertical rudder is also seen on the right at the rear.

FIG. 2.—END VIEW OF AEROPLANE, SHOWING THE VERTICAL AND HORIZONTAL RUDDERS, PROPELLERS, GASOLINE TANK, MOTOR, AND RADIATOR.

This photograph gives a good idea of the slight curve of the planes as well as of their construction.

ERNEST ZENS AND WILBUR WRIGHT. MR. ZENS WAS MR. WILBUR WRIGHT'S FIRST COMPANION.

THE ARMY SPECIFICATIONS.

The machine was built to comply with a specification issued by the War Department for a heavier-than-air flying machine. A few of the more important provisions of this specification are: The construction of the flying machine must be such that it will be supported entirely by the dynamic reaction of the atmosphere and without any gas bag. It must be capable of being disassembled readily for transportation by army wagons. It must be capable of being assembled readily for flight in one hour. It must carry two passengers having a combined weight of 350 pounds, and a sufficient supply of fuel for a flight of 125 miles. Its speed in still air must be 40 miles per hour, and for that speed it will be paid for at the rate of 100 per cent of the tender price.

A 10 per cent reduction will be made for each mile less than the 40 miles per hour specified. However, any machine will be rejected that does not attain a speed of at least 36 miles per hour. Again a bonus of 10 per cent will be paid for each mile in excess of the specified 40 miles per hour. During the trials the machine must be continuously in the air for one hour without landing. It must return and land at the starting place and be ready for another flight at once. The machine must be capable of being steered in all directions and must be at all times under perfect control. The starting device must be of such a nature that it can be easily transported in army wagons. If at any time the propelling power is rendered inoperative, the machine must return to the ground without injury to itself or any of its mechanism. It must be capable of landing in any open country without having a special landing place prepared for it.

THE AEROPLANE.

The views here published show the Wright aeroplane. Its general outlines are well known. It consists of two long parallel planes that carry the machinery and operator. In front are two small horizontal rudder planes, and in the rear are two vertical rudder planes. It weighs complete about 850 pounds.

The large planes are some 40 feet in length, 6½ feet wide and spaced about six feet apart. They are constructed of a light framework of white spruce, covered with a good quality of white muslin. The struts between the planes are of wood, and the trussing is by means of wire. The front of each plane is rigid, but the rear edge, although the cloth is stretched tightly over a wire passing through the ends of the ribs, is flexible and can be warped when the proper lever is moved. By means of this lever one end of both planes is thrown downward, and the other end is thrown upward, as shown in the diagram, Fig. 4.

MADAM HART O. BERG AND MR. WILBUR WRIGHT BEFORE THEIR FLIGHT IN MR. WRIGHT'S MACHINE.

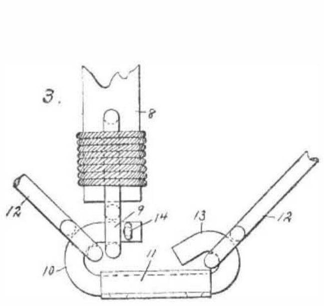

FIG. 3.—JOINT USED IN CONNECTING UPRIGHTS TO PLANES.

