forces which gravity has imprisoned within this thin smiling earth crust on which we so securely and unthinkingly disport. There those forces are slightly unsealed to our quailing vision.

Before an hour had passed the darkness began to close down, and the brilliance of the fires to blaze forth. Heavy clouds of vapor often obscured the sight. It was seldom that the whole lake could be seen at once. The vapor was innocuous—pure steam, with a faint whiff of sulphurous acid. High up around the cliffs shone out incandescent points of light, recesses where still molten lava lingered, preserved from cooling in the spongy, non-conducting rock. Every few minutes fragments of rock would scale off the cliffs and dash down toward the lake. A considerable mass plunged in on the opposite side. An enormous surge arose, splashing high upon the talus of the cliff and saturating the loose pile of rocks with fire. Out from their interstices for some minutes continued the living fire to pour, in streaming cascades, over a breadth of sixty feet in width and height.

These night views of the lake and its fountains have an immense fascination. The brilliance is intense. The play of fountains and crevice gleam is constantly varying. Fire is alive in giant might and activity. It is in colossal play, foaming, flinging, tossing, surging. It is always hard to tear away from the spectacle. Two of us who had often seen it, and a mother who yearned to be back to her babe, tore ourselves away early, and, trudging and riding by lantern light, reached our inn at nine o'clock. The others came in after ten; telling how, after we left, the whole surface had broken up into a glorious, tossing sea of fire.

It is the regular thing for the evening parties from the crater to get a hearty ten or eleven o'clock supper. Sometimes, when very tired, we first take a hot steam sulphur bath. The nights are chill at that latitude, and when the house is full, as it was that night, the three parlor fireplaces are burning merrily, as indeed they do much of the cool day hours. During this summer, a large number of island residents have tarried at this delicious upland retreat. Foreign tourists are more numerous in the winter. Now that the splendid road from Hilo is complete and the journey up is converted into a delight, both residents and foreigners will be attracted in greatly increased numbers.

Our good government has been getting on securely and comfortably these few weeks without the protection of any United States warship. The Charleston is now calling here for coal, en route to China. Three German ships have come in on a like errand. The fallen queen is still pretending to the ignorant natives that Mr. Cleveland is going to restore her, and that all of them who take the oath for the republic will be hanged when she returns to power. This farce cannot last much longer. It may avail to deter a majority of the natives from registering in time to vote at the election near at hand.

IMPROVED HYDRAULIC CAPSTANS.

By ARTHUR RIGG.

HYDRAULIC capstans as hitherto constructed are wasteful in their use of pressure water, actually taking more when running unloaded than when performing their full work. It is mainly from this cause that there has been comparatively little extension in the use of hydraulic engines, and as the governing arrangement now to be described proportions the quantity used according to the demand for power, there is now no further reason why the application of these useful and convenient motors should not become greatly extended.

The hydraulic power supply companies practically restrict their sphere of operations to working lifts and cranes, as their pressure water is so much more costly than gas or steam power, and few opportunities occur where this convenient but costly power can be used for anything else. It does not seem to have occurred to these companies that it might pay much better to supply a cheaper power for a more extended class of customers than to keep up the out of date system of high prices and restricted output. As if to handicap still further the use of such hydraulic engines as have been hitherto put up, they use the same quantity of water when running at the same speed whether there be a full load or none, thus comparing in extravagance with a steam engine provided with a throttle valve, and using steam throughout its stroke. Any arrangement, therefore, by which the stroke can be altered in proportion to variations in load improves the economical working of hydraulic engines much as the working of steam engines was improved when an earlier cut-off gave the advantages derivable from expansion. What with the original high cost of water pressure and its wasteful application, it is not surprising that hydraulic engines have not, up to the present time, become generally used for obtaining power, although their extreme convenience as compared with gas engines or steam engines is allowed on all hands. Before a governor can be applied, it is necessary to arrange for a variable stroke, which cannot well be managed with an ordinary crank. A reduction of speed seems the simplest method for regulating power, but as a uniform speed is so generally required, very few cases occur where this plan can be followed. For cranes or hoists regulation may be carried out by providing two or more rams and a system of valves, whereby one or more rams can be put into action, thus giving relatively proportionate powers. Such systems, however, are inapplicable to engines turning shafts, or at least they would be so inordinately costly and complicated as to preclude their general use, and an alteration in stroke remains the sole convenient and practical method whereby hydraulic engines can be satisfactorily regulated, and the speed maintained at a uniform rate.

In spite, however, of such drawbacks accompanying the use of hydraulic engines, great numbers are used at railway stations, docks, and other places, for driving capstans, and the surpassing convenience of such an unfailing power, so easily distributed, is found to compensate for the waste attendant upon its use. In order to mitigate, in some degree, the losses which occur when such capstan engines are running unloaded, it is usual to design their ports and passages extremely small, so that friction through them shall prevent too rapid a current, and also shall limit the speed

at which the capstan can run when unloaded. Then the reciprocation of their rams frequently reverses the current of water, and this operation entails a series of destructive shocks upon the engine. Nevertheless, the combined effect of insufficient passages and the reversal of currents at a tremendous pressure imposes a limit—of utterly unscientific and wasteful character, it is true—upon the speed at which such capstans can be driven.

