

CHURCHILL'S MARINE ENGINE GOVERNOR.

IT WILL be within the recollection of Members of this Institute that the writer was specially requested, at the time he read his paper on "MARINE ENGINE GOVERNORS AND THE BENEFITS TO BE DERIVED FROM THEM," in November last, to read a paper on his own Governor, a compliment which he highly appreciates.

The paper above referred to ought to be read as a preface and introduction to the subject before us to-night. Before, however, dealing with the subject matter of the paper, the writer desires to draw your special attention to the serious disaster to the s.s. "City of Paris," which more than any theorising, demonstrates by terrible facts the correctness of the arguments contained in the author's previous paper. It appears that this steamer, in perfectly fine weather, broke her screw shaft and the engine flew away at such a fearful speed that it completely annihilated the starboard low-pressure engine, smashed the fore and aft bulkhead through, thereby putting in imminent peril over a thousand lives. It is stated that she was fitted with Governors such as referred to in the previous paper where the writer says, that, "His remarks referred solely to Governors operated or driven by the main engines, as he considers all others are but very poor apologies, and are not entitled to the name of Governors, as they have only occasional control over the engines, not available in case of accident; whereas a real Governor, properly fitted and worked, has continuous control over all the cylinders under all conditions and circumstances. Had these magnificent Engines been properly fitted with efficient Governors and worked continuously as he so strongly urged, in all human probability they would have been intact at the present moment, as it would have

given the engineers ample opportunity of stopping them before much, if any, damage could have been done."

It is only just to the builders of this engine to say that they purchased a Governor and Compound Attachment Appliances for her, clearly indicating their intention to provide the best known appliances to prevent accidents, or, in case such should occur, to minimise the amount of damage done; but, unfortunately, their judgment appears to have been over-ruled, and another machine fitted which was utterly useless under the circumstances. The writer is particularly desirous, whilst commending the builders, not to cast any reflections upon those who over-ruled them, as there can be no question but that they acted to the best of their judgment.

Referring to the illustrations—Drawing No. 1—you will perceive that the main casting consists of a bracket for bolting on to the bulk-head or other support, carrying a depending bracket for the driving spindle, and at the further end is the water, or retarding cylinder with baffles, within this cylinder is a fan carried by the fan spindle working through a gland and stuffing box. On the end of the fan spindle is a small cup which has two pieces cut out of its sides so as to form a double cam. This cup works inside of a larger cup (carried by the driving spindle) which cup has two parallel slots cut in it.

It will be noticed that there is no direct connection between the fan spindle and the driving spindle; between these two is the intermediate spindle, a T-shaped piece, on the two short arms of which are four friction rollers, the *coned* rollers bearing on the double cams of the small cup—the other two friction rollers work in the parallel slots of the large cup. The driving shaft is hollow at its inner end, and there is a slot cut through at right angles to its length; into this hollow shaft the long arm of the intermediate spindle is inserted. Between the bearings of the driving shaft and its cup there is a space left for a collar and its skid, and movement in the axial line. A pin passes through the collar and through the slotted holes in the driving shaft, thereby forming a bearing for the end of the intermediate spindle. The skid forms a bearing for the bell crank lever, which is pivoted in a double jaw on the main bracket. The long arm of the bell crank lever is held down by a spring. The short arm is connected with the slide valve rod of the steam cylinder. The steam chest is at its rear end, where the cylinder is pivoted so as to swivel in an arc of 180°, thus facilitating the obtaining of as direct a lead as possible

for the connection with the throttle valve. There are steam connections on both sides of the steam chest.

It will be seen that this machine can be driven in either direction, as the cams on the fan spindle are double acting. This is a great advantage as it can always be driven with an open rope; not only so, but it has control over the engines when going astern. The author knows of a case in connection with some Naval manœuvres when, while going full speed ahead the order was given to reverse instantly to full speed astern, when the engines raced heavily and broke down. This Governor would have saved them. The driving spindle carries a V-shaped driving sheave, and also a loose sheave. When it is in action the power to drive the fan is transmitted from the large cup to the small cup through the intermediate spindle, causing it to mount the inclines of the cams, thereby forcing the long arm further into the hole in the driving shaft and carrying with it the pin which passes through the collar and slotted hole, thus moving the collar and its skid and carrying with it the bell crank lever against the tension of the spring. At the same time, the short arm of the bell crank alters the position of the small slide valve, operating the piston in the auxiliary steam cylinder. The movement of the intermediate spindle is controlled by the spring attached to the long arm of the bell crank. This spring is adjustable by a thumb screw.

The principle on which this machine acts is very simple. On the one side you have work done in the water cylinder, on the other side the tension of a spring: the differential gear being the fulcrum or pivot, on which the two forces are balanced. If the work done in the water cylinder by reason of increment of speed exceeds the tension of the spring, the balance is upset and the throttle valve is partially or wholly closed, and *vice versa*. In this machine we have a Governor of the most delicate and sensitive description, in the smallest and most compact form, for operating a very small slide valve on the auxiliary steam cylinder; the piston of which does the heavy work of operating the throttle valve of the main engine. In fact, it simply indicates when the steam cylinder shall do the work.

With regard to the extreme delicacy and sensitiveness of the action of this machine, the writer cannot do better than quote some remarks made by Mr. R. R. Bevis, of Messrs. Laird Brothers, some few years since at the Liverpool Engineering Institution, when he remarked:—

“In one instance, although the vessel was being tried at moorings (that is, with her nose end on to the dock wall), with one of Messrs. Durham and Churchill's machines, where the variations of the speed of the engines working under those conditions would be very slight indeed—one would not be able to see any difference—yet the Governor being put on, we were able by means of the indicator diagrams to tell the way in which it worked. The variable speed of the engine was so slight that an ordinary eye could not detect it, yet the Governor was so sensitive that it was able to take up the difference of speed and record it on the diagram.”

A Governor which could record its actions upon the diagram under such conditions must indeed be a marvellously sensitive machine.

FITTING.

In selecting a position for the Governor it is above all things advisable, that it should be easy of access; preferably from the starting platform, even though this may entail a little extra cost in fitting.

Unfortunately, Governors are generally stuck up in position where the cost of connections will be reduced to a minimum, without any reference whatever to accessibility or efficiency of working. If a machine be not easily accessible, it will be rarely, if ever, properly attended to, as it is altogether unreasonable to expect men to stand on greasy hand rails, or to hang on by the skin of their teeth, in a gale of wind, whilst adjusting or regulating it.

At times it is a matter of some difficulty to select a position easily accessible, and at the same time good for the driving and connecting gear.

If all these conditions cannot be combined from the starting platform, it is generally an easy matter to provide a small platform or grating on which the engineer can stand with some degree of comfort and safety whilst attending to the machine. Where a permanent projection of this sort would be inconvenient or objectionable, the difficulty can generally be surmounted by providing a small hinged platform—like a hinged bracket—which can be let down when not in use, as shown in Drawing No. 3.

Care must be taken that the machine is not so situated that grit can fall on it from overhead. If it is absolutely necessary to put the

machine in such a position, some canvas or thin sheet iron ought to be put under the grating immediately over the Governor.

Wherever it is possible, even at the expense of considerable inconvenience and cost, all Governors ought to be so located that they can be driven from the forward end of the crank shaft, as this is the *only position* in which it has absolutely full control over the engines in case of an accident. If the driving sheave is put on the screw shaft, and a break occurs between it and the crank shaft, the Governor would immediately be thrown out of action, and the engines would fly away uncontrolled; whereas, if it is on the forward end it is bound to control the engines. Drawings Nos. 3 and 4, show an arrangement for facilitating the fitting of the Governor-sheave on the forward end of the crank-shaft. As will be seen from these drawings the arrangement consists of fitting a pair of narrow-faced friction driving sheaves, the small sheave being carried by a counter-shaft, under the starting platform, the forward end of which is carried by a small bracket attached to the bulkhead. Close against the bulkhead is a rope driving sheave so as to lead the rope as close up to the face of the bulkhead as possible. By the arrangement shown the Governor can be thrown on or off at pleasure without touching the driving rope.

The machine ought to be so situated as to get the most direct lead for the driving rope; this can generally be taken round corners by means of guide pulleys. A tightening gear must be fitted so as to take up the slack of the rope. Frequently, objection has been taken to these driving ropes on account of their wearing out so soon. This wear is due to non-attention to the very specific instructions sent with each machine, with regard to the section of the grooves in which the rope has to run. If these instructions are fully carried out there is no reason why they should not run for twelve months or more. Plenty of similar ropes—hundreds of miles—are working continuously in cotton mills at speeds eight to ten times that required for driving the Governors.

Of course the sheaves on the Governors are turned to their proper section and well-finished, and the difficulty always arises in the driving sheave, which is generally left to a prentice hand to turn up to his own section, which is always fatal to the life of the rope. The groove of the driving sheave ought to be $1\frac{1}{4}$ inches wide at the top, 1 inch deep, and $\frac{3}{16}$ inch radius at the bottom. If the V is left rough it is bound to cut the rope. The rope used ought to be white cotton

$\frac{1}{2}$ in. to $\frac{5}{8}$ in. diameter according to the size of the machine, well stretched and put on tight with a good neat long splice, and well smeared with waterproofing composition. If this is properly put on the rope will not expand or contract from wet, damp, or heat. It will always be supple, smooth, and have a good face for adhesion.

The driving sheaves ought to be so proportioned, according to the speed of the engines, as to give 250 revolutions per min. to the Governor sheaves. There have been cases where the machines have had to run as high as 750 revolutions per min., which necessitated special arrangements.

Drawings Nos. 3, 4, 5, 6, 7, 8, and 9 show several different arrangements for leading and guiding the ropes.

The position of the Governor which offers the greatest facilities for driving and accessibility having been decided on, the next question is regarding the connections between it and the Throttle valves, which sometimes are difficult to arrange satisfactorily. Drawings Nos. 3, 4, 5, 6, 7, 8, and 9 show how some of these connections may be made. In all cases the connecting rods ought to be provided with right and left hand adjusting screws as shown in drawings 3, 4, 5, 6, 8, and 9.

Where the connections are exceptionally difficult on account of the number of turns or want of space, the connection between the Governor piston and the Throttle valve may be made by means of two steel wire ropes or cords, which can be lead over and round any number of turns and at any angles without difficulty, and can be placed in position and carried through spaces where it would be utterly impossible to get connecting rods, brackets, or guides. Drawing No. 7 shows one arrangement where these wire rope connections are used. At a distance of not less than three feet from the end of the piston rod, when it is out, is a double lever connected to the piston rod by a connecting rod, provided with an adjusting screw. To either end of this lever is attached a steel wire cord, which can be led away direct to a double lever on the throttle valve spindle, or to a similar lever on a small counter-shaft. These wires are always in tension, so that any movement of the Governor slackens one and pulls on the other. A very small steel cord is good for a pull of over a ton, which is in excess of what any throttle valve ought to require to move it.

The Governor will work in any position; so that by fixing it with

the trunnion of the cylinder vertical any horizontal lead may be obtained, or if it is fixed so that the trunnion is horizontal any vertical or inverted lead may be got by swivelling the cylinder.

Throttle valves ought always to be of the balanced butterfly type. Every engine ought to have a *separate* and independent Throttle valve for the Governor, as it is very dangerous to connect it with the hand gear, unless the precaution is taken to disconnect the hand lever. This latter arrangement is not recommended, as every Engine ought to be provided with a Throttle worked by hand, totally distinct from that worked by the Governor.

In no case ought a *double-beat* Throttle valve to be used.

STEAM-PIPES.

Be careful that the steam is taken from the steam-pipe between the Throttle valve and the Boiler. Many instances have occurred where it has been taken between the Throttle valve and the Steam chest, so that when the Throttle was closed there was *no steam* for the Governor to open it with.

It must be distinctly understood that the steam fittings are not intended as gauges for the sizes of the pipes—a small cock will discharge more steam than a long length of pipe double its diameter can possibly carry. It is very important to bear this in mind, otherwise the movements of the Governor may be very slow.

The shorter the steam-pipe the better, on account of condensation, and in no case should it be less than $\frac{1}{2}$ in. in the bore. If it exceeds 12 feet in length it ought to be larger.

In nearly every instance the steam-pipe has to be brought downward to the machine. When this is the case it is advisable to bring the pipe down with a bend or pocket at the bottom provided with a small drain cock so as to keep it free of condensed-water. Unless this is done the action of the machine will be very sluggish, as it will be actuated by hydraulic instead of steam pressure. Not only so, but there is a liability, when in a cold climate and the engines not at work, of the pipes filling with water and bursting.

