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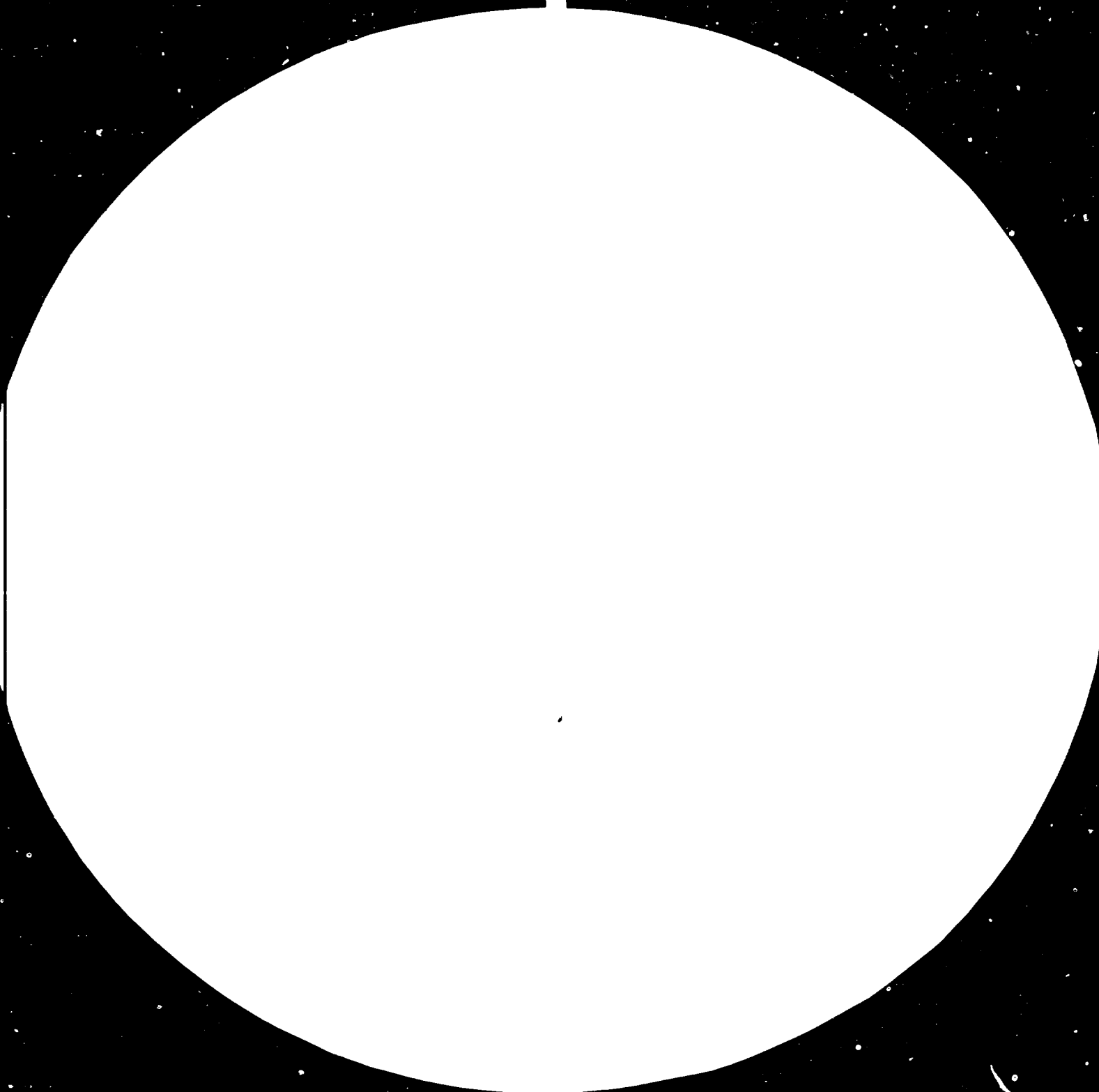
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CHINA'S SMALL  
HYDROELECTRIC MACHINERIES\*

by

Bureau of Farmland Water Conservancy\*\*

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China is rich in water resources, with abundant rainfall and a wide distribution of rivers and streams crisscrossed here and there. How to exploit and harness these valuable natural resources for the benefits of the people and mankind has long been an emphasis of the Chinese government. Since the founding of the People's Republic of China, especially in the past 10 years, small hydroelectric power has been developed rapidly. At present, more than 80 thousand small hydroelectric stations have been erected, the total installed capacity of them amounts to 6.3 million kw. Most of the equipments are designed and manufactured by our own efforts. The manufacturing plants of the Ministry of Machine Building as well as the Ministry of Water Conservancy have provided a large amount of equipments for the exploitation of medium and small rivers in our country. However, up to the present, the exploited water power resources are only 3% of the total. Therefore, the development of small hydroelectric power in our country is very promising. Undoubtedly, it also provides a very bright future for the manufacturers of small hydroelectric equipments.

**(I) The Special Features of China's Small Hydroelectric Equipments.**

China has a vast expanse of land. There is a great difference in temperatures as well as hydrological parameters between the northern and southern parts of China. In bitter cold winter, the lowest temperature of the northeast border is  $-40^{\circ}\text{C}$ , while burning hot summer, the highest temperature at Hainan Island which belong to the sub-tropical hot and moist climate is  $+40^{\circ}\text{C}$ . Some of the tidal hydroelectric stations there are arranged almost at sea level, but the elevation at Tibet is about 3000 to

4000 m. These complicated natural conditions between regions impose much difficulties on the manufacture of small hydroelectric equipments. However, through assiduous efforts of the manufacturers, they ensure the supply of various kinds of equipments to suit the different conditions. Therefore, a large variety and a wide range of applications are the special features of our small hydroelectric equipments.

