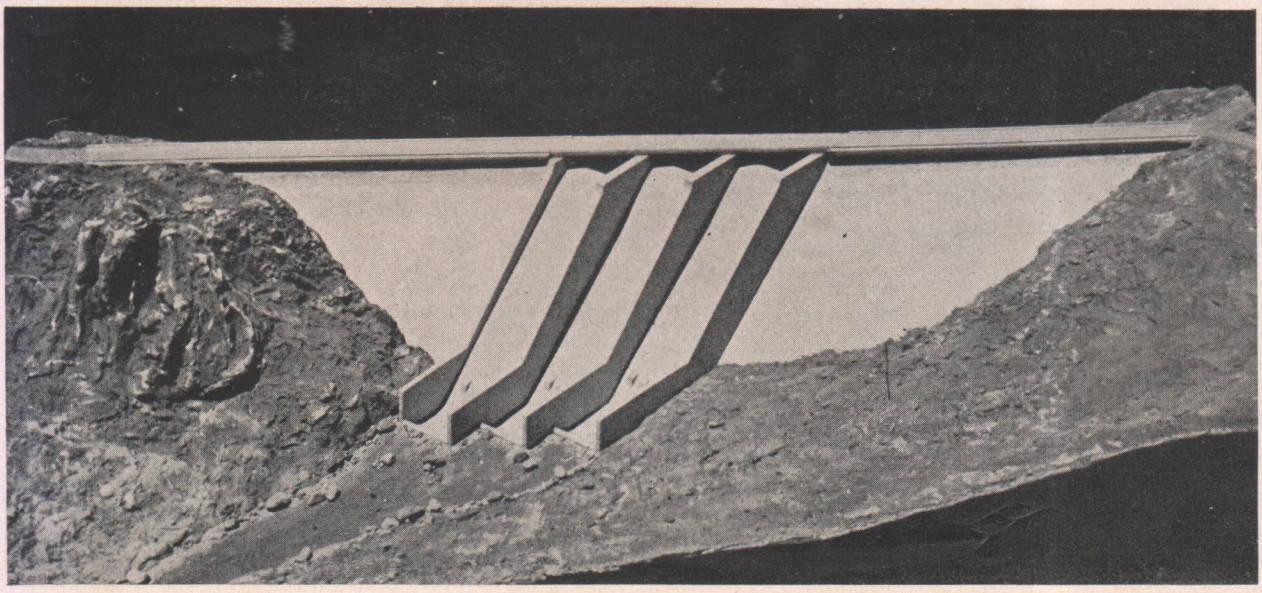

Fig. 1. Model of Los Hurones dam (spillway buckets since modified)

Developments on the Guadalquivir

Supplementary notes on the development of this river are given by S. H. Wearne to the material we published last year

A SURVEY by M. Castillo, of the Hidroeléctrica Española Company, covering Spanish dams and hydro-electric plants in service and under construction in 1950 appeared in WATER POWER in April, 1951. This indicated the large scale of the development programme in progress for 43 new dams, nearly doubling the number of 56 then in service.

Fig. 2 is based upon a recent seven-weeks' tour of fourteen sites in all parts of the river Guadalquivir. Five further new dams are shown: Cubillas, an earth dam on the river Genil near Granada; los Hurones, spillway gravity dam (Fig. 1) on the river Gaudalete; and three low-head power-house dams on the main river: Cantillana, Pedro Marin and Doña Aldonza. These last two are similar left- and right-hand designs, employing two identical 6,500 kVA sets and four 5 by 15 m. sector gates each; a project for a third similar station nearby had not been adopted. Thirteen other projects for dams of considerable size are shown on the map.