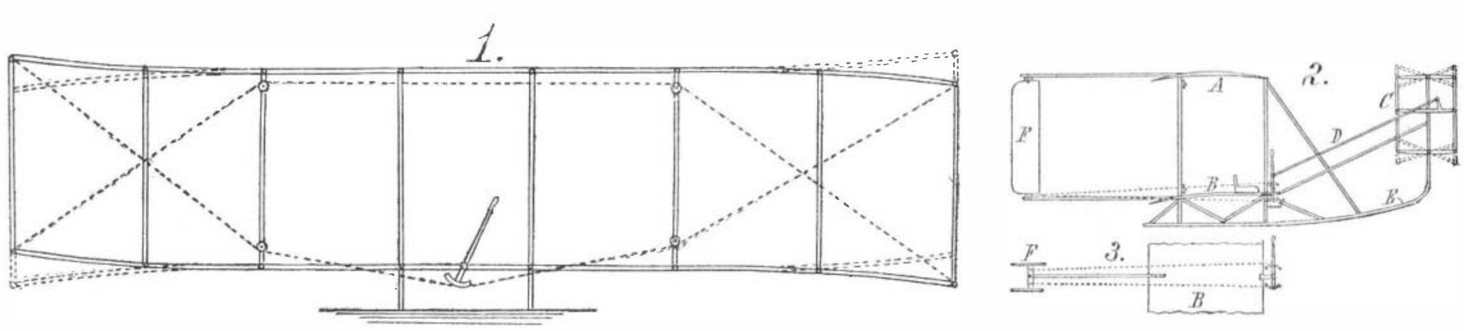

FIG. 4.—DIAGRAMS SHOWING HOW THE SURFACES ARE WARPED AND HOW THE RUDDERS ARE OPERATED.

1. Diagram showing connections for warping the planes. 2. Side view, showing connections, *D*, for operating horizontal rudder, *C*, which is carried on an upward projection of runners, *E*. 3. Plan view showing connections for operating vertical rudder, *F*.

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This movement is made use of in balancing and in turning in the air.

The pair of small front-rudder planes, shown best by Figs. 4 and 6, are pivoted along a horizontal shaft that is supported and braced by the framework extending forward from the main planes. These rudder planes are spaced by wooden struts and are trussed together by means of wires. They are operated in unison by a long rod extending forward from one of the vertical operating levers. The small D-shaped vane between these two planes has a damping effect when the machine turns, or tends to turn, sidewise; in this way it adds to its stability.

At the rear is a twin vertical rudder, best shown in Figs. 2 and 4. Its method of support and attachment is plainly shown. An operating handle controls its motion about a vertical axis, and its use is to turn sidewise in flight. The entire machine is mounted on runners resembling sleigh runners, and best shown by Fig. 4.

The wood used throughout is clear white spruce, selected because of its lightness, strength and resilience. In finish the wooden parts are painted with aluminium paint; the cloth covering is left untouched and is, therefore, its natural white. The surface of the parts of the machinery is so small in proportion to the area of the planes that the general white effect of the entire machine is in no way disturbed.

THE PROPELLING MECHANISM.

The propelling and transmission machinery is shown by Fig. 1. The propellers themselves can be best seen in Fig. 8. The engine is a four-cylinder four-cycle gasoline engine, designed and built by the Wright brothers. It weighs 170 pounds and develops from 25 to 30 horse-power. It is fitted with make-and-break igniters, the current for which is supplied by a magneto. It also has automatic inlet valves and a special direct-feed arrangement for supplying the fuel, which is pumped to the inlet valves, thus dispensing with a carbureter. A large fuel tank is placed beside the engine. A four-section radiator occupies the entire height between the two main planes. This is composed of flattened brass tubing, connected into suitable headers at top and bottom.

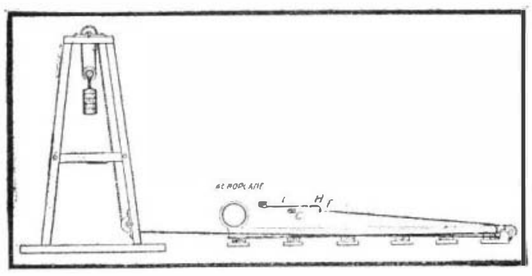

FIG. 11.—STARTING MECHANISM OF THE AEROPLANE.

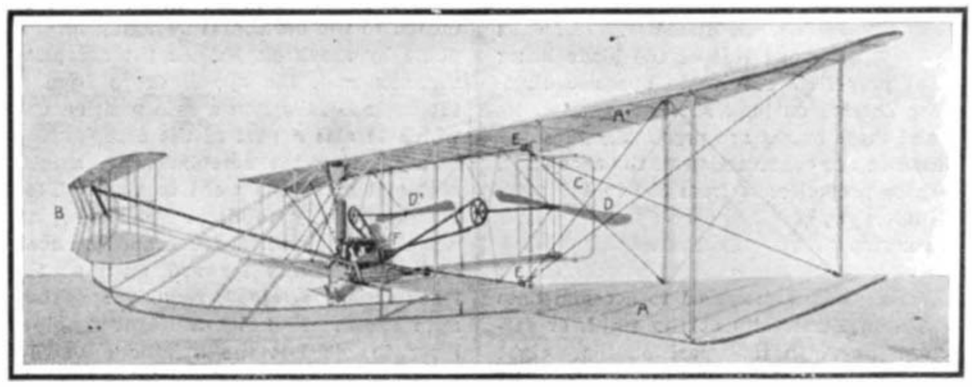

FIG. 12.—STEERING GEAR OF THE WRIGHT MACHINE. From Umschau.