The exhaust pipe ought to be in proportion to the steam, and drain towards and be carried to, the Condenser, on which there should be a cock or stop valve.

The drain from the steam-pipe and also from the Governor cylinder ought to be carried into the exhaust pipe with as short a connection as possible.

WORKING.

The most important points in connection with these Governors are:—

- 1st. That they ought always to be running whenever the Main Engine is at work.
- 2nd. Keep them clean and properly lubricated. Ten minutes out of the twenty-four hours will be ample time for this.
- 3rd. Don't give too much steam, nor have any water with it, and give free exhaust. See that the cock on the Condenser is open.
- 4th. See that the driving rope is not slipping; but don't have it too tight like a fiddle string.
- 5th. Set the drain cock so as to keep the cylinder just free of water.
- 6th. See that the water cylinder is quite full, with water or an oil which will not churn thick.
- 7th. Do not screw the gland nut on the slide valve spindle too tight, or it will prevent the machine from working.

To *increase* the speed of the Main Engines *tighten* the thumb screw on the top of the spring To *reduce* the speed of your Engine *slacken* this screw.

Treat these machines as if they were really your own invention; they will then give you every satisfaction.

COMPOUND ATTACHMENT.

This is a very simple contrivance for controlling the low pressure Cylinder in an ordinary compound engine, or the intermediate and low pressure in a triple compound. As a rule it will be sufficient to fit this on the low pressure Cylinder *only* of a triple job. The apparatus itself is fully detailed on drawing No. 2, which illustrates the cheapest and quickest form in which it can be applied to existing engines. The relief valves are raised from the cylinder cover by means

of the T-pieces shown; on these T-pieces are stop valves. The two stop valves are connected by a properly proportioned pipe with a valve in it operated by the Governor. This arrangement, of course, necessitates the removal of the top connection in lifting the cylinder cover.

By the courtesy of Mr. Bain, Superintendent Engineer of the Cunard Company, the writer is enabled to show drawing No. 9, illustrating the arrangement of the Compound Attachment as fitted to the Cunard S/Ss "Scythia" and "Bothnia." You will see that this arrangement allows the cylinder cover to be lifted without interfering with the attachment.

The best arrangement undoubtedly is that on drawing No. 7, showing a connection between the Compound Attachment and the steam passages; the advantages of this arrangement are:—

First of all, it does away with the two stop valves, and materially shortens the length of the pipe; and further, the Compound Attachment valves do not move until the H.P. throttle valve is one-half or two-thirds shut, when the remaining one-half or one-third stroke of the Governor piston throws the valve wide open, and on the return stroke fully closes the valve on the first one-third or one-half of its stroke.

GENERAL REMARKS.

Governors, as generally fitted, *only control* the admission of H.P. steam; such being the case it is manifestly unfair to condemn them if they do not govern a triple engine so well as might be desired, as it must be evident that to control a Triple Cylinder Engine perfectly, you must have hold of *more than one* of the cylinders. This question of the duplex controlling of multiple cylinder engines was strongly urged in the writer's previous paper.

It is generally found that a Governor is specified without any reference to the *size* of the machine to be fitted. So frequently is this the case that one is almost led to believe that they are generally considered to be known quantities, but this is not the case in connection with Governors, and is a frequent source of trouble and disappointment. The Governor ought to be in proportion to the size of the engines to be controlled; but this is rarely the case. When it is simply specified "a Governor to be fitted" the smallest size is generally selected because it is cheapest. Surely it will be

patent to all present, that a Governor ought to *bear some proportion* to the Engines it has to control, on the same principle that a Safety-valve has to be in proportion to the size of the Boiler.

In deciding the size of the Governor to be fitted, besides the actual size of the engines, some reference must be had to the weight and friction of the gearing between it and the throttle valve.

The writer recommends :

| | | | |
|---|---|------------|-----|
| For an engine indicating not more than 400 H.P.—a Governor marked A | | | |
| „ | „ | 1,200 H.P. | „ B |
| „ | „ | 2,500 H.P. | „ C |
| „ | „ | 4,000 H.P. | „ D |
| „ indicating over „ | „ | 4,000 H.P. | „ E |

Very erroneous opinions are held with regard to this Governor : the remark frequently having been made “ Why, a 3 in. cylinder and 150 lb. of steam ought to work any throttle valve ! ” So it would if there were no conditions attaching.

First of all, it is not advisable to work with such excessively high pressures, better results are obtained when the steam pressure is reduced to from 80 to 100 lb. per square inch.

In the second place, if the above remark were correct it pre-supposes that there is a perfect exhaust from the cylinder, in which case the Governor would be acting like a steam hammer, dashing the throttle valve backwards and forwards from wide open to dead shut. With such a Governor, it would puzzle the cleverest of us to control any Engines.

In the third place, in this Governor, when at work, there is a constant steam pressure in both ends of the cylinder to the extent of about two-thirds the initial pressure, so that the piston is moved by allowing a small quantity of steam to exhaust from one end, and admitting some live steam to the other end. By this arrangement, the piston is caused to float in the middle, or any portion, of its stroke.

The piston never goes right in, unless to prevent a heavy “ Race.”

Since the writer had the honour of reading the paper previously referred to, he has had his attention drawn to a very extraordinary case of improper fitting of a Governor much too small for its work. On examining the machine on board the vessel, it was found to be a “ B ” size, which as a maximum, was only suitable for an engine of

1,200 I.H.P., whereas the engines to which it was fitted were between 5,000 and 6,000 I.H.P.

It is outrageous that the Builders should have fitted such a machine, as they must have known, in fact *did* know, the machine was utterly incapable of performing the work it was intended to do. Such conduct is wholly unbecoming of any respectable firm, and is a gross imposition upon both owners and makers, as the machine was sold on the distinct understanding that it was to be fitted to proportionate sized engines. Cases such as this only tend to bring the machine and its maker into disrepute. It therefore behoves Engineers to be on their guard—first of all, to specify exactly what they want fitted, clearly defining their requirements by the initial letters above referred to (which are cast on the cover of the water cylinder), and secondly, to see that they get what is specified. If you do err, err on the right side, and have the Governor a little too large, it will certainly tend to efficiency in working.

The writer cannot conclude this paper without again urging on the Members of this Institute the importance of more attention being paid to what has hitherto been considered such an insignificant thing as a Marine Governor. As compared with the Main Engines it is undoubtedly insignificant, and the treatment it receives, it is much to be regretted, generally renders it still more so.

Referring to the writer's remarks in the previous paper respecting the proportion of breakdowns in fine as compared with rough weather he has recently communicated with most of the leading Steamship Companies, and their replies fully confirm his statements; 95 % of them have never had any breakdowns except in fine weather.

One breakdown will pay for a cargo of Governors.

It is to be hoped that the time has now arrived when they will be assessed at their real value by Owners and Underwriters as well as by Engineers.

MR. P. SMITH'S REMARKS.

Mr. P. SMITH said: I have had much pleasure in listening to the very interesting and instructive paper on the Marine Governor just read to us. I think Mr. Churchill deserves great credit for the time and trouble he has taken in perfecting his Governor, and for placing in the hands of the Marine Engineer such an efficient speed regulator in bad weather, as is the ingenious little machine he has just described to us. It is a great pity that Engine-builders pay so little attention to the fitting of the Marine Governor, it seems to be looked upon as of only secondary importance, and often placed in some inaccessible corner, where it is impossible to give it the care and attention it deserves.

I have no doubt Mr. Churchill has often been discouraged by having his Governor badly reported upon, if not condemned altogether, simply through bad fitting. I ought to state that I have been ship-mates with this Governor for the last two years, and that I have found it to be the most sensitive and effective Marine Governor I have yet seen. It does not anticipate the racing as some Governors are supposed to do; but it does the next best thing, it shuts off the steam at the slightest increase of speed. It will reduce the speed to any number of revolutions by slackening the thumb-screw shown on the drawing, until the Governor closes the throttle valve to give the required speed. I have proved this by adjusting the screw to give, say 50 revolutions, I have then had the steam pressure reduced to 120 lb., with the result that as the steam-pressure decreased, the Governor gradually opened the throttle to maintain the same speed, then by raising the steam to the loaded pressure of 150 lb., the Governor again closed the Throttle, I had this purposely done several times during a watch of four hours, and it was found that the average revolutions per minute as registered by the counter, and taken every half hour, did not vary more than a decimal point; no more can be expected from a Governor than that.

There is one thing I wish to draw your attention to, that is the small Valve shown on the drawing for admitting steam to top or bottom of the Cylinder; I think Mr. Churchill might introduce a better valve here, that valve is a D-shaped valve, and I found that with 150 lb. pressure on the back, plus the vacuum on the other side (as the exhaust leads to the Condenser) the friction on the valve face was too much for the resistance of the fan in the tank to overcome, so that the Governor remained inactive, that is the only defect I found in the Governor. This can be obviated by using reduced steam, I found that

with the Governor exhausting to the Condenser, 60 lb. of steam was quite sufficient to do the work.

I think we require a better style of Throttle-valve for Governors : I don't know of anything better myself than the *butterfly* valve, and that is the sort of valve that Mr. Churchill recommends for his Governor ; but even with that valve, owing to the high pressures we have to deal with now, when the Governor shuts the Valve dead we have the Boiler pressure on one side and something approaching a Vacuum on the other, which causes an enormous friction on the spindle, and requires a heavy pull to open it. I don't recollect any further points I wish to speak on ; but will hear what other members have to say on the subject.

MR. H. W. WHITE'S REMARKS.

I have listened with interest to Mr. Churchill's paper, and am glad to have heard it. It is difficult to understand how it is that so efficient a Governor is not put into every passenger steamship afloat, unless the cost be perhaps higher than for other descriptions. I have been informed that there are Marine-engine Builders who prefer to put the money into their own pockets that ought to go to provide a Governor, and on this point Mr. Churchill himself can probably enlighten us. I have known cases where Governors, much too small for the engines they were intended to control, were put in, and recently I saw a Governor only fit for a land engine, put into a ship against the strong protest of the Engineer. But what, I would ask, can compensate for the difference in first cost, when the result has to be measured by a breakdown such as that of the "City of Paris?" The slightest reference to that instance is enough ; to my mind it is absolutely certain that had her Engines been fitted with a Governor dependent for its primary motion on a variation in the resistance to the Engines—those Engines would at this moment have been in as good condition as they were up to the time of the smash.

In the case of the "Deccan" the Governor was *not* working when the shaft broke. The description of the racing and its influence on the minds of the passengers, as told me by one of them, will not be easily forgotten. In the case of the "American" it was, I believe, admitted that the shaft broke somewhere in the fine part of the ship, the free end during the racing that ensued, punched holes in the hull

plating or the Stern-tube so that the sea could not be kept out, and *in an absolute calm the ship went down* many miles from the nearest land. By the greatest of good fortune no lives were lost; but the Ship and all that she contained was.

The case of the "Danmark" is so fresh in all your minds that I only refer to it as in entire corroboration of the arguments. From a reliable source I learn that a very large percentage of breakdowns occur in fine weather—that is to say in weather such as would not give the starting impulse to a Governor dependent on varying draught at either the bow or stern of the ship—can any reasonable doubt then exist in the minds of impartial and experienced men as to the necessity of a Governor whose impulses are due, as I have before said, *to varying resistances of the shaft?* I think not, and I do not particularly envy the reflections of the Engineer at whose instance such a machine has been put into a vessel, when a little later his action is endorsed by the Engines racing to their fullest extent, and then smashing themselves to pieces—*Verbum sat.*

My own experience of the Durham & Churchill Governors, has been limited to two ships—one of about 9,000 H.P., the other nearly 12,000 H.P. In these ships I always kept the Governor running with the Main-engines, although they required a little attention to maintain their perfect condition, I was amply compensated for the additional work by never having a breakdown nor any anxiety in that direction. The Compound Attachment described in the paper, I have had no sea experience with; but I am quite of opinion it would as effectually control third or fourth Cylinders, as the high pressure is by the action of the Governor on the Throttle-valve, and that it should be fitted to triple and quadruple Engines. If I have not taken up too much time, I will beg your permission to express the earnest hope that the Maritime Authorities of this Kingdom will insist, not only on a Governor reliable at all times for efficient control of the Engines being fitted in every passenger steamer under the flag; but also that the Governors shall always work with the Main-engines subject to some such regulations as are now compulsory with Safety-valves.