The Government have recently decreed the principle that electrical generation should be incorporated into reservoir systems originally designed for flood control or for irrigation and civic water supply. Thus small power plants will be installed at Cubillas, Guadalén and in the Bornos-los Hurones water-supply system for Cadiz. Pintado and Tranco de Beas are multi-purpose designs with more important power generation; at Pintado, capacity to the extent of 17,500 kW is being installed and a further 3,600 kW projected, and at

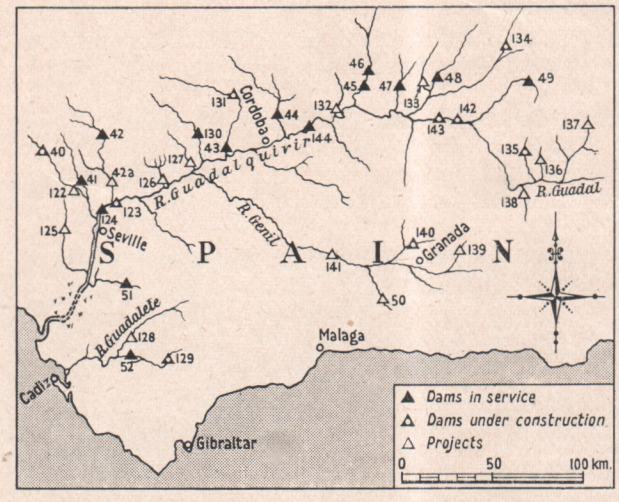

Fig. 2. Map of the Guadalquivir developments

40 Aracena
41 Cala
42-42a Pintado
43 la Breña
44 Guadalmellato
45 Encinarejo
46 Jándula
47 el Rumblar
48 Guadalén
49 Tranco de Beas
50 Bermejales
51 Torre del Aguila
52 Guadalcacin
122 la Minilla
123 Cantillana (L)
124 Alcala del Rio (L)
125 Cuervo
126 Guadalbacar
127 Retortillo
128 Bornos
129 los Hurones
130 Bembezar
131 Puente Nuevo
132 las Eguas
133 Guarizzas
134 Guadalmena
135 Guadalentin
136 Portillo
138 Negratin
139 Quentar
140 Cubillas
141 Iznajar
142 Doña Aldonza (L)
143 Pedro Marin (L)
144 el Carpio (L)

137 unnamed L indicates low-head power-house dam.
The site numbering used by M. Castillo on his map is continued here. No. 44 appears to have been renamed.

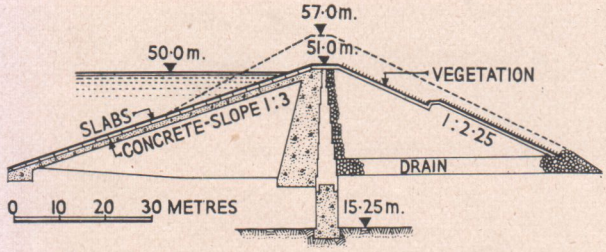

Fig. 3. Torre del Aguila dam, showing proposed heightening

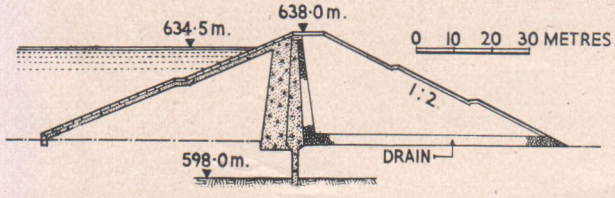

Fig. 4. Early design for Cubillas dam

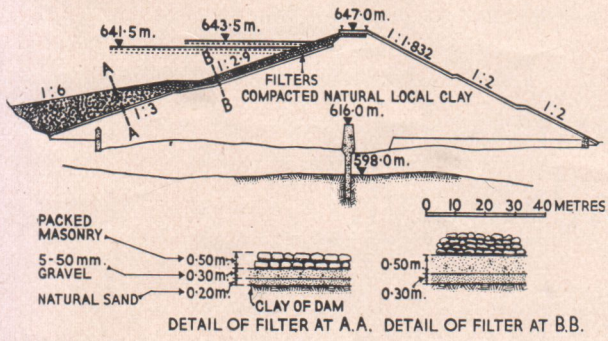

Fig. 5. Final design of Cubillas dam (third project) as now under construction

Tranco an underground power house for plant of 29,750 h.p. is under construction.