A and *A'*. Main planes. *B*. Horizontal rudder. *C*. Vertical rudder. *D* and *D'*. Propellers. *E*. Plane warping cable. *F*. Motor.

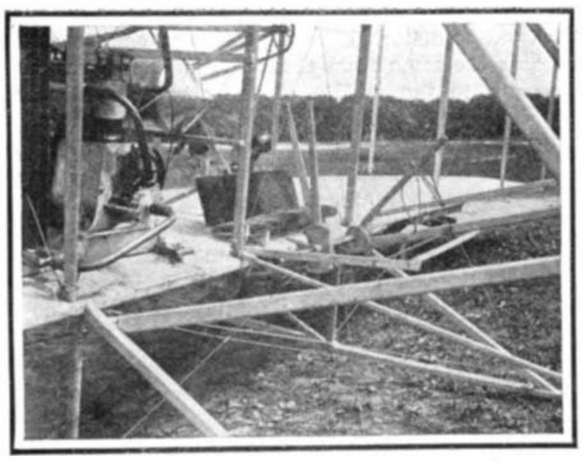

FIG. 5.—FRONT VIEW OF LOWER PLANE.

The radiator, motor, fuel tank, seat, and levers are visible. The aviator sits farthest from the motor and holds the horizontal-rudder lever in his left hand and the vertical-rudder and wing-warping levers in his right. Note foot-rest in front of levers.

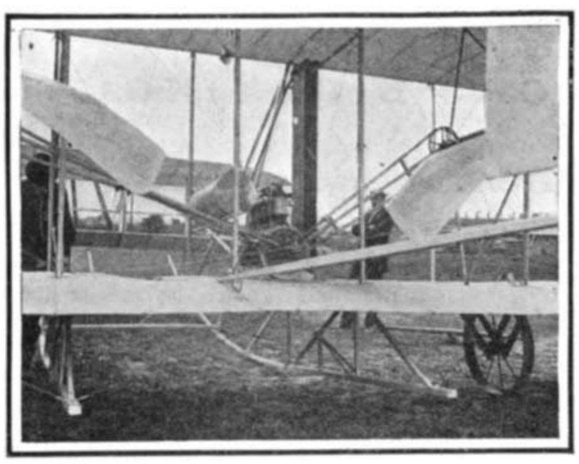

FIG. 7.—REAR VIEW, SHOWING MOTOR, PROPELLERS, AND DRIVING CHAINS.

FIG. 8.—THE AEROPLANE ON AN ARMY WAGON.

The runners are folded back against the front edges of the planes and the rudder is placed against their rear edges.