Capstan engines are made with two rams, having cranks at right angles, or with three cylinders, acting on the same shaft and cranks at 120°, so that they will start when water is turned on, and their dimensions are such as to provide an ample reserve to start a load beyond the nominal power at which they are intended to work. If we take the case of a capstan engine driven by three single acting engines set radially around the same crank and at 120° to each other, it is well known that the crank receives a tolerably uniform tangential effort, and a fairly regular movement ensues. But because of the crank turning round it is highly inconvenient to alter its radius, for this has already been attempted with results by no means successful from a practical point of view. If, now, we regard the same three cylinder engine as having its crank centers fixed, so that when pressure is turned on the pistons will drive the capstan by revolving round the main shaft center while the cylinders revolve around the crank center, we get exactly the same results as to power by the ordinary system, with more than one very distinct advantage. As the crank has now become stationary, it is easy to move its center nearer or further from that of the main shaft, and all difficulty as to its regulation is at an end. If the crank centers be 3 in. apart, then the stroke becomes 6 in.; but if these centers be closed together until only 1 in. apart, then the stroke becomes 2 in., and there is the further utility in being able to alter the stroke, that

its full available power may be brought into operation.

In hauling vessels, a curious effect is shown by the capstan running at a high speed at about one-third stroke while drawing in the slack rope; then it acts with full energy until the load begins to move, and afterward keeps changing between its shortest and longest stroke, as the cable tightens or slackens. Thus the governor keeps up a constant watch, and always regulates the stroke according to the load, however that may alter. As the capstan runs unloaded at one-third stroke, it may fairly be assumed that the average quantity of water used will, at most, be under one-half of that which would have been used had the hydraulic engine been unprovided with any governing arrangements. As three tons, moved at the rate of 60 feet per minute, requires at least 20 horse power exerted by the main hydraulic pumping engines, it is obvious that any contrivance by which this demand can be reduced to one-half represents a somewhat important economy, and one that justifies any additional cost of a secondary engine, with its valves and governor, to gain. It means a saving of one-half the existing engine power, or doubling the number of capstans that might be employed on a railway or docks driven by the same power; and as it is well known current expenses very soon represent an enormous interest upon capital, such a saving at so moderate an expense is a thing that, in the present days of keen competition, no company can afford to neglect.

It is sometimes useful to have the power of reversing a large capstan, particularly when new cables are being used. These sometimes acquire a kink which cannot be quickly released, and it may become necessary to cut and sacrifice a new cable to let a vessel go free. By reversing the capstan, however, a cable can be released, and the handle—shown dotted—is intended for this purpose. The governor acts only for the usual

RIGG'S IMPROVED HYDRAULIC CAPSTAN.

by transferring the crank center to that opposite the main shaft the engine reverses.

Having secured this mechanical convenience, it is no longer necessary to contract the area of water passages, for these can be made as large as desired, and the arrangements for governing, by altering the stroke, are all that remain to be carried out. There is now no appreciable loss by friction, and the full pressure may be admitted under the rams, and the speed can be maintained constant, while the power can be regulated in a thoroughly scientific manner by causing the stroke to vary as the governor balls move in or out. As a considerable pressure is required to move the center carrying the cylinders, it is necessary to provide a supplementary engine, as a "relay," to perform this duty, leaving the governor to move its valves and so determine how long the stroke shall be with any current load, and the engine running at any predetermined speed. The method by which this operation is carried out is shown by the accompanying illustration.

This figure shows a three-ton capstan driven by a revolving engine, with the general arrangements of its governor—an apparatus of any ordinary kind. When the intended speed has been reached, the governor balls extend themselves, and through the intervention of levers and connecting rods, the valves of the subsidiary engine are actuated, so as to shorten the stroke of the main engine until it runs at any speed for which the governor has been arranged. The same speed is kept up while winding slack rope, and as this can now be made much faster than usually permitted with other capstans, a very adequate control is maintained and the capstan quickly gets hold of its load. As the rope tightens speed reduces, and the governor balls close together, permitting the weight, W, to descend and act upon the valves of the subsidiary engine in such a manner that the main engine has its stroke increased, and the hauling power of the capstan shows a corresponding augmentation, even until

direction of hauling, but does not act when reversing is adopted for a few moments in order to release a cable. As there are no reversals in the direction of currents when driving one of these engines, it follows that there are no severe shocks in running, and this fruitful cause for the destruction of packings, if not for the breakdown of engines, is absent in those of the revolving type. If the water should not be flowing into one cylinder, it will be flowing into another, and that which is in any one cylinder when the inlet closes revolves with it at considerable velocity, and in no case is brought to rest, as in any other type of engines with reciprocating pistons. It is this evil caused by stopping and starting a column of water which so quickly injures the packings of these engines where such shocks occur. In the revolving type either cup leathers or ordinary packing glands can be used, and both are found extremely durable. The cylinder bosses and valve faces are somewhat peculiar in their construction. Their external packings are made of hydraulic leather, and there is a piston within the boss of that cylinder which is furthest from the valve face for the purpose pressing all the bosses together, and for resisting any pressure against the face of No. 1 cylinder that would tend to force it away from the valve face. By the operation of such a balance piston, all the cylinder faces are retained in proper, easy contact, and waste is prevented.

These engines have been running for many years, and although the relay engine, with its valves and governor, may seem somewhat complicated to those who see it for the first time, these additions are by no means so intricate as the Corliss or any other gear used for a like object—the economizing of power in the use of steam; as the cost of water power from an accumulator is necessarily greater than that of the steam power by which its pressure is obtained, it follows that the economical use of water is of correspondingly greater consequence than the economical use of steam.—The Engineer.