I should be glad to be able to state with some accuracy the annual loss to Steamship-owners by their vessels being laid up through causes that to my mind are largely preventible. At this moment all I do know is that the loss from this cause is enormous, and I am certain the Members of this Institute will generally agree that loss, from a preventible cause, is much to be deprecated. I do not doubt that.

many here spend a large proportion of their time in doing all they can to reduce this loss, and I am sure every right-thinking man here, or elsewhere, will wish them success in their efforts, I beg leave to thank Mr. Churchill for his paper on a subject that has always been of great interest to me, and now more than ever so.

MR. C. E HUDSON'S REMARKS.

Mr. Churchill points out that the mechanism of his Governor is very sensitive, very delicate, and that it should be used as a continuous action machine.

No doubt the Marine-engine requires a Governor whose functions should be two-fold at least, first, it should be of an anticipatory character; and secondly, it should efficiently control the Engine.

I cannot say in my experience with very many Governors that I have met either one or the other to the degree necessary.

In endeavouring to search out a cause for these defects it almost invariably was in the detailed fittings on board ship, such as the ropes chafing in a short time, through defective leads, the various small rods springing, &c.

It is to be regretted that the Makers of these various machines have not found it necessary that these parts require more than ordinary supervision in the fitting up.

In actual practice I think I may say that most Engines are governed by hand, unreliable as the human element may be.

Under such circumstances it has this value, that an Engineer of short experience instinctively knows when to shut off the Steam, here you have something of an anticipatory character; from this same cause, no doubt, can be traced the reason why Engine-builders do not trouble themselves more about the Governor fittings.

Up to the present the making of the machine was thought one thing and the fitting up another, the fault is somewhere, and between it all the Governor has suffered. I hope this state of affairs will be so no longer.

In the various mechanical appliances now being fitted to Steamships great care is necessary that these are complete in every particular; it is within my experience that this attention has been paid by various Clyde firms, and the same feeling is spreading to the Tyne.

I see no reason why the Governor should be any longer an out-cast; on the contrary, if these various points are carried out satisfactorily it will, I feel sure, become an integral part of the engine.

I should like to hear this evening something from an anticipatory point of view.

MR. J. G. HUDSON'S REMARKS.

There is no doubt that many a good Governor has been robbed of its efficiency through the faulty attachments, and has given the Governor itself a bad character, when, in most cases, it has not been with the Governor itself that the want of efficiency has been felt. I coincide with Mr. Churchill that they ought, if possible, to be driven from the fore end of the crank shaft, and also that the connections from the Governor to the Throttle should be reduced to a minimum. I think, also, that Mr. Churchill is right in saying that the Governor should have a separate Throttle, but at the same time, I think that the Engineer should have control of that or some other throttle in case of any accident to the Governor, so that he could throttle by hand. By control, I mean that he should be able to manipulate it from his Starting-platform.

I, myself, have a painful remembrance of how a Governor ceased to become a Governor owing to the manner of fitting the driving gear; as for the Governor itself, it was one of Mr. Churchill's older forms, without the Compound Attachment, and which in other ships I have been in I found to work admirably.

I will describe the manner it was driven:—Imagine a 4 in. strap running from the after-coupling of the Crank shaft, at an angle of 60°, with the horizontal plane, to a counter shaft just under the top platform on the port side of the ship, this shaft having other duty to do; viz., to drive a fan for the purposes of ventilation, and was made stronger than it would otherwise have been if it had only had to drive the Governor. The counter shaft ran in three bearings which were bolted to a bunker, and ran the whole length of the engine room fore and aft, say 24 feet; from the forward end of this shaft a rope connected across the breadth of the Engine-room to the Governor, which was placed on a shelf on the starboard side, directly opposite the Throttle-valve. The connection between the Governor and the Throttle left nothing to be desired, only a connecting rod some 18 in. or so, long, connecting the piston rod of the Governor piston to the Throttle-valve lever. It is not at this end that I found any fault, but at

the other end, where the fault was. Firstly, the trimming of the coal and the consequent buckling of the plates threw the shaft out of line, and it absolutely refused to revolve at all. This was remedied by placing packings behind the bearings and freeing the bearings in their brasses. You will bear in mind that this work had to be done just when it was most difficult, namely, when the engine was racing heavily and the ship pitching and tossing, when it required all hands and feet, to keep oneself steady on the platform. Having got the shaft to work, our next difficulty consisted in keeping the strap on the coupling, the splashing of oil and water causing it to slip so much: until, after having exhausted all our ingenuity, the strap eventually gave way, and consequently the Governor ceased to act altogether. In our case we had no means of opening and shutting the Throttle *by hand* from the Starting-platform, and therefore our only resource left was to govern the Engine by throwing the link motion into mid position when we wanted to ease her. This ship eventually lost her Propeller blades, and had to be towed part of the way into port.

MR. A. SOMMERVILLE'S REMARKS.

Mr. Churchill has told us in all human probability, if his Governor had been used with Throttle-valves on the steam pipe of each Cylinder, and his Compound Valve on the low pressure Cylinder, and kept continually at work, the lamentable but instructive breakdown on board the "City of Paris" would not have taken place.

I have no doubt but this system would have *lessened*, but not entirely prevented, the disaster, at least my own practical experience in a breakdown, somewhat analogous, tells me so.

Twenty years ago I was Second Engineer of a ship with Oscillating Geared-engines, about 1,500 I.H.P., geared about three to one, averaging about twenty revolutions per minute. I recollect well standing with the Throttle valve handle in my hand reducing the revolutions to twelve, by orders, so as to make a port at daylight; when suddenly I saw the driving wheel, thirty tons weight fly round at a terrific speed, I could not see the circle the Cranks made, and as the Air, Feed and Bilge pumps were of the trunk type, and of course full of water at all times, what with the water flying out of them, and lubricator cups flying about like rockets, all the firemen and trimmers, and all the Engine-room staff (Europeans, I am sorry to say) ran up on deck for their lives, and left me to do the best I could. There was no Steam-

starting-gear in those days, and it was out of the question for me to put over the Links by myself, I ran up and shut the "Main-stop-valve" on the front of the Boilers, and of course stopped the Engines at once.

There was no harm done to the Engines, the Pinion-shaft had broken short off at the forward end of the second bearing; strange to say, as long as the Engines went round the Pinion kept in its place, and did not fall down until the Engines were stopped, when it brought the forward Plummer-block with it.

The lesson I learned from this break down, and which I shall never forget as long as I live, was, that Butterfly valves can never be made tight enough, so as not to allow sufficient Steam to pass to break the Vacuum, and of course the Engines would work as long as there was Steam in the Boilers.

I hope Mr. Churchill will invent some means of breaking the Vacuum, and prevent in future the serious breakdowns we hear of from time to time, and which have caused so much loss of Life and Property.

MR. R. LESLIE'S REMARKS.

I think this subject of Marine Engine Governors is one of great importance and deserving of our deep study, and I cannot say that I agree with Mr. Sommerville when he says that it is only necessary when the Engines are racing in a heavy sea way.

My idea of a good Governor (like the one before us this evening), is that it ought to be automatically constructed so as to be always on the move, ready to stop any irregular movement in the Engine over which it has, or ought to have, *complete* control; and with a Governor of this description fitted I should say that the revolution of any Marine Engine would to a great extent be regular. I have had a good many years experience at sea in many different engine-rooms, both as Junior engineer and also as Chief Engineer, and my natural impulse was (where the Governor did not work well,) to shut off the Steam as soon as possible when the Engines made any attempt at racing. I do not say that had the engines of the "City of Paris" been fitted with the arrangement before us this evening that they would not have broken down as they did; but I have a very strong impression that had Mr. Churchill's or any other equally good Governor (if there are such in the market) been fitted, the destruction to very costly machinery would

not have been so great. One thing I cannot understand, and that is, why Owners of powerful and very costly machinery (like our present Marine-engines) should allow them to move without a Governor. It cannot be because the price of a Governor is so very much, and all the attention they require is very little, and very little steam will work them. I am convinced that a great many non-engineers who are owners never give it a thought. But I am sure that many Engineers will agree with me when I say that it is not the constant sixty revolutions of the Engine but the racing, that (as we say) knocks the engine to pieces. Up to the present the fitting up of Governors has not been attended to as it ought to have been, and the working parts of many of the Governors are not made for constant working. But I sincerely hope that in future as much attention will be given, first, to the construction of the Governors, and second, to the best possible way to fit it in place, as is now given to the Marine-engine of the best make.

MR. L. P. COUBRO'S REMARKS.

In my opinion a Governor, to be really efficient, should be always at work ready to take charge of the Engines at any moment. The idea of trying to control the L.P. Engine as well as the H.P. is not by any means original, as I have been in a steamer which was fitted with a partition across the L.P. Receiver in which were doors actuated by the Governor at the same time as it closed the Throttle-valve. It was however not a success, as, apart from the fact of its making a terrible noise when the doors were shutting, it did not seem to check the Engines racing any sooner than the old arrangement, which simply acted on the Throttle-valve. I think the testimony borne by the Engineers present, who have had experience of Mr. Churchill's Governor with the Compound Attachment, shews that his is without doubt the best Governor at present in use. I fail to see how it is practicable to make a Governor which would be anticipatory in its action.

MR. J. H. THOMSON'S REMARKS.

Several of the vessels in which I have sailed were fitted with a Governor driven in a similar manner to Mr. Churchill's, and if we had to slow down or stop, there was always a difficulty in getting under way again whilst it was in gear, because as soon as the Engine moved, or we tried to increase the speed, the Governor would shut off

the steam with *its* Valve, while we were trying to increase the speed by opening the Main Throttle-valve. Where friction driving gear was fitted it was easy to disconnect it; but if otherwise it was the cause of delay, and that often at a critical moment.

It would be interesting to know if Mr. Churchill's Governor acts in the same way, or if this defect has been overcome.

MR. J. W. DIMMOCK'S REMARKS.

After listening with a great deal of interest to Mr. Churchill while reading his useful paper, and to the discussion which has followed, these two things force themselves upon my mind. First, the Governor under discussion is undoubtedly eminently capable of performing the functions allotted to it: viz., controlling the Main-engines; that as far as construction is concerned (save the double eyes, which may be advantageously improved to suit constant wear, and be made capable of adjustment), the machine is substantial and practical. The second point is, why do we see so many Governors fitted in Engine-rooms which are seldom or never used after one voyage? The answer, that it is owing to the gear—which generally is ill fitted, and with an eye to cheapness rather than efficiency—is far from satisfactory; the Engine Builders have been given the credit for this state of things,—allowing *the nobody* to see it fitted up. To my mind, he who sees that the Crank-shaft is nicely bedded and the Piston properly fitted should also see the Governor fitted to act, and become the Engineer's friend and the Shipowner's insurance; instead of being—as it is too often the case, a great nuisance and anxiety to all on board, and discarded at the earliest opportunity, with a result that the blame is generally misdirected and attributed to the Governor, which may be near perfection. Until a *reliable* Governor is fitted properly, to every Engine, valuable machinery is at stake, and accidents will arise, causing considerable delay, expense, and annoyance to all those concerned.

MR. J. MACFARLANE GRAY'S REMARKS.

Mr. Churchill deserves our best thanks for the very complete paper which he has this evening presented to us on his Governor. The recent disaster on board the "City of Paris" has emphasised very remarkably the statements made and opinions expressed here when the paper on Marine Governors was read by him. It appears that that steamer

was fitted with a Governor which was intended to check racing, only when that was the result of the Stern lifting, and it was therefore of no use when a Shaft broke. I would not on this account however condemn entirely *that* form of Governor. If properly adjusted there is no doubt those Governors have peculiar advantages in checking weather racing. It would be interesting, I think, to have both principles applied in the same ship. That could easily be done in the "City of Paris." There they have already the fittings for the Stern-lifting Governor and it has also a Steam-moved piston for actuating the Throttle valve. If the Durham-Churchill chronometric paddle Governor were added—the slide valve of the one being on the back of the slide valve of the other, and moving in opposite directions—then, whether the acceleration was due to a break-down or to stern-lifting, the Governor, would shut the Throttle valve. The two methods are quite distinct in principle and in this way they might be found to be supplementary to one another. It would be, of course, only in the largest steamers where it would be thought necessary to have both systems. I mean only *one* governing Throttle-valve moved by a steam piston, but *that* actuated by the two automatically controlled slide valves.

