One feature of a well designed, modern power house is the remote control of all auxiliary machinery and equipment, particularly of the dangerous switching operations on high voltages. The control and the protecting devices of the Gatun station have been worked out carefully and will permit of an extremely flexible and reliable operation of the generators upon any probable condition of loading. A main control switchboard of the unit panel type is to be erected upon the second gallery floor, where the operator possesses a good view of the entire station. Command of all operations is obtained through master control switches, and indication thereof is procured by means of small pilot (signal) lamps. The operator at the switchboard remotely controls all switching operations, both on the high tension and the exciter buses, and, in addition, controls the headgates, the governors, the rheostats, and the field circuit breakers.

Besides the control switches, the main switchboard contains all indicating, integrating, and recording instruments, which are essential for an intelligent and economical operation of the station. Time limit relays are mounted upon the rear panels to serve as a protection to circuits and generators in case of overload. Continuity of the operating circuit for the control of switches will be obtained by the installation of a storage battery upon the first gallery floor, the switches being mounted upon one panel of the main control switchboard. A voltage regulator, which will automatically maintain a uniform bus pressure, will be assembled upon a smaller station panel at one end of the main board.

The canal commission will try one slight variation from standard practice in an attempt to secure the greatest reliability in the excitation system without the necessity of installing additional water turbine exciter sets. In any alternating current station, it is absolutely necessary that the fields of the alternators be supplied continuously with direct current, usually at 100 to 125 volts potential. When the station is running smoothly, this direct current supply is obtained most economically through motor-driven exciter sets, which are operated directly from the 2,200 volt buses. Two such units, each of 100 kilowatts capacity, will be erected in the Gatun station. Difficulty is encountered, however, when the station is inoperative, as no source of 2,200-volt energy is available to drive the exciter sets. It is customary practice in hydroelectric stations to install independent exciters, which are driven by small water turbines. The small water turbines are more complicated than motor-driven sets, requiring adjustment of governor and of valves, and also additional penstocks and gates, with the resulting complication of operation. At Gatun, each main will be equipped with a 50-kilowatt exciter mounted upon the vertical shaft in the 6-foot space which separates the turbine and the generator. When starting, after complete shut-down, the direct-connected, 50-kilowatt exciters will furnish the necessary excitation until such a time as the motor-driven exciter may be connected to the system. This selection of exciter equipment results in a very simple and easily operated system which possesses ample capacity under all conditions of operation and exceptional reserve in event one exciter is accidentally damaged.

RAIL BREAKAGES.

The weather generally gets the blame for the great railway accidents which are so characteristic of this continent. It is a happy explanation because it is a verdict which doesn't hurt anybody. Extremes of cold and heat are held responsible for the breaking and warping of rails and it has been rather hastily assumed that such "accidents" were unavoidable. The Union Pacific has, however, according to the Wall Street Journal, discovered the secret of avoiding the "unavoidable." Our esteemed contemporary says: "While a joint committee of the railroads and rail manufacturers is wrestling with the problem of eliminating the dangerous breakage of rails, Julius Kruttschnitt and his consulting engineer, John D. Isaacs, have solved the rail problem to so complete a degree that the Harriman lines are far in advance of any other roads in the country in the matter of reduction of rail breakage.

In crucial form the rail problem has been a winter problem. During the winter of 1911-12 there was an epidemic of broken rails on a score of roads, attributed without exception to the severity of the cold weather. The Harriman lines have discovered a remedy for the cold weather rail breakage so effective that the number of the new rails broken during the winter months of 1909, 1910 and 1911 was no greater than the number broken in July or August. Moreover, the cold weather breakage of the new style of rails is far below the breakage of the old style rails in summer months, when they are under least stress.

The secret of the elimination of the broken rail from the Union and Southern Pacific is fundamentally a matter of "section," that is, the shape of rail. The Harriman officials solved the problem by giving the rail a heavier base During the cold weather the base of the rail has a tendency to become bowl shape. In forcing the rail back into shape there is great likelihood of starting a surface fracture. Rails, highly tempered as they are, act like glass. A good scratch on the surface is all that is necessary to cut glass. It is the same with rails. In laying rails the rail is never cut. A slight incision is made on the surface and the rail is broken. With a rail whose base is heavy enough to prevent change of shape in cold weather, obviating the necessity of forcing the rail back into shape, causing surface breaks, the percentage of breakage was reduced to practically nil.

"With 20,000 miles of road offering different styles of rail, all different sorts of climate and traffic conditions, it is obvious that the possible combinations of conditions surrounding rail breakage were infinite," said Mr. Kruttschnitt, "and it is probably for that reason that the task of solution has struck the average railroad official as hopeless. When a series of rail breaks occur, the division officials get panicky and attribute the event to some mysterious factor instead of sitting down to work out the cause.

"We simply went at the situation systematically. Mr. Isaacs suggested that we chart our rail breakages and see if it were possible to discover some law of breakage. We went over our record of breakages to discover whether any blame could be attached to the various kinds of rail, localities or traffic. The result was as simple as astounding.

"We found that the 90-pound rail of the shape in general use gave an average of 6 breakages to the 100 miles during the summer months when the mean temperature was about 75 degrees, and 23 breakages per 100 miles in winter with the temperature around 40 degrees. We found that the rail with heavier base gave only two breakages to the 100 miles in the winter months, the same average as during the summer months, so that so far as the Harriman lines are concerned the rail problem is solved. We are proud of our rail record. We feel that we have solved the problem for all the roads. Of course, we have been careful in giving our orders to the mills we had found most reliable and have insisted on a high grade rail, but it is the shape of rail that has solved the problem fundamentally."

The experience of the Union Pacific is important, because if there is any way of preventing at any cost the deplorable accidents that occur every year through broken rails, there will be a public demand for its adoption, which neither the railway companies nor the legislatures can afford to ignore.