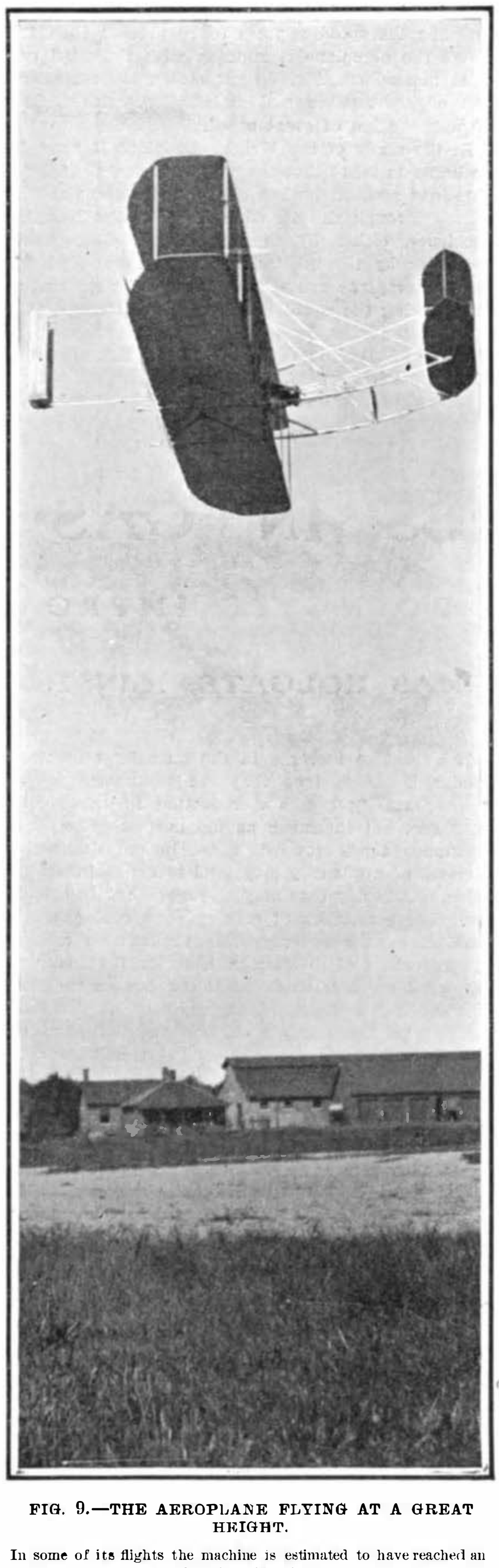

FIG. 9.—THE AEROPLANE FLYING AT A GREAT HEIGHT.

In some of its flights the machine is estimated to have reached an elevation of 300 feet.

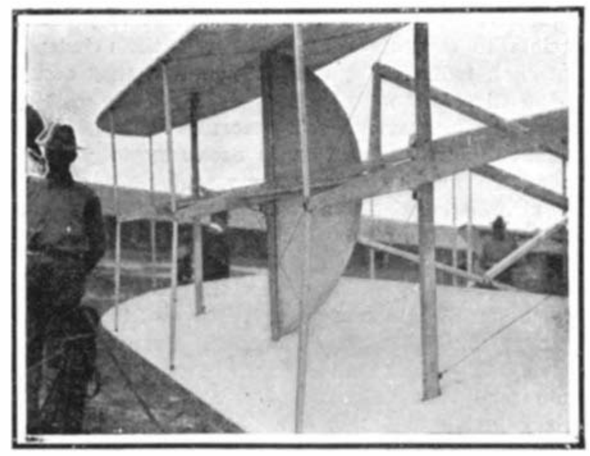

FIG. 6.—DETAIL VIEW OF FRONT HORIZONTAL RUDDER.

In this photograph the rudder is shown tipped downward. The operating lever and wood rod connecting to lever on aeroplane are visible. Also note semi-circular vertical surface which is loosely mounted at the center.