THE CHAIRMAN'S CLOSING REMARKS.

(MR. G. W. MANUEL.)

I have listened with great interest to Mr. Churchill's paper describing his Marine Governor. Most of us who have been at sea in the Engine-Room where there were no Governors fitted to the Marine-engine, remember the anxious times we have had when standing by, endeavouring to control the Engines in rough weather, and check "racing," a most difficult, and many times impossible duty; for, however careful, often we found that the very time the Throttle-valve was closed, it should have been opened, and we were glad when our watch was over without having a smash of some part of the Machinery.

The Governor brought to our notice to-night has the merit of being simple as to its parts, and simple in adjustment; this being effected by the tightening or slacking of a single screw.

It is no doubt open like all inventions to further improvement, such as pointed out by Mr. Smith, who has been in charge of one of these Governors about two years, but on the whole Mr. Smith has expressed himself as well satisfied with its efficiency.

It has been well criticised by a number of the Members present, especially as to the details of the working parts in the event of its being used both in fine and rough weather, so that the serious effects of breakdowns may be lessened, such as in the "City of Paris"; all the speakers have dealt with Mr. Churchill's paper in a fair and impartial manner creditable to this Institute. Mr. Churchill, I trust, will make use of the hints thrown out for the further improvement of his Governors.

I may add that the reports I have had from the Chief Engineers of the steamers fitted with Mr. Churchill's Governor, as described, have all been favourable.

From the experience I have had of the different movements of a steamer in rough weather, I doubt if we will ever have what is termed an automatic Governor that will adapt itself to the varied conditions; but that a good deal will still depend on the Engineer in charge.

I regret to say that my own experience with Governors has been that their non-efficiency to do what was required, arose from an expectation that a Governor was perfect, and if it failed to act it was put down as unfit, whereas by a little adjustment after carefully watching its movements, it would have done frequently what was required, the result being that they were too often put aside and neglected, through want of a *little* perseverance.

Mr. Churchill's Governor is nearing perfection, and he deserves credit, along with all who are assisting to improve the efficiency of the Marine Engine, and to keep pace with the improvements that have been made for that end.

I hope that Mr. Churchill will keep us informed of any further improvements that may be made in his Governor.

He deserves your hearty thanks for the paper and for the simple and practical manner he has brought it before us.

MR. CHURCHILL'S REPLY.

Mr. Smith's remarks are particularly interesting and instructive, as first of all he is a perfectly independent and impartial experimentalist with the machine, and I only regret that all Engineers

are not like him. If they had been, there would have been little or no difficulty with regard to Governors. The particulars of the experiments he made are conclusive proof as to the efficiency and delicacy of action of this machine. Mr. Smith's remarks as to the discouragement I have met with in connection with the fitting of these machines are only too true. In fact, in many instances it has not merely been a question of discouragement, but actual disgust with the way in which the work has been done. There are very few who realise the difficulty of the situation. When a Governor has to be fitted the Builders send an order for it, very frequently their inquiry is for a number of machines, when they kindly favour us with an order for one *pro rata*. At one time my firm had a skilled Engineer whose sole duty it was to watch the cases of fitting, and to give gentle hints and suggestions whenever possible. This worked very well at first, but latterly his inspection, much less his interference was declined, doubtless on the ground of economy, and both he and I have frequently been requested, when offering a suggestion as to the size of the machine or the fitting, to go to a place a little warmer than the stokehold.

The only way I see out of the difficulty is that the machines when specified should be specified *to be fixed by the Makers*. By so doing two difficulties will be got over. First, I should certainly decline to fit a machine too small for its work, and secondly, I should be responsible for its efficient fittings.

I think the above remark also deals with some of the questions raised by Mr. HUDSON, Mr. HAWTHORN, Mr. LESLIE, and Mr. DIMMOCK.

I had previously heard of the extraordinary case of fitting referred to by Mr. HAWTHORN, and am thankful to say I never had anything to do with it.

Referring to Mr. SOMMERVILLE'S remarks, then Engine he refers to, appears to have been more dependent for power on her Vacuum than on the Steam; certainly no modern type of Engine with anything like a properly-fitted Butterfly-valve could go through the performance he so humourously describes when once that Valve was closed.

The difficulties referred to by Mr. THOMSON do not apply to this machine.

With regard to the anticipatory action of Governors referred to by Messrs. HUDSON and J. Mc. F. GRAY. The matter has had my

consideration for years, and I fail to see how such a thing can be, under ordinary conditions. The nearest approach to this is undoubtedly in the case of Governors whose action depends on the extent of the immersion of the Stern of the Vessel. With a head sea such an arrangement might show a tendency to be anticipatory, but the extent of that anticipation must be limited to the time of the passage of the wave from the entrance into the chamber to the Propeller. Suppose we take a vessel going 15 knots = 25.3 ft. per second. If the aperture is close up to the propeller, *i.e.* in the finest part of the run, the distance from that aperture to the propeller will only be a few feet and can only represent an anticipation by a small part of a second, and it is probable that the water would have left the Propeller *before* the motion could be communicated from the air chamber to the engine-room. If in a following sea the action is the *reverse* of anticipatory as the seas must leave the propeller before leaving the air-chamber. With seas on the quarter it is well-known the racing is very heavy.

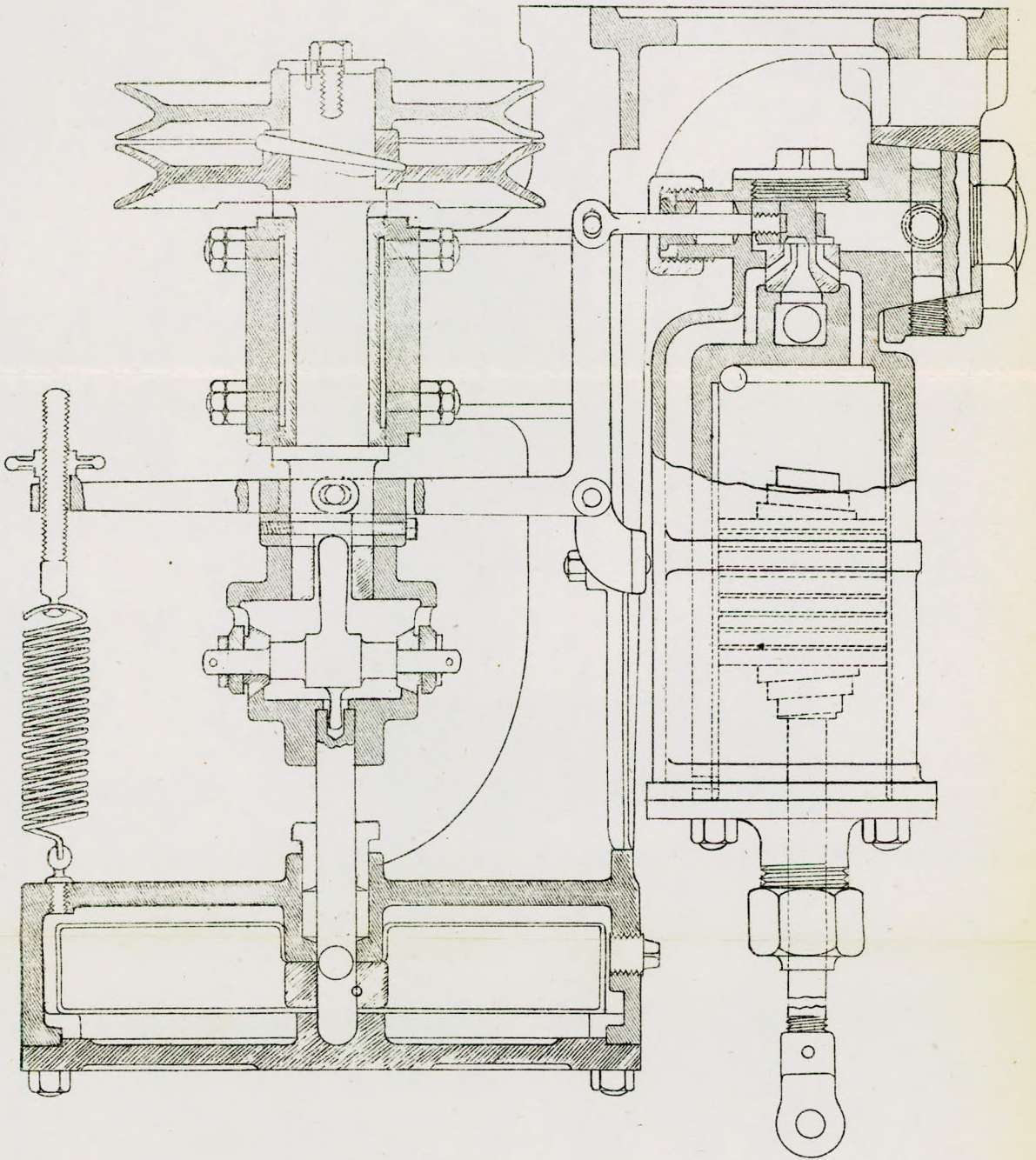
Mr. Mc F. GRAY is always a welcome speaker at these meetings as he generally tells us something worth knowing. It is, therefore, with some regret that I have to differ with him, in regard to his suggested combining of two machines, when my own does everything that is required. To my mind such a combination would be somewhat analagous to adding a fifth wheel to a coach, and an altogether needless complication and expense. Had Mr. GRAY witnessed the experiment made by Mr. SMITH on the P. and O. ss. "Oceana," I think he would have seen that such a combination was wholly unnecessary.

I feel highly complimented by the favourable reception my Paper has received from the Members of this Institute, and I endorse our President's statement as to the full and free discussion of this somewhat knotty matter, and am highly gratified to find that the machine has met with the approval of so many practical men, as it is no light matter to run the gauntlet of 80 or 100 critical Engineers satisfactorily.

MR. ROWE'S REMARKS.

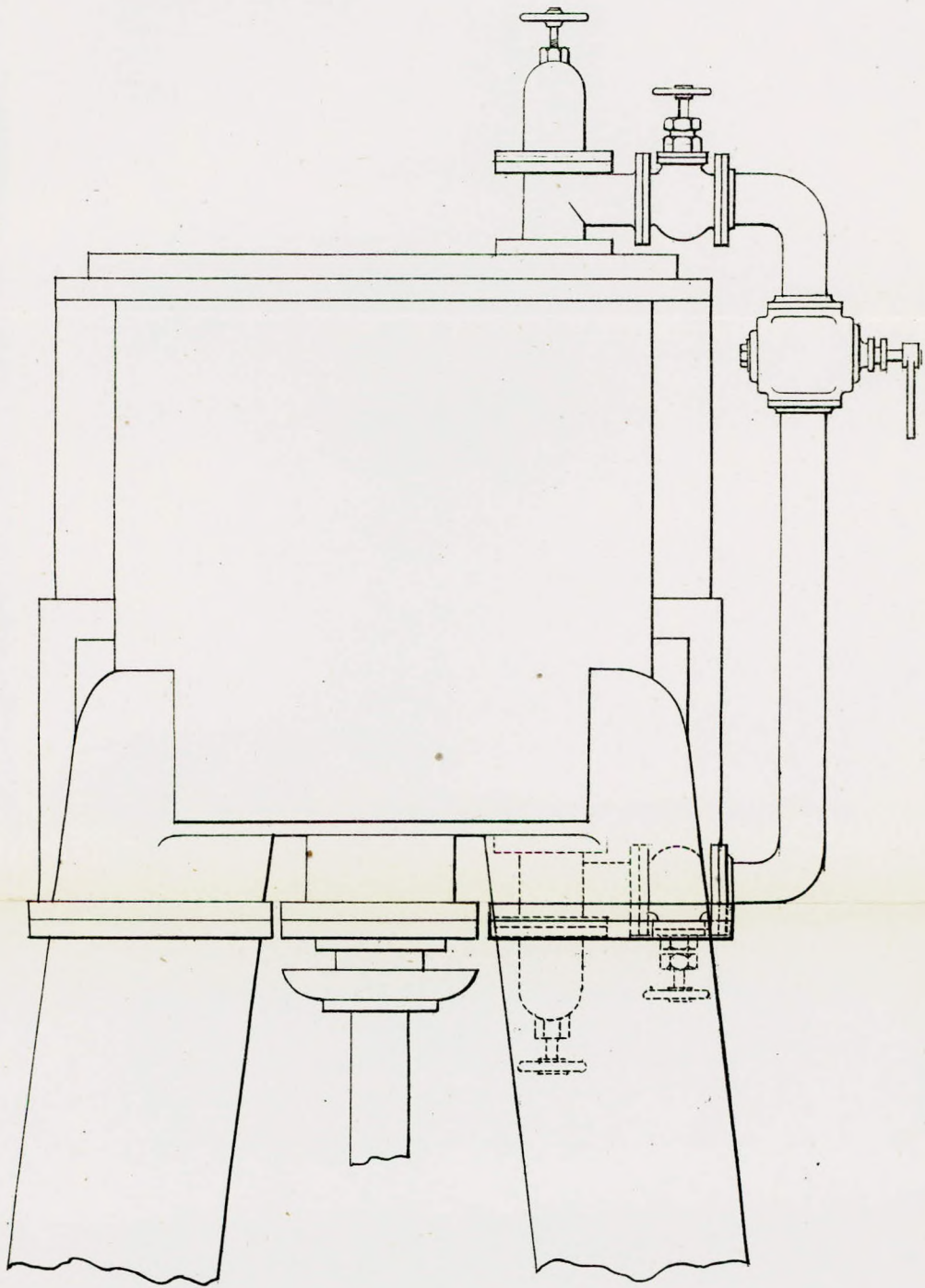
I beg to propose a vote of thanks to Mr. Churchill for his valuable and highly practical paper. I admire the courage he has displayed in coming into a metaphorical den of lions, and holding his own with the

