

### A NEW TYPE OF SIXTY-FOOT SUMMIT LEVEL CANAL FOR PANAMA.

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In the *SCIENTIFIC AMERICAN* of June 30 a brief outline of the proposition forming the subject of this article was published with an appended note by the Editor, referring to the rejected 60-foot level type adopted by the board of consulting engineers for comparison with the sea-level type, recommended to Congress for adoption in the majority report. It proposed a dam of moderate height at Gatun, and specified a second dam with locks at Bohio for the maintenance of its 60-foot summit level, and the control of the Chagres floods, by the usual dam and basin at Gamboa. The serious engineering difficulties discovered in the proposed foundations at Bohio were chiefly instrumental in compelling its abandonment, although the almost identical altitudes of Bohio and Gatun suggest a secondary reason.

In seeking to evade these difficulties and a portion of the cost of the three great dams incorporated in this proposition, a minority of the engineers advised a colossal structure at Gatun for the maintenance of an 85-foot water level submerging the whole central valley of the Chagres, combining the three Atlantic locks in duplicate flight, and extending the location of the second lock site to Pedro Miguel on the Pacific slope. A strenuous controversy between the opposing engineers was thus precipitated and during the succeeding Congress the criticisms of the alternative type were continued with a vehemence and volume unprecedented in the annals of that august body, and resulted, contrary to general expectation, in the absolute rejection of the sea-level type. But although the chimerical character of a sea-level canal for Panama was satisfactorily exposed, its opposing lock type was shown to be far from perfect, and indeed some of the criticisms seem almost equally fatal and certainly should influence the administration to carefully consider the arrangement of the dams and locks which is shown in the accompanying illustration.

Beginning near Colon, the first eight miles of the canal will be constructed at sea level, 500 feet in width, as proposed in the recommended type. At Gatun the first dam and single-step lock (in duplicate) will be erected for the maintenance of a 30-foot water level, which will extend to the foot of the northern slope at Culebra. The second single-step lock (in duplicate) and dam across the artificial channel at Obispo will then change the water level to that of 60 feet, which is continued through the cut to Pedro Miguel on the Pacific side, where the third dam and lock site is located. In order to supply the summit level with water a side channel, connected with Gamboa basin as shown in the illustration, is constructed and provided with regulating sluices for the control of the variable levels and floods of the Chagres, which will be received in the space reserved above the minimum 60-foot level of the basin. As the low-water level of the river at Gamboa is nearly at the elevation of 60 feet, almost the entire space inclosed in the basin will be available for water storage. A spillway directly connected below Obispo with the 30-foot level also forms a part of the equipment at this point. If advisable a tunnel could be used instead of a side channel.

At Pedro Miguel the 30-foot level is again reached through a single step lock, also in duplicate, and here, as at Obispo, the cost of the equipment will be reduced to a minimum, as the artificial channel will only be encountered, probably with bed rock foundations at its bottom. Spillways will be necessary at both of these points for the discharge of requisite volumes of water from the summit level. Lake or broad channel navigation will then be resumed and continued to La Boca dam, where a single-step lock (in duplicate) at Sosa will connect with the tidewater of the Pacific, regulated for shipping by the proposed tidal lock at the head of the four and one-half miles of sea-level channel.

The work of dredging the channel across the terminal lakes could be done during the erection of the dams, beginning with the submerged sections in or near the river estuaries and avoiding deep-water dredg-

ing as far as possible by suitable regulation of the lake levels. Dry excavation will be necessary for two or three miles below Obispo until the flooding of the channel will permit of its completion by the use of dredges. The low-level sections of the canal will thus be inclosed by parallel embankments of dredged material, partially submerged for the greater portion of the way, marking the course of the channel, and protecting it from currents and floating or partially submerged obstructions. A submarine forest or jungle, such as will cover the beds of the lakes for many years after the completion of the canal, would soon cover the surface of an unprotected channel with water-soaked trees and rubbish, dangerous to shipping, and especially so to the propellers of steamships. It would be difficult to protect a high-level channel from such obstructions.