Torre del Aguila and Cubillas Earth Dams

The Torre del Aguila earth dam was one of the earliest works for flood control and irrigation storage in the valuable agricultural area of the Guadalquivir basin. Exploratory work is now in progress on increasing the crest and water levels by six metres, as indicated in the sketch (Fig. 3) of the dam profile. According to extrapolation of the storage curve, this will increase the reservoir capacity from 80 to approximately 135 million cubic metres.

The existing lateral 'staircase'-type spillway, which consists of a regular series of rectangular stepped sills, will be unsuitable for modification for flood discharge at the increased water level, and will be abandoned. Model tests are therefore in progress on a modern type of spillway canal, having a sill formed by a weir, curved in plan, similar to that under construction at Cubillas.

The general design of Torre del Aguila has been found unsatisfactory, the heavy core being too rigid to suit the movement of the foundations under load. Following this experience, the first design (Fig. 4) for Cubillas was twice modified, and also considerably enlarged.

The dam is now well under construction to the design shown in Fig. 5. There is a small concrete cut-off, and the entire fill is local clay, compacted by sheepsfoot rollers. The method of protection against core erosion by reversed filters is indicated in separate detail in Fig 5, the actual construction being shown in Fig. 6.

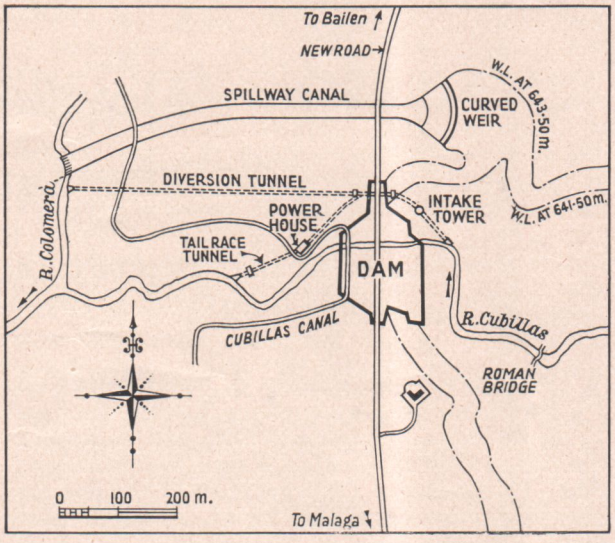

Fig. 7. Plan of Cubillas dam and spillway canal

Fig. 6. Filter construction at Cubillas

The reservoir capacity will be 25 million cubic metres at the spilling level, which is at an elevation of 641·50 m. The maximum water level is two metres higher, the spillway being designed for a discharge of 2,000 cu. m. per sec. under this head. The greatest recorded flood is 700 cu. m. per sec.