severest of critics, some of whom, though rising as if to disparage, were unable to sit down without offering a tribute of praise to the excellence of Mr. Churchill's invention. The discussion briefly summed up amounts to this. The Churchill Governor negligently fitted and worked is an unreliable instrument. The same Governor properly fitted and intelligently looked after is a most valuable machine to regulate the speed of the engines when racing would occur. Mr. Churchill deserves a hearty vote of thanks.

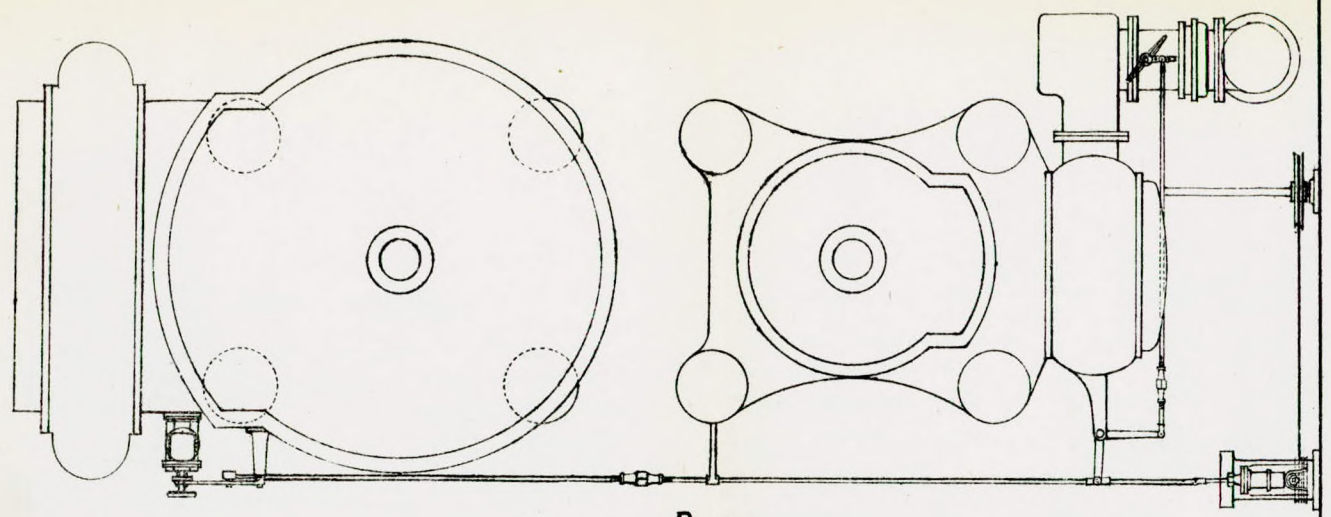


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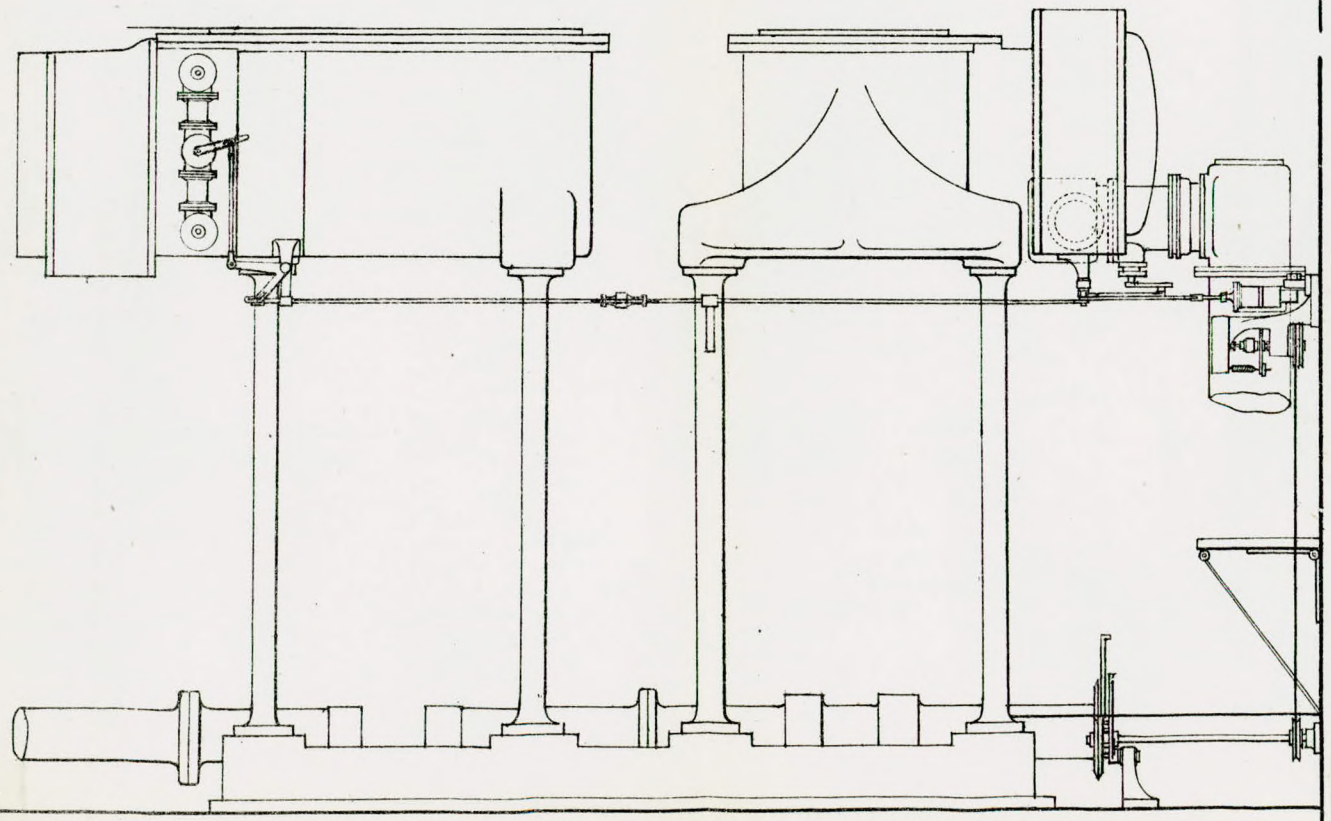
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LONDON, E. C.



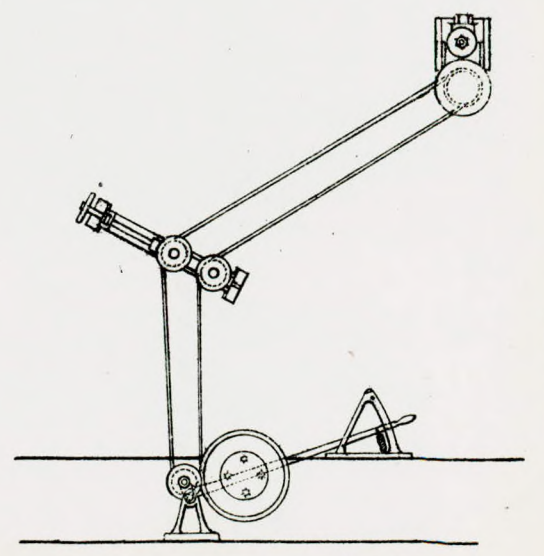
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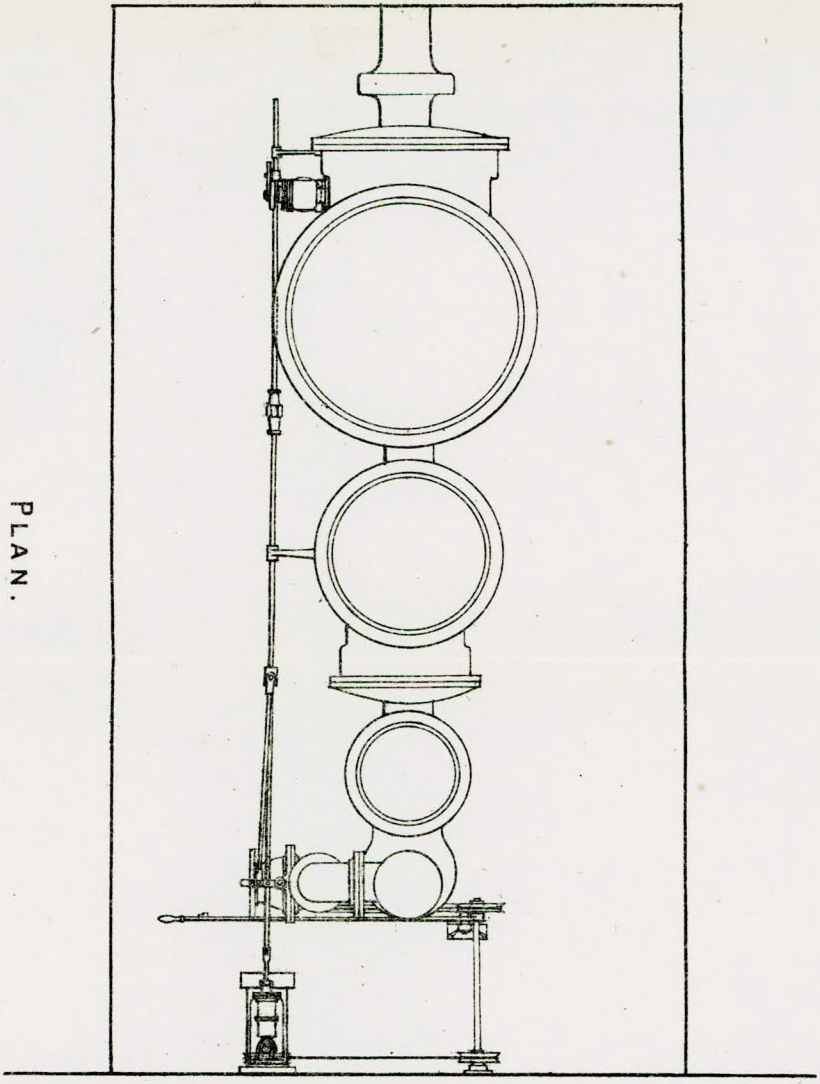