Practically all the free sailing advantages of the high-level canal will be retained. With suitably drawn contours, a channel from 200 to 300 yards in width will afford as safe and speedy navigation as any inland lake or river. A few miles above Bohio the channel will become more restricted than that proposed for the high-level canal, but the work of meeting all essential requirements throughout this section of the canal will not materially increase the outlay. Above the head of the lake, with the exception of the Chagres, there are no streams of any importance, and the proposed basin for the reception of its floods will serve, with equal efficiency, the purpose of the abandoned dam at Bohio. Nature seems to have had a definite object in view when she contrived the impossible foundations at this point. There was no need for a

(in duplicate) with the cost of their operation and maintenance, and a much more important advantage in the adjustment of the conditions to the avoidance of locks in flight.

Locks in flight are the one serious innovation in the high-level plans. The outlay for land damages incurred in the submersion of large areas of fertile lands will be much greater, and the controversy concerning the permanency of the Gatun dam, impounding an additional depth of 55 feet of water, has reached a hopeless stage of opposing of irreconcilable convictions, but the former may not be a serious matter from the viewpoint of an opulent country, and it may be proper to say that the latter danger is at least potential in its character. If it is a danger, however, it threatens not only the gigantic structure at Gatun, with its double flight of triple locks, but the very existence of the canal itself. If the dreaded disaster ever comes there will be no canal at Panama, and America will be bowed in shame at folly that squandered the millions her discretion had saved from the pursuit of the chimera that humbled the national pride of a sister republic. Earth dams impounding a moderate depth of water are not an experiment even on foundations similar to those at Gatun, and America cannot afford to try one at Panama.

But the incorporation of a system of locks in flight at La Boca as well as at Gatun is a feature of the high-level plan that even its own advocates make little effort to defend. The first objection is the costly work of securing suitable foundations for them at these points, and especially at Gatun, where it seems that Nature has provided a subterranean peak of barely

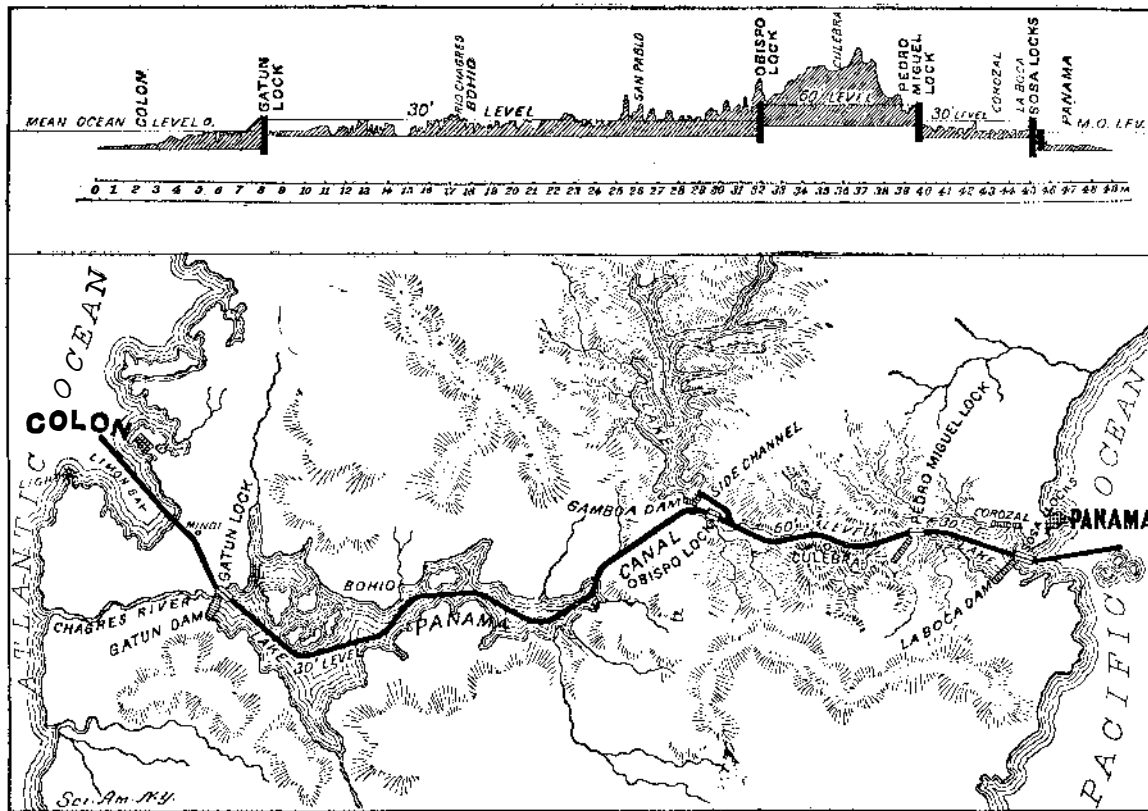
sufficient area. She seems to say to the engineers: Build one lock here and no more. But even if we are heedless of the suggestions of our great teacher, the use of such equipment is endangered by the fact that it has never been tried in the special service for which it is proposed. Locks in flight are an appropriate and useful feature of barge canals, and in similar service have yielded their designed efficiency for many years, but that the experience gained from such usage will be found almost wholly inapplicable to the work of handling ponderous battleships and ocean liners in such positions is evident. Those who have watched the process of docking one of these great ships will appreciate the difference in the character of the work imposed by their enormous bulk and momentum. The danger of crippling the canal by the destruction of one of the summit lock gates has