The Cubillas reservoir is situated at the centre of a system of seven minor dams

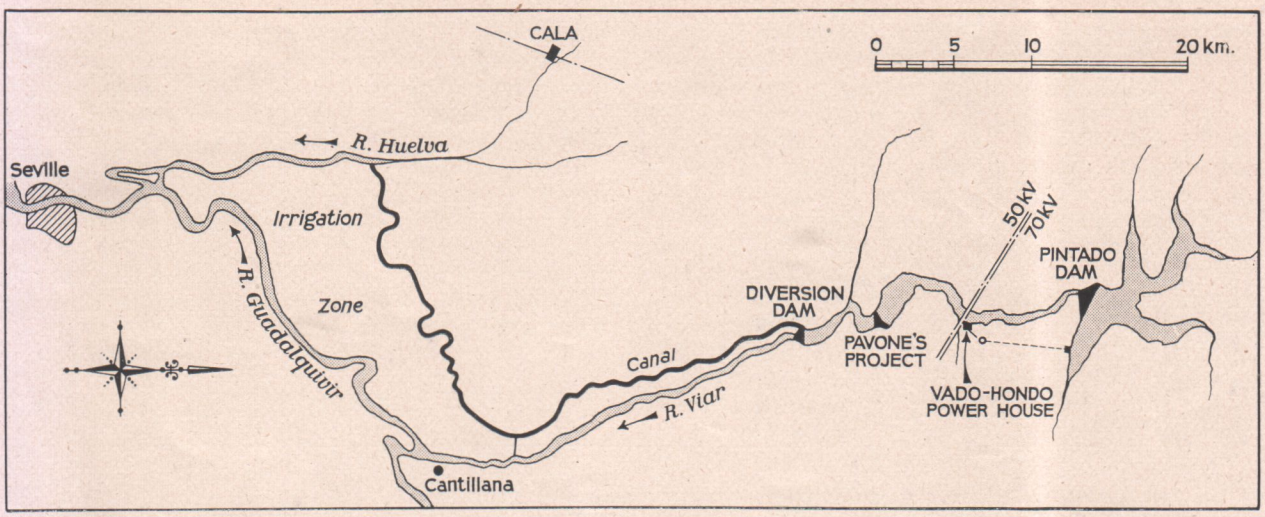

Fig. 8. The river Viar scheme

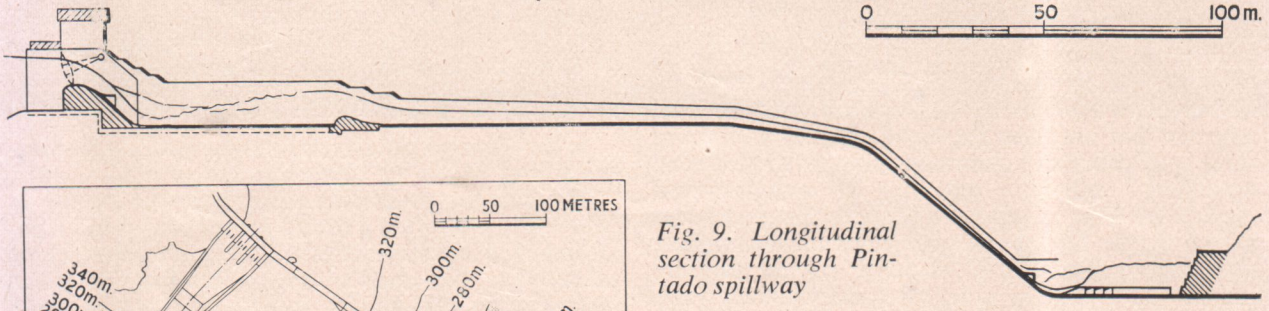

Fig. 9. Longitudinal section through Pintado spillway

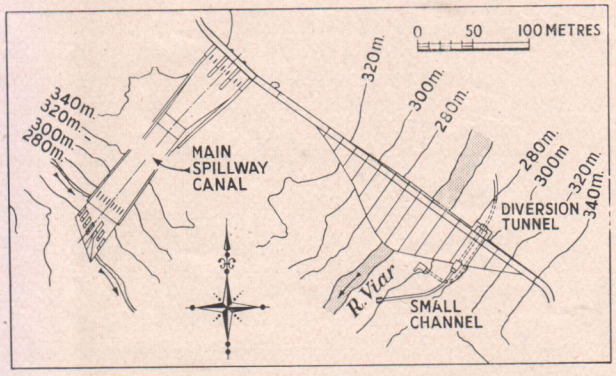

Fig. 10. Pintado dam and spillway

in an irrigation scheme for over 8,000 nectares* in the Granada-Santafe area, the reservoirs and irrigation zones being linked by canals.