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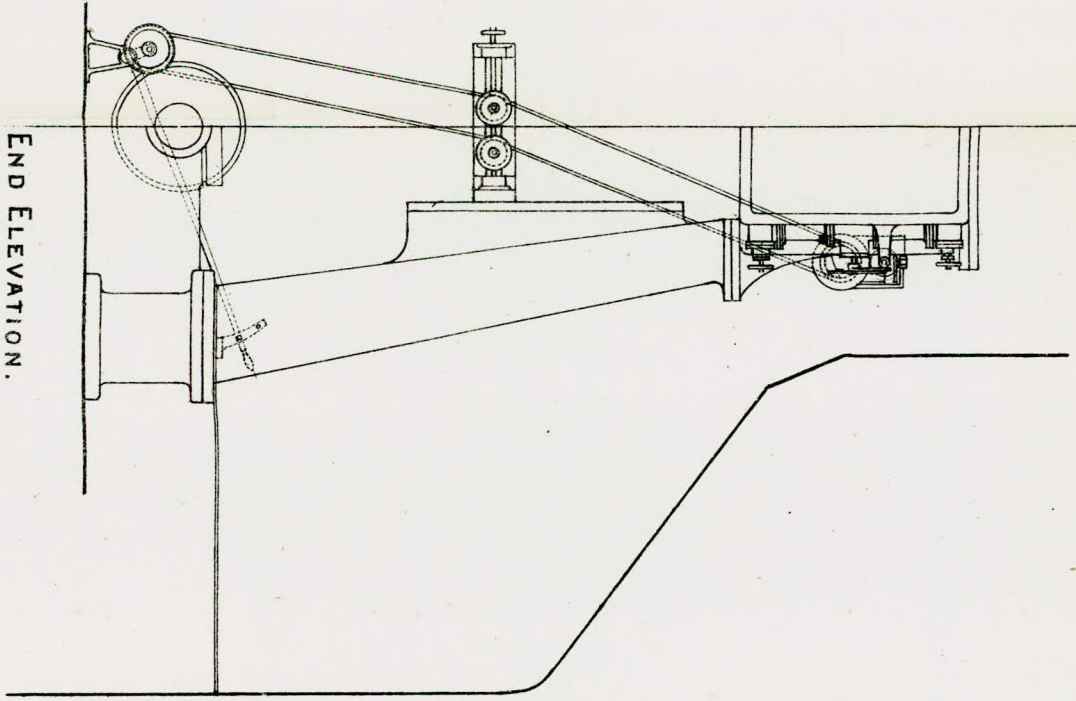


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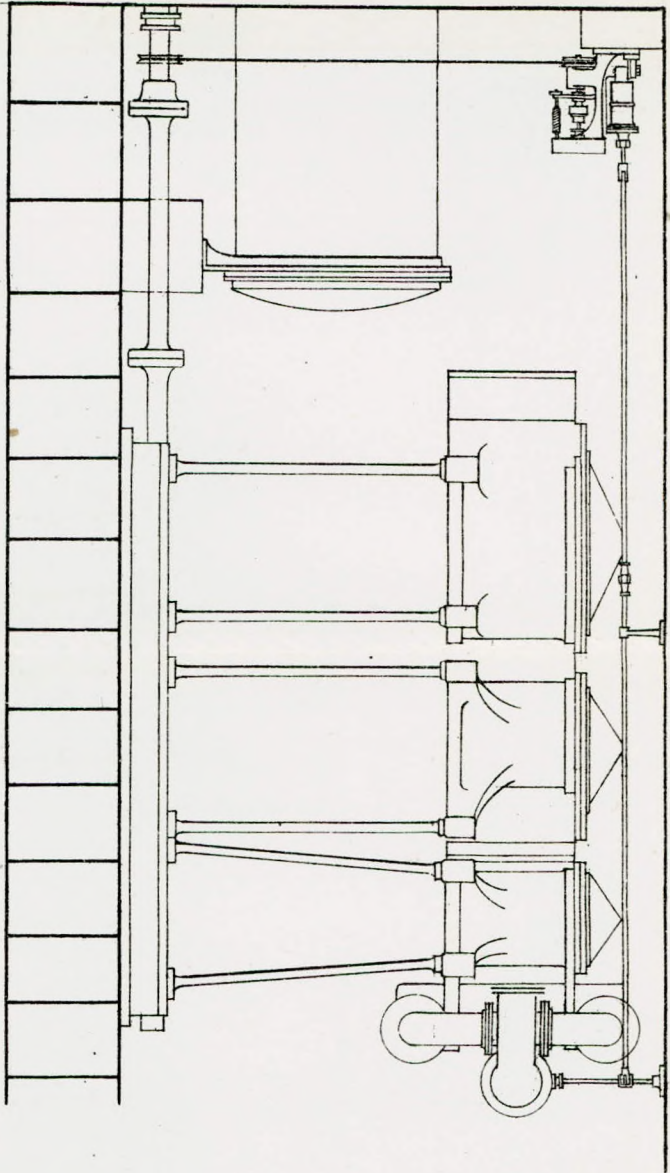
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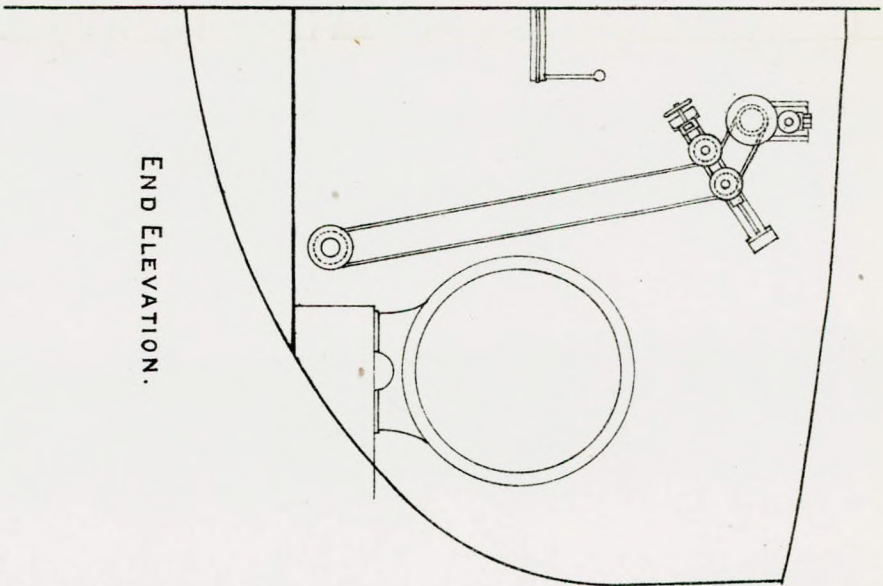
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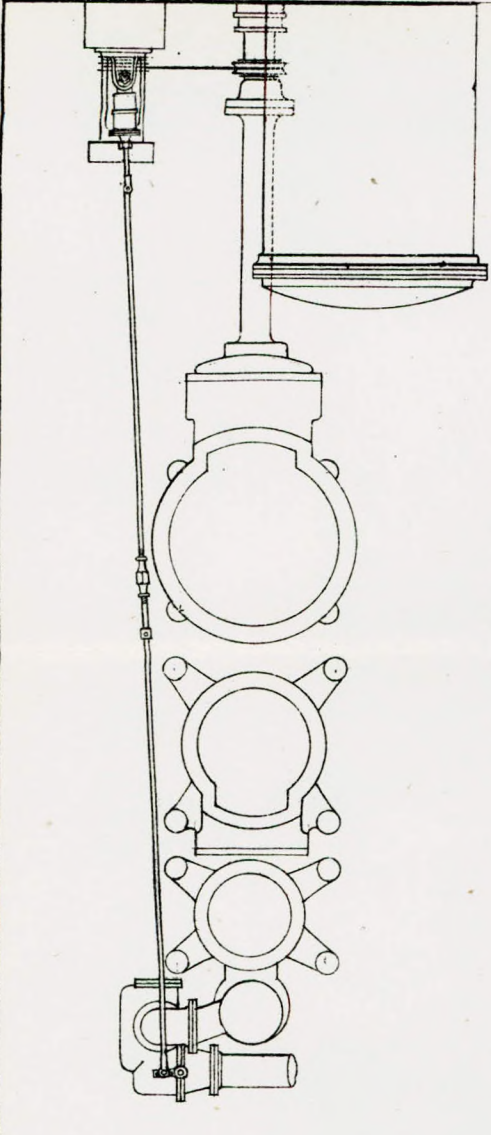
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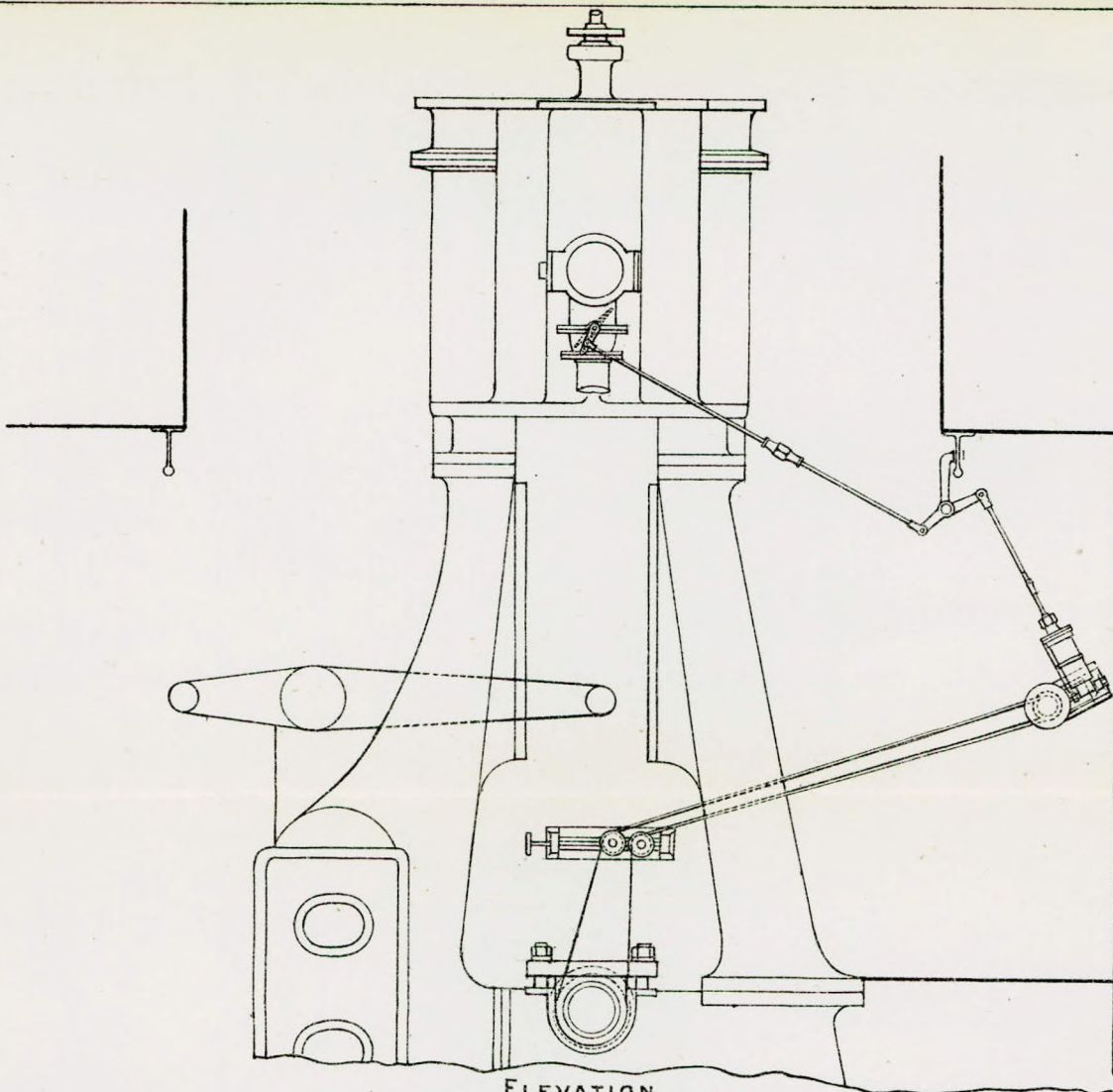
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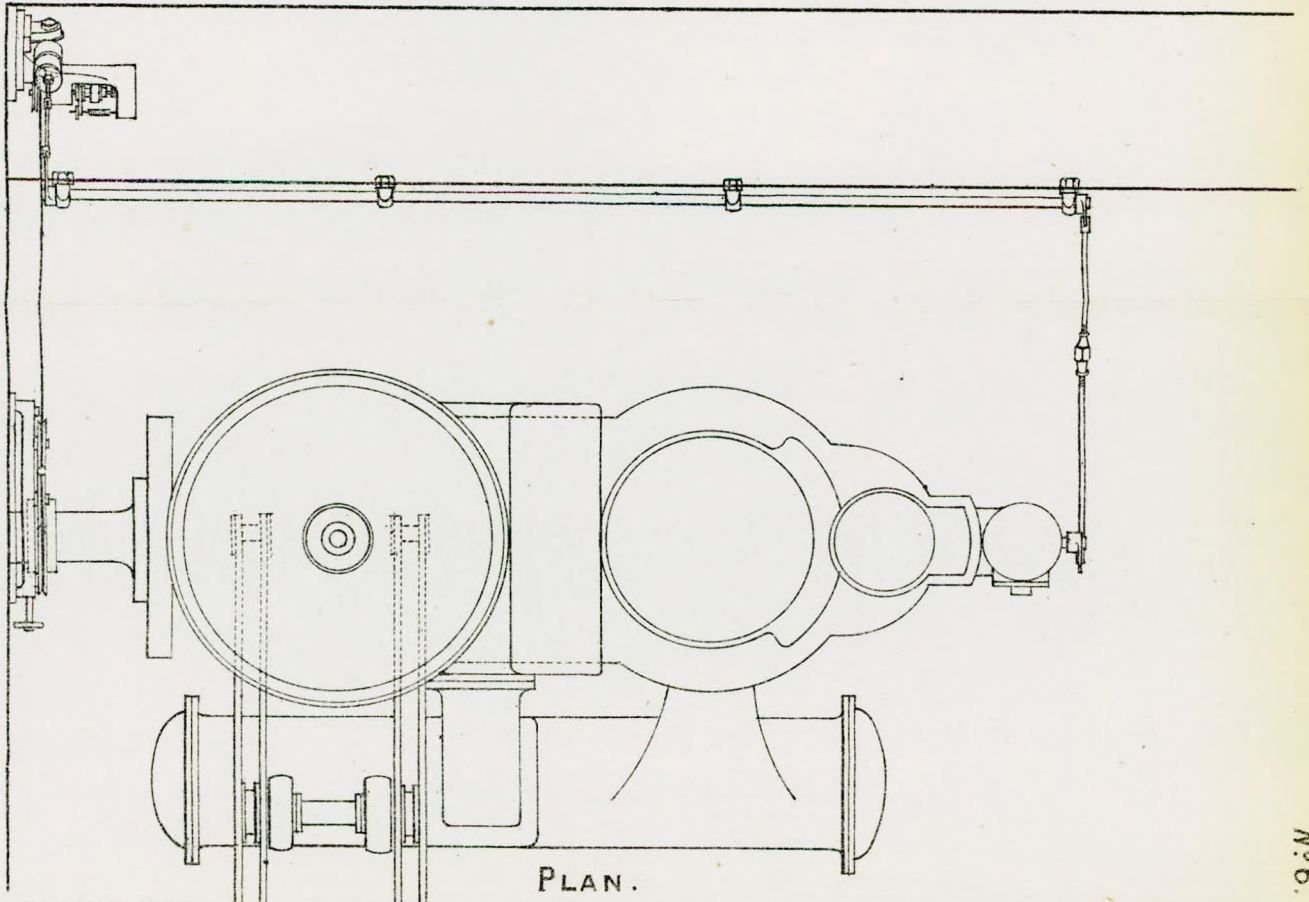
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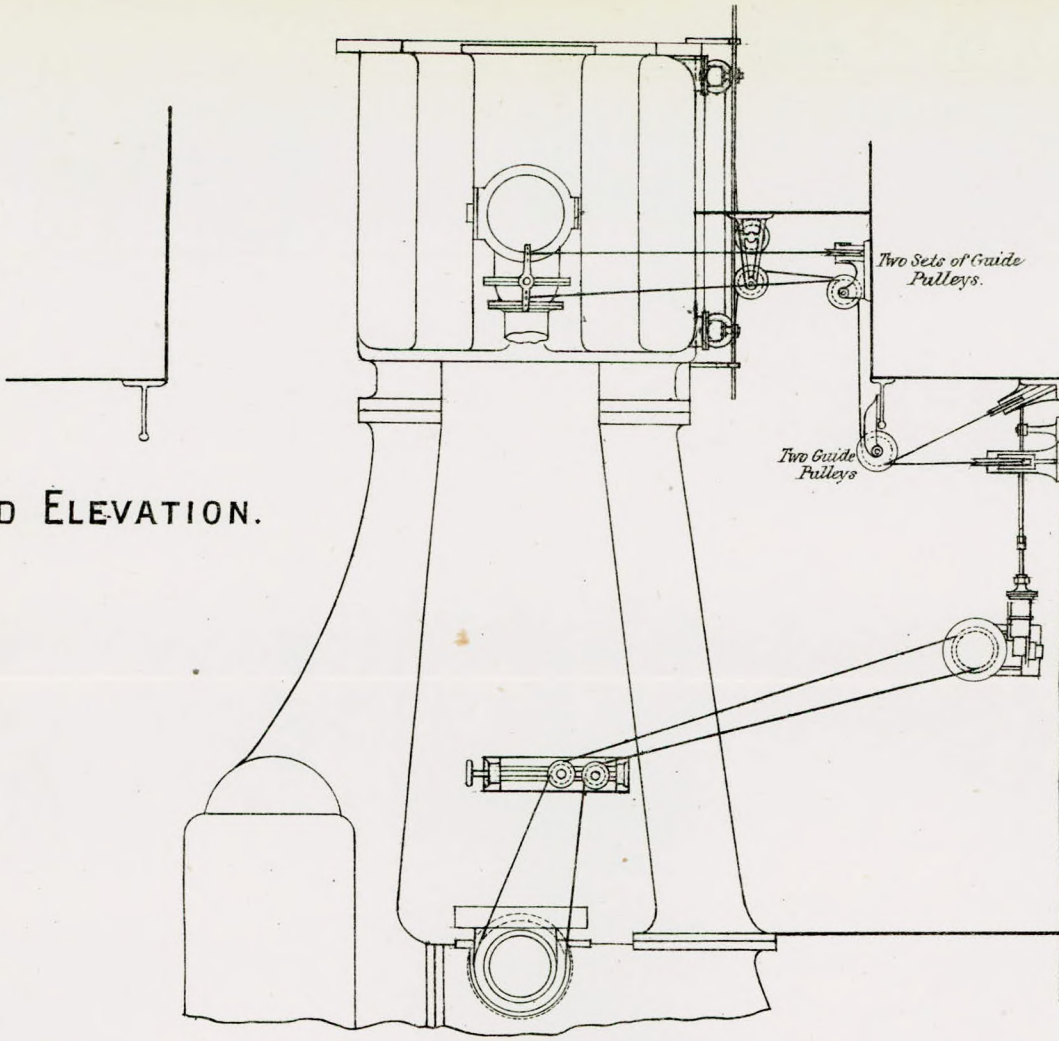