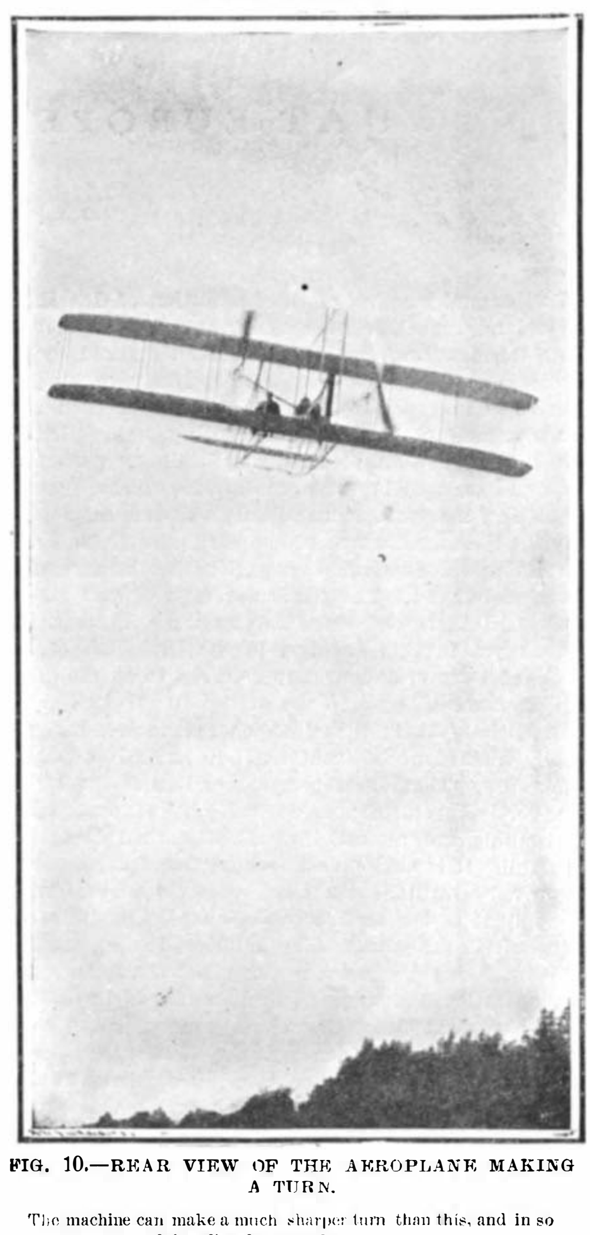

FIG. 10.—REAR VIEW OF THE AEROPLANE MAKING A TURN.

The machine can make a much sharper turn than this, and in so doing dips downward much more.

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The power is transmitted from the engine shaft to the propeller shafts by means of automobile chains. The ratio of speed reduction is 9 to 32. At this point is one of the most interesting mechanical devices of the entire machine—the crossed chain connecting the right-hand propeller with the engine. The chain is carried through guide tubes and we are informed works with perfect success.

The propellers are 8½ feet in diameter. The ends of the blades are square, one side of the blade being beveled off. The propellers revolve in opposite directions. They are carried on long shafts supported by metal braces, and these braces are practically the only metal braces used in the construction of the aeroplane. The speed of these propellers is from 350 to 400 revolutions per minute.

CONTROL OF THE MACHINE.

Three operating handles can be seen in front of the seat in Fig. 5. The seat is arranged to accommodate two persons. The operator sits at the right, or farthest from the engine. In that position his weight practically balances the weight of the engine. The second person sits on the midline of the machine and therefore automatically preserves the balance, whatever his weight may be.

Of the three operating levers, the one at the right of the illustration is connected with the front pair of rudder planes. These planes are used in controlling the vertical movements of the aeroplane. Of the other two handles, the one nearer the engine controls the swinging of the vertical rear rudders and its mate the twisting of the ends of the main planes. These two levers are placed back to back, as they are ordinarily worked together; although it is perfectly possible to separate them and work them independently, as indicated by the position that they occupy in the illustration.

STARTING THE AEROPLANE.

Only a short explanation is necessary to give the reader a clear idea of how the machine mounts into the air. Briefly, the aeroplane is practically shot obliquely into the air by the action of a heavy falling weight. Reference to Fig. 11 will show diagrammatically a single-rail track laid on the grass on blocks. At one end of this runway is a four-post tower, looking very much like an oil derrick. Suspended on a system of pulleys connected with a five-eighths-inch hemp rope is a weight of several hundred pounds. This weight is pulled up into the air for, say, 10 feet, and the rope from it runs out alongside this single track to its end, where it passes over a six-inch iron grooved pulley and back to the bottom of the aeroplane framework. This rope is attached to the aeroplane by a sort of trigger *L*. This trigger is so constructed that when the aeroplane, pulled by the jerk of the falling weight, reaches the end of the runway, the trigger releases the rope from the aeroplane and leaves it free to mount into the air. The weight by this time has about reached the ground.

As shown in Fig. 11, the eye *E* of the rope is attached to the horizontal swinging lever *L* of the aeroplane by the hook *H*. As the aeroplane shoots over the monorail, the eye *E* drops from the hook, and the lever *L* falls into a safe position on a crossbar *C*, which is also a part of the aeroplane.