been pointed out. All the succeeding gates might be swept away, permitting a torrent of water to sweep through the locks, impossible of control, and doubtless inflicting irreparable damage. That such an accident should occur in the Manchester canal without serious results may be attributed to its single-step or tidal-lock design.

Panama has been the sepulcher of engineering reputations, but the disasters that have overtaken its distinguished pioneers should warn their successors against false or partial solutions of the great problems that Nature has imposed at this strange coupling of the western continents. The world is watching the progress of the work, and the expenditure of a few additional millions, if such is necessary, will be small matter, so that it aids in securing the safety and efficiency of the canal. The delusions of the sea-level dream have been happily dispelled, and the choice of a lock type evidently superior to its surviving competitor is offered at the close of a destructive controversy, but still in plenty of time for adoption.

#### Aluminium Paper in Germany.

Aluminium paper is now manufactured in Germany, and recommended as a substitute for tin foil. The paper used is a sort of artificial parchment obtained through the action of sulphuric acid upon ordinary paper. The sheets are spread out and covered upon one side with a thin coating of a solution of rosin in alcohol or ether. Evaporation is hastened by means of a current of air, and the paper is then warmed until the rosin has again become soft. Then powdered aluminium is sprinkled upon it, and the paper subjected to strong pressure to fasten the powder thereon.



PROFILE AND PLAN OF PANAMA CANAL PROPOSAL WITH FOUR LOCKS AND 60-FOOT SUMMIT LEVEL.

dam at Bohio. The erection of the Gamboa dam on primary rock foundations at a depth of only 54 feet will be justified by the element of safety that long experience in the maintenance of similar structures has engendered, and that it will effect the solution of the problem imposed by the erratic habits of the river it will convert into a lake, there is no dispute among engineers. It seems strange, however, that the sea-level advocates should have given so much attention to this problem and such indifferent consideration to a score of other rivers uniting at the bottom of the valley traversed by the proposed canal and swept by the same tropical floods for an equal portion of the year.

At the close of the rainy seasons an enormous volume of water will be stored in the basin, supplying ample volumes for lockage throughout the annual droughts, and permitting the diversion of the surplus, through the regulating sluices and side channels, into the summit level, where the overflow will be divided, with the view to as large a discharge as possible at Pedro Miguel, as the lower level spillway at Obispo will increase the output at this point. The proposed dam at Alhajuella, intended for the storage of lockage water, forming part of the plans for a high-level canal, will not be necessary to the success of this project.

At Culebra cut the volume of excavated material in the 25-foot stratum below the bed of the high-level channel will impose an additional outlay, but the work will be confined within the limits of the navigable channel as the wide summit excavation of sliding material is demanded, regardless of the choice of plans. It will yield a direct return in the avoidance of two locks