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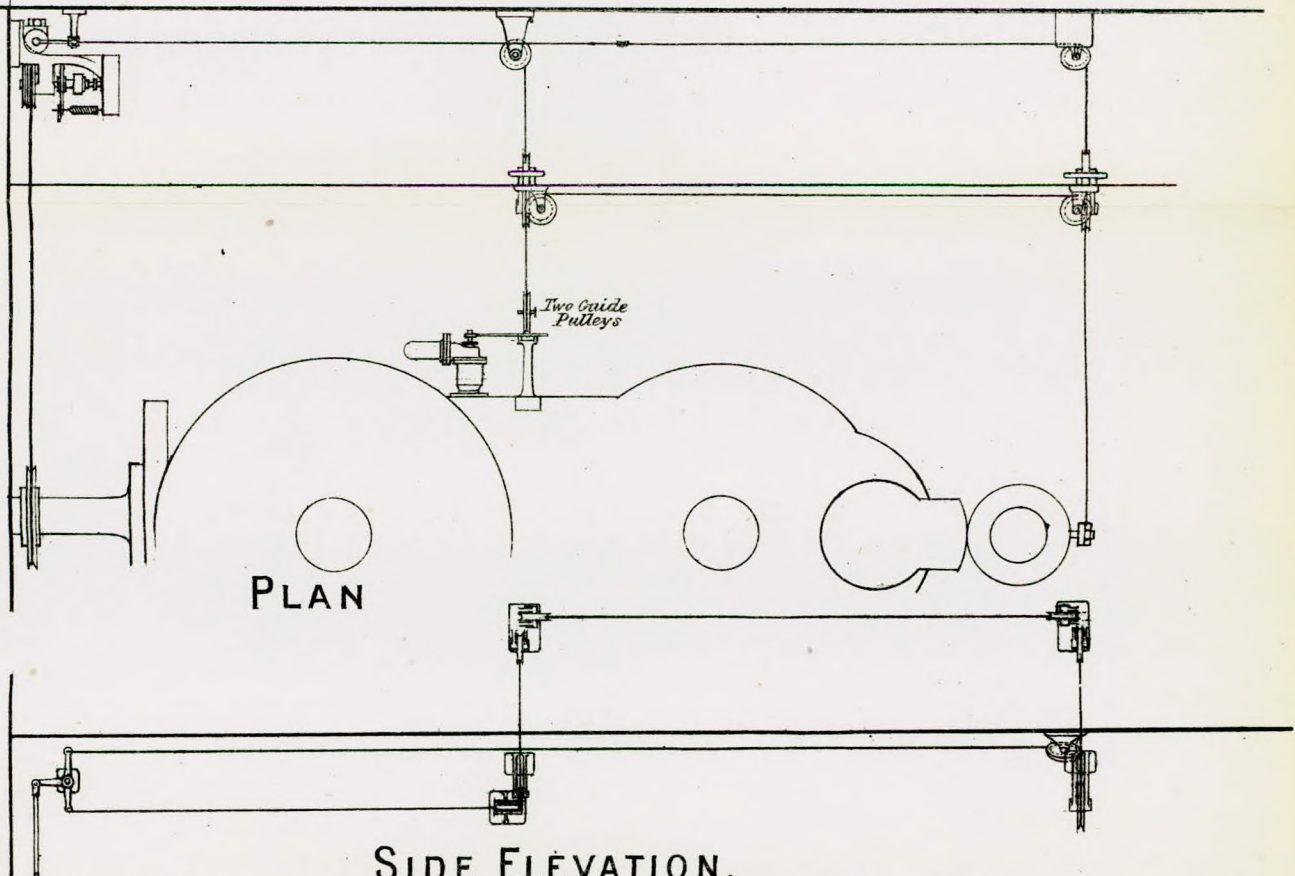