A small hydro-electric plant has been incorporated into the Cubillas design by arranging that the irrigation water is discharged through a turbine. This may be bypassed if required, or alternatively the turbine discharge may be diverted to a separate tailrace tunnel when the irrigation demand is small.

The Pintado Scheme

The river Viar development, Fig. 8, is a typical multi-purpose scheme. An area of 12,000 hectares is to be irrigated, and generating plant of 17,500 kW is being installed and a further 3,600 kW projected in a system comprising one major and two minor dams.

The completed Pintado gravity dam is 81 m. high and the overall crest length 406 m. The crest was heightened 3m., without amendment to the main design, to increase the storage from 175 to 202 million cubic metres. The spillway is still under construction, and will carry discharges up to 1,400 cu. m. per sec., controlled by three Taintor gates each 12·5 m. wide, 7·5 m. high (Figs. 9 and 10).

M. Castillo's note on the extreme irregularity of flow in Spanish rivers (p.137) is well illustrated by the figures for the Pintado catchment. This has an area of 1,100 km. and an average annual rainfall of 675 mm. from which the average run-off is 175 million cubic metres per year. The maximum recorded is 514 million, and the minimum two million.

A small spillway channel on the left bank downstream of the dam will release irrigation water when the turbines at Vado-Hondo are not discharging the

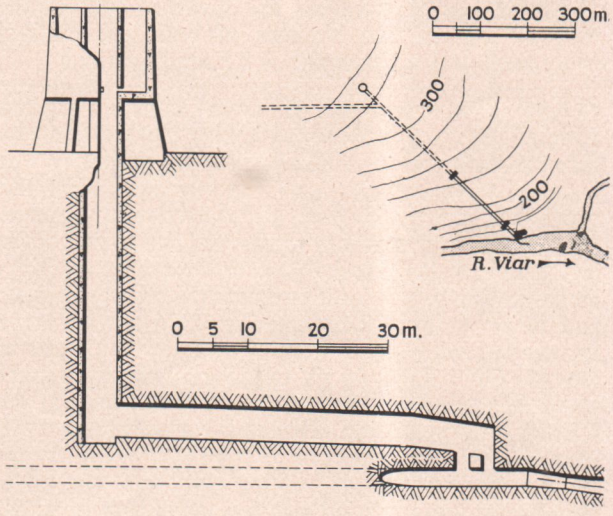

Fig. 11. The Vado-Hondo surge tank

* 1 hectare = 10,000 sq. m. = 2.49 acres.

full amount required. The flow into this channel is regulated in a small gatehouse on the downstream face of the dam. The main gatehouse on the upstream face contains a stairway and a lift to the galleries, the intake and relief gates for the spillway-channel conduit, and the control gates for the diversion tunnel.

The intake to Vado-Hondo is 2½ km. east of the main dam. The 2·5 m. diameter pressure tunnel is approximately 6·3 km. long and will pass 12 cu. m. per sec. to the turbines under a total head of 199·3 m. One of the two machines is already in operation. The differential surge tank, Fig. 11, has a shaft diameter of 4·25 m., and an upper chamber 12·0 m. diameter. The penstock tapers from 2·0 m. to 1·7 m. diameter.

The Pavones scheme, some 5 km. downstream, comprises a dam 21 m. high, with a useful storage of 1·4 million cubic metres, receiving a largely controlled flow. The turbine will take 10 cu. m. per sec. under a head of 46·8 m., this being achieved by discharging along a canal 8·28 km. long.

Downstream of Pavones, the diversion dam will also receive a regular flow. The dam will be a spillway gravity structure, automatically maintaining the canal level. The canal follows the contour line of the northern boundary of the 12,000 hectares to be irrigated, to which some 125 million cubic metres of water will be supplied annually.

NOTE.—A description of Guadalén and notes on the author's tour appeared in the *Guilds Engineer* (of the Imperial College, London) for 1952.