In starting the aeroplane, the aviator mounts his seat and gives the word to start. The weight is allowed suddenly to drop. The aeroplane resting on a sort of single-wheel truck and balanced by a man at each side, shoots forward until at the end of the track it has attained, roughly speaking, about a 20-mile speed. Now by a slight manipulation of the lever to his left the aviator elevates the nose, so to speak, of the aeroplane (viz., front horizontal rudder) and the machine instantly leaves the track, and mounts in a most graceful manner into the air, thereafter forced ahead by propellers.

According to Mr. Wright, one of the chief sensations at starting is a realization of the great noise of the motor, and the seeming rush of the ground backward beneath him. Once in the air, the higher the aeroplane mounts the slower it seems to go. When at quite a distance from the ground, although really going at the same high speed, the motion seems to the aviator to be "slowing up," except in cases where the machine is running directly into the wind. In this instance the speed appears to be greater than it is. When the aeroplane is running with the wind or in calm atmosphere, Mr. Wright states, the sensation is one of great peace and satisfaction, with little or no appreciation of great speed.

In the study of the Wright aeroplane it must first be borne in mind that the weight is sustained by the reactions resulting, when one or more aeroplanes are moved through the air edgewise at a small angle of incidence, either by the application of mechanical power or by the utilization of the force of gravity. In the aeroplane are provided means for maintaining or restoring the equilibrium or lateral balance of the apparatus, means for guiding the machine both vertically and horizontally, and at the same time the structure must combine lightness, strength, and convenience of construction.

In flying machines of this character the apparatus is supported in the air by reason of the contact between the air and the under surface of one or more aeroplanes, the contact surface being presented at a small angle of incidence to the air. The relative movements of the air and aeroplane may be derived from the motion of the air in the form of wind blowing in the direction opposite to that in which the apparatus is traveling; or by a combined downward and forward movement of the machine, as in starting from an elevated position; or by combination of these two things; and in either case the operation is that of a soaring machine, while power applied to the machine to propel it positively forward will cause the air to support the machine in a similar manner. In either case, owing to the varying conditions to be met, there are numerous disturbing forces which tend to shift the machine from the position which it should occupy to obtain the desired results.

The chief object of the design of this aeroplane is a means for remedying this difficulty.

Now, without going into a detailed description of a delicate yet simple method of construction, whereby the planes at their outside ends may be warped or twisted (a matter which the designers do not wish to explain in detail) it may be stated that by this means it is possible by a single movement of one lever at the right of the aviator's seat to move up or down the back edge or corner of the lateral edges of the aeroplane. They may be warped, at will, on one side of the machine either above or below the normal planes of the aeroplanes, a reverse movement of the similar corners on the other side of the machine occurring simultaneously.

During this operation each aeroplane is practically twisted or distorted around a line extending centrally across the same from about the middle of one lateral margin to the middle of the other lateral margin, the twist due to the moving of the lateral margins to different angles extending inward toward the central portion, from side to side, so that each aeroplane surface is given almost a helicoidal warp or twist. This construction and mode of operation gives a gradually increasing angle to the body of each aeroplane from the central longitudinal line outward to the margin, thus giving a continuous surface on each side of the machine, which has a gradually increasing or decreasing angle of incidence from the center portion of the machine. Any construction whereby the angular relations of the lateral margins or portions of the aeroplanes may be varied in opposite directions with respect to the normal planes of the aeroplanes, comes within the scope of the designer's idea.

RECENT PROGRESS IN GAS MANUFACTURE.

WHAT EUROPE IS DOING TO IMPROVE GAS LIGHTING.

BY THOMAS HOLGATE, M.INST.C.E., F.C.S.

THE annual meeting of the Institution of Gas Engineers lately concluded has synchronized with that of their German *confrères*, and has been marked by an interchange of information that is likely to be productive of much good to the industry concerned. At the termination of their own meeting eighty British gas engineers were received in Berlin as guests of their professional brethren, mainly for the purpose of inspecting the various installations of vertical retorts used in the manufacture of gas for that city, and also for seeing the admirable street lighting by means of inverted burners. The particular type of vertical retorts used there and elsewhere on the Continent, but not as yet in this country, is the invention of Dr. Bueb, of Dessau, and usually referred to as the "Dessau" system.