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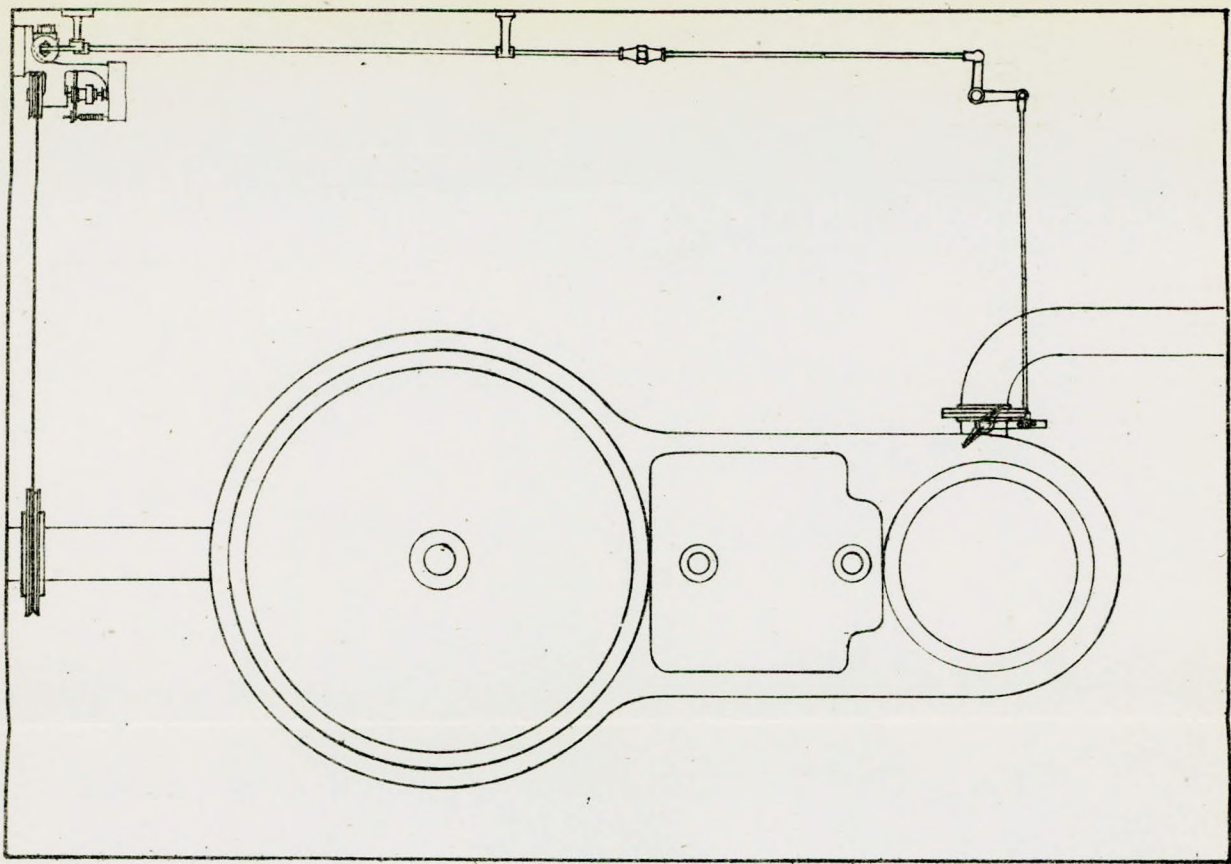
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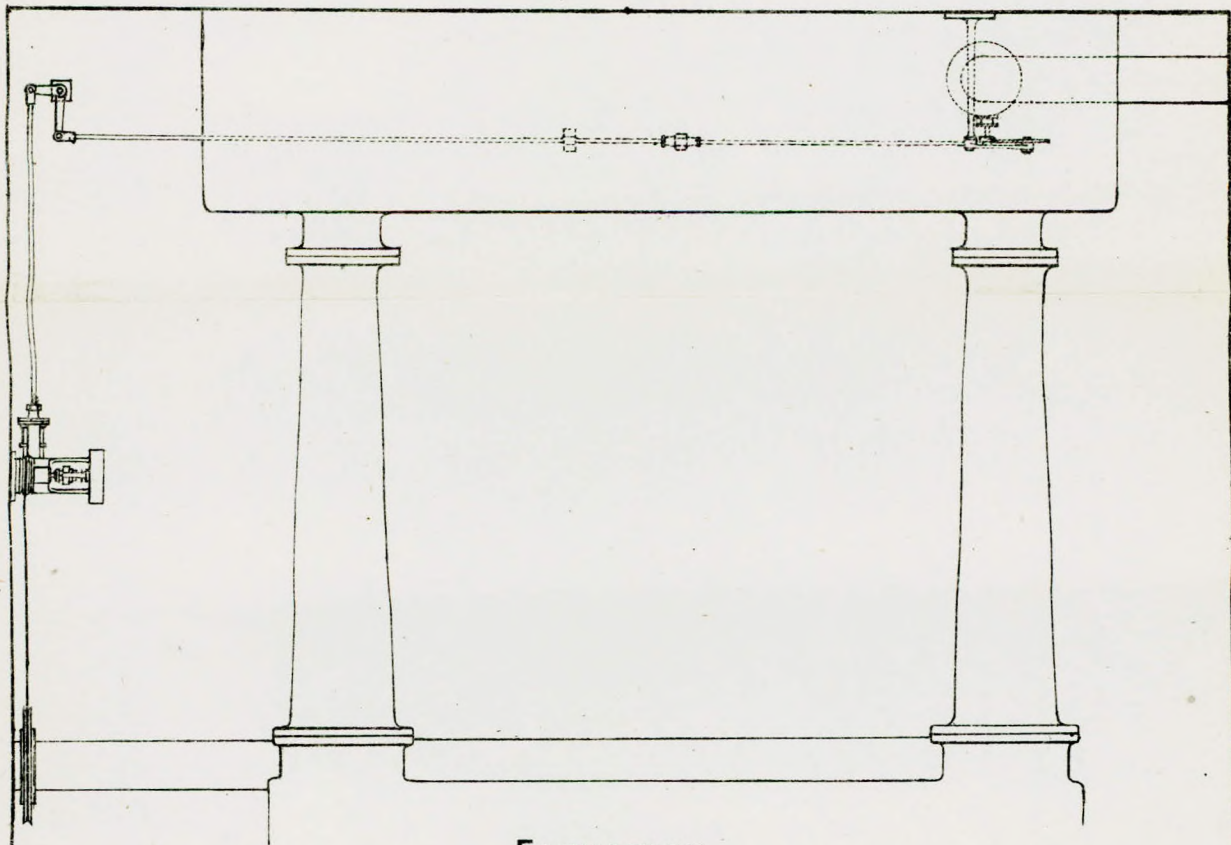
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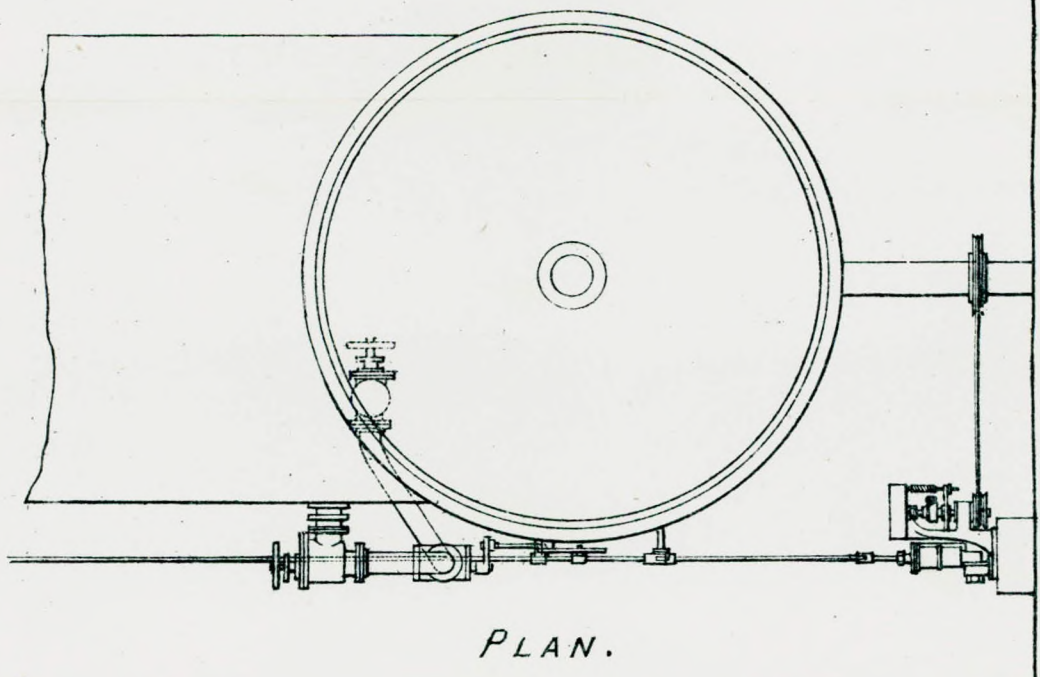
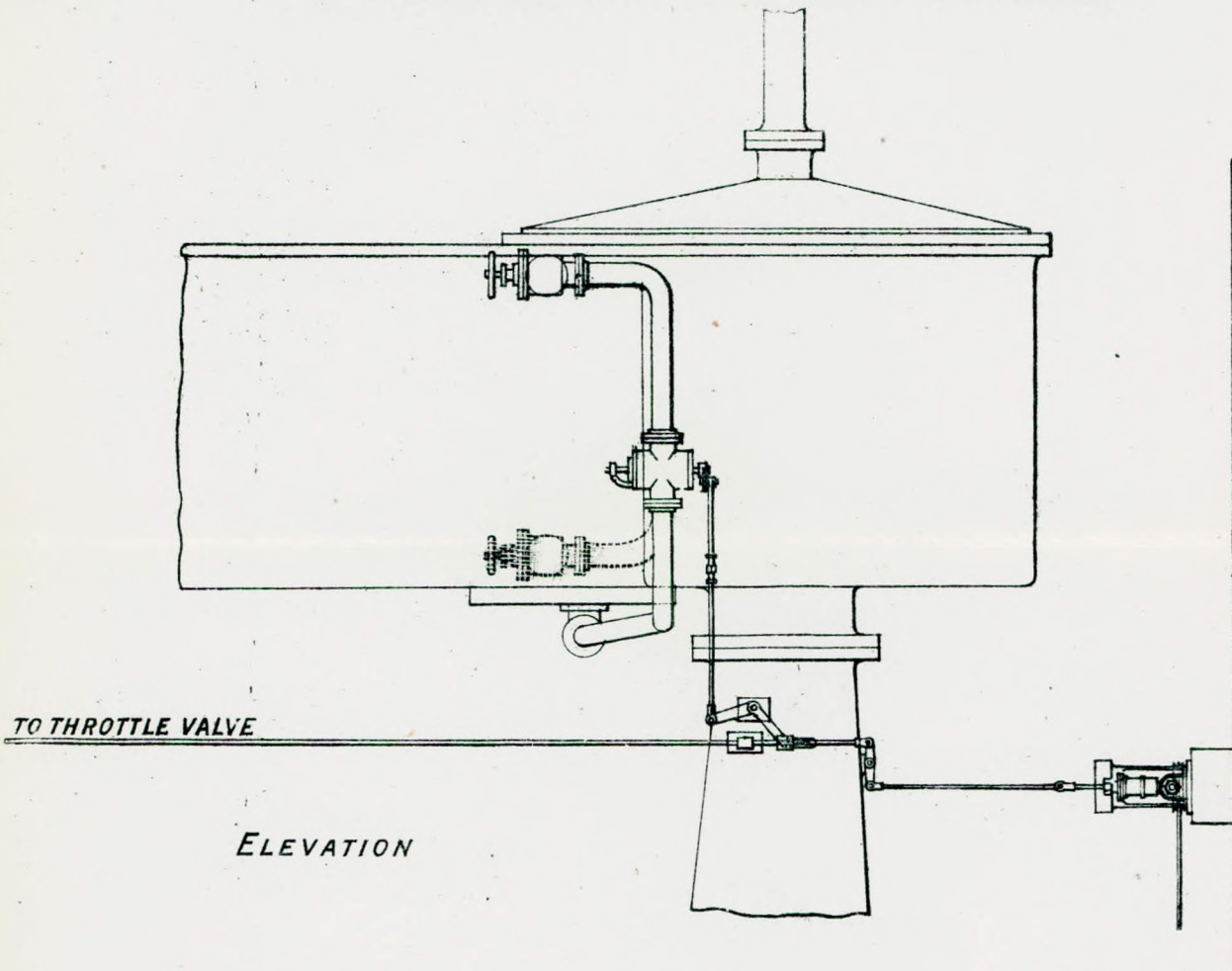


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ELEVATION.

ARRANGEMENT OF GOVERNOR GEAR WITH COMPOUND ATTACHMENT,
AS FITTED ON THE
CUNARD S.S. "SCYTHIA" & "BOTHNIA".



J. D. CHURCHILL,
LONDON, E.O.

PREFACE.

THE BROADWAY, STRATFORD,

May 20th, 1890.

A Meeting of the Institute of Marine Engineers was held this evening presided over by MR. G. W. MANUEL (President), when MR. R. E. CROMPTON (Honorary Member) read the second portion of his paper on "Electrical Engineering." The first portion was read on Tuesday, 6th May.

The whole paper complete will be found in the following pages.

The importance of this subject to all Engineers is considerable, especially so to Marine Engineers, and we are greatly indebted to MR. CROMPTON for what he has contributed, and for the very hearty manner in which he has carried out his intention of giving practical information on the details of Electric Lighting.

MR. MCFARLANE GRAY has kindly agreed to deliver a course of brief lectures on the subject of Electricity during the Autumn. MR. CROMPTON may also favour us with another paper in continuation of what he has already given.

With the wide-spread use of Electric Light in Steamships and the probable introduction of Electricity on a more extended scale to other Departments of Engineering Science, it is to the advantage of all, that to Electrical Engineering should be given some prominence among the various studies and researches of Marine Engineers.

MR. CROMPTON, in the concluding portion of his remarks after the Paper, referred to a possible development of Electricity in the direction of effecting an improvement in the social condition of certain classes, which gives rise to very interesting speculations.

JAMES ADAMSON,

Hon. Sec.