Book Reviews

Civil Engineering Plant and Methods. By Rolt Hammond, A.C.G.I., A.M.I.C.E. Ernest Benn Limited, Bouverie House, Fleet Street, London, E.C.4. 1952. 229 pp. 41ff. 14 plates. Price 25s. net.

This book is in the nature of a causerie on current civil-engineering equipment and practice. It consists largely of sketch accounts of specific constructional schemes that are regarded by the author as holding some special interest, and of descriptions of plant and machinery, with due reference to manufacturers' specialities. This somewhat discursive treatment does not go deeply into the subject, nor is it comprehensive, but it provides a readable commentary on present-day trends in practical constructional work. The subjects considered include excavating plant, pilings and foundations, concrete mixing and placing equipment, cranes and lifting appliances, plant for dock and harbour construction, tunnelling methods and equipment, unit construction, welding, road-making machinery, and the organisation of civil-engineering work.

Annuaire de l'Association Suisse des Electriciens. (A.S.E.) Published by the "Association Suisse des Electricien," 301, Seefeldstrasse, Zurich 8. 126 pp.

This yearbook is a special issue of the well-known "Bulletin de l'Association Suisse des Electriciens," now published in common by the A.S.E. and "Union des Centrales Suisses d'Electricité" (UCS). The names and addresses of members are given in part I, and part II contains the byelaws of both Associations concerned, and a list of the A.S.E. publications.

Outdoor Switchgear. A leaflet from Cooke & Ferguson Limited illustrates outdoor switching units which were recently built for an Australian supply authority who required a two-switch 33 kV outdoor substation. As space was strictly limited, all protective equipment, control gear and auxiliary equipment had to be housed in the mechanism kiosks, and to ensure accessibility the mounting panels for instrument meters were hinged and the mounting of the remaining equipment arranged for easy withdrawal. A second leaflet gives details of the type OF.1 800 A 66 kV outdoor oil circuit breaker which has been submitted to short-circuit tests at the KEMA testing station, Holland. Certificates have been obtained for ratings of 750 to 1,000 MVA, covering the requirements of existing contracts, and additional tests were carried out for the rating of 1,500 MVA.

From page 209

Some monthly advances obtained from the Mignano heading where the six rounds scheduled per 24 hours were often surpassed and up to nine rounds were made per day, are very striking:—

July 1950	290 m.	(950 ft.)
September 1950 ...	314 m.	(1,030 ft.)
October 1950 ...	300 m.	(985 ft.)
November 1950 ...	342 m.	(1,125 ft.)

In the Venafro heading the advance during November was of 356 m. (1,170 ft.).

The rate of progress on the Volturno tunnel is believed to constitute a record for tunnels of this type. During 236 working days 4,636 m. (15,200 ft.) of tunnel were excavated with a rock volume of about 90,000 cu. m. (317,000 cu. ft.). The records, obtained through the organisation of the works by Eng. Silvio Arrigoni, are as follows:—

Record advance per month: 356 m. (1,170 ft.) during October 1950 with an average of 13·60 m. (44·6 ft.) advance per day.

Record advance per week: 90 m. (295 ft.) during the week October 8—15, with an average of 15 m. (49 ft. 3 in.) advance per day.

Record advance per day: 21 m. (69 ft.) on the 29th November 1950.

From July 1, 1950, for the tunnelling work as described, twenty type RH-655W Atlas rock drills with pneumatic pushers and 180 Sandvik Coromant drill steels were used. During the work no interruption was caused by breakdowns and the consumption of spare parts is understood to have been insignificant. The average length of hole drilled by each Sandvik Coromant hard-metal-tipped steel was about 450 m. (1,500 ft.).

From page 214

from all participants if it is to be carried out to schedule. The tests at Grudie Bridge were completed, once all plant and equipment were in position, in only about five hours by the active help of the owners, their consulting engineers, and the various contractors concerned.

Acknowledgments

The North of Scotland Hydro-Electric Board and The British Pitometer Co. Ltd. are thanked for their kind permission to allow the publication of various details contained in this article.