Essentially it is the time-honored retort, set vertically instead of horizontally, but worked somewhat differently. That difference is found in the fact that the vertical retorts are worked full of coal, while horizontals are almost invariably worked less than half full. It is obvious that when once this procedure is proved advantageous, it ought not to be impossible to apply it to horizontals; and, indeed, this is in certain British gas works being more or less approached, and machines are already installed that can effect the operation the moment such a course is desired. At the present time it would appear that the rapid spread on the Continent of the Dessau system is due to side issues, rather than to an incontestable increase of light-giving constituents from the coal. In saying this, however, it must be made clear that these side issues are of considerable importance. The advantages that appear to be beyond doubt are: 1. The reduction in the quantity of the naphthalene formed. 2. The reduction in the quantity of the organic sulphur compounds formed. 3. The superiority of the tar produced. 4. The increase in the quantity of ammonia produced. It is true that the last-named increase quite naturally causes a reduction in the yield of cyanogen, but inasmuch as the market price of this substance tends toward a continuous decline, the removal of a quantity may tend to maintain a higher price, and in any case may be regarded with equanimity. The possibility of making pure coal gas or an admixture with water gas, in the same retort, and the reduction of distressing heat for the fewer men employed are also in favor of the Dessau system.

According to Herr Weiss, engineer of the Zurich gas works, the number of men required for hand-stoked horizontals, inclines, and verticals is in the ratio 28, 7, 2 respectively.

From these general statements it is quite evident that there is justification for the rapid adoption of the systems, provided that there is no falling off in the values of the gas and coke produced, and about these there appears to be no reason for anxiety.

The tests made by representatives of the two associations of gas engineers, and by others—with one exception—indicate that where pure coal gas is made there is no falling off in the heating or lighting value obtained in the gas from one ton of coal.

Thanks to the labors of Mr. J. F. Bell, of Derby, and other British gas engineers, the naphthalene difficulty, in horizontal retort working, has been overcome by washing the gas with suitable tar or petroleum oils in separate washers or scrubbers. As this involves some little capital expenditure, the Dessau system is entitled to the small saving in working and capital charges which attaches to "prevention being better than cure."

Similarly, in the more urgent matter of organic sulphur, the same adage has secured a welcome exemplification.

Having thus briefly referred to a method which has been recently described by Mr. Hayman, of the Imperial Continental Gas Association, Berlin, as the one which, by its extensive adoption, is shown to be proof against all competitors, it must now be mentioned that there are friendly rivals undergoing experimental and commercial evolution in Great Britain.

The first vertical retort installation was that of Mr. Andrew Scott, of Musselburgh, and that was followed by the general adoption of the vertical form in the distillation of shale in the lowlands of Scotland. Meanwhile at Rheims was introduced the inclined retort, which set at an angle of 30 deg. has been largely adopted at home and abroad. The revival of the idea of the "vertical" is due to Mr. Settle, of Exeter, who combined therewith the idea of a continuous feed, previously tried on a rotated horizontal iron retort. He adopted a vertical retort terminating in an inclined shoe or base to facilitate the frequent discharge of coke therefrom without requiring the use of a water seal as in Scott's retort. Unfortunately, Mr. Settle has not been very successful in his trial installations, but the soundness of the general principles has been largely accepted in Great Britain, and other systems having a continuous feed have been or are being tried at (1) Bournemouth, London (Nine Elms), and Liverpool; (2) Guildford; while shortly another type is to be tested at St. Helen's.

The method employed by Mr. G. R. Love at Guildford is a retort set at an angle of 45 deg., and worked full. The charging in the first trials was continuous, but now is intermittent, as with the Dessau, and the results in the main are confirmatory thereof. At St. Helen's the engineer, Mr. Samuel Glover, has erected a setting of vertical retorts in which continuous charging and discharging will take place, and which system may be taken as embodying the ideas