(a) We have a complete range of various products:

As the exploitation of medium and small rivers is in steady progress, the manufacturers continue to supply more and more small hydroelectric equipments. Having gone through several stages of developments, the various types of equipments manufactured by our manufacturers are now quite complete. We not only have equipments for high head operations up to 620 meters to suit mountainous region development but also those for large discharge low head operations in rivers and streams up to 2 m. head.

At present, standard designs become available. Hydraulic turbines are classified, according to new regulations, into 3 main categories, with 27 series and 85 different types. They are of the axial flow type, the mixed flow type and the impulse type (refer to table I attached). Corresponding generator supports are 16 in numbers and of 121 types (refer to table 2 attached). In order to fully utilize the widely dispersed water power resources and to furnish electricity to remote and mountainous regions, the manufacturers produce a special series of 0.25 to 75 kw micro-unit-sets. They are mostly produced by Qinglong Hydroelectric Equipment Manufacturing Co. of Hebei Province. Because the micro-unit-sets are small in volume, light in weight, simple in construction and low in cost, they are very much appreciated and welcomed by the people residing in the mountainous regions. Since we have produced a large variety of small hydroelectric equipments, it is convenient for the consumers to select those equipments that suit them best.

(b) Our products meet the requirements of standardization, generalization and seriation.

The above requirements are important for countries having much diversified hydrological parameters like China.

The advantages of these products are: simple to manufacture, suitable for mass production, increased productivity, insurance of good quality, reduction of cost and ease in operation and maintenance. For these reasons, the costs of our products suit the economic conditions of our country best. Our manufacturers can also supply special equipments not in series to specific customers on requests.

## **(II) The Applications of Small Hydroelectric Equipments in Our Country**

Up to the present, we have produced over 200 thousand sets of hydroelectric equipments. A portion of which is for export and the rest were installed in more than 80 thousand small hydroelectric stations scattered over a vast region. Some of them have been in operation for more than 20 years. Judging from their operating

conditions, it has been proved that they are sound in quality and adapt very well to the varying operating conditions in different localities. For example, two 580 m. head, 500 Kw units produced by Chongqing Hydroelectric Equipment Works, have been in safe operation for more than 10 years in Xiang Gong Dong Hydro Power Station, Dayong County, Hunan Province. The condition of cavitation is satisfactory. Jinghua No. 1 turbine runner is self-designed. Through repeated operations and comparisons, it has been proved of good quality and is now listed in state-set seriation (i.e. ZD 760). Lately, Jinghua Manufacturing Works has trial-produced a GZN-005-WP-250 type double-flow turbine generating unit and has already been installed in the tidal hydroelectric station in Wenling County, Zhejiang Province. Over the years, the following producers have produced a large number of equipments for our small hydroelectric stations:

1. Shaoguan, Huazhou, Luoding and Longchuan Hydraulic Turbine Works; Xingning, Chaoan Electrical Machinery Works of Guangdong Province.
2. Hangzhou Generating Equipment Works; Linhai, Leqing Machinery Works; Jinghua, Linhai Electrical Machinery Works of Zhejiang Province.
3. Zhong County, Leshan, Yaxi, Jiannan Machinery Works; Chongqing, Deyong Electrical Machinery Works of Sichuan Province.
4. Nanping Electrical Machinery Works; Yongchun Hydraulic Turbine Works of Fujian Province.
5. Kunming Electrical Machinery Works of Yunnan Province.
6. Lingling, Shaoyang Hydroelectric Equipment Manufacturing Co. of Hunan Province.
7. Jiangxi Hydroelectric Equipment Works, Shangrao Hydraulic Equipment Works and Guanzhou Electrical Machinery Works of Jiangxi Province.
8. Liuzhou Hydraulic Turbine Works of Guangxi Province.

Manufacturers belonging to various departments of water conservancy, under the spirit of self-reliance, have made many contributions in the construction of small hydroelectric stations. For example, the Machinery Co. of the Bureau of Water Power, Guangdong Province has produced about 160 thousand Kw., 1100 sets of Hydroelectric generating units and have already installed in special regions like Tibet and Hainan Island. These equipments have withstood the tests of many years operation. Moreover, Bailianhe Hydroelectric Equipment Works Hubei Province; Qinghai Hydroelectric Equipment Works, Xixia, Huangchuan Hydraulic Turbine Works of Henan Province as well as the Hydraulic Equipment Works of the Bureau of Water Power of Gansu Province also produce various kinds of Hydraulic equipments. Even the border province like Xinjiang, has its own hydroelectric equipment works.

The sub-tropical hot and moist climate is detrimental to the insulation of generators. Through the unceasing efforts of the researchers concerned, this thorny problem has already been solved. Generators of the 6300 volts level can readily withstand corrosion of moisture and have been in safe operation for more than 10 years.

The exciters of the early made generators were mostly d.c. exciters. The unavoidable wear between the brushes and the commutator is a serious drawback. An extensive research is made on semi conductor excitations. At present, comparative matured alternatives are SCR and triple winding phase shift compound excitation and silicon rectifiers with double winding shunt reactor. Repeated examinations have been made on them at different places under various modes of operation such as single unit operation, two units in parallel, integration into county level grid and national grid. They have been proved to be reliable in operation with good static and dynamic stability and of excellent performance in automatic voltage regulation and maintaining stable operation under various sorts of load under different power factors. Moreover, they have a broad range of no load voltage setting and can be operated in parallel with any kind of networks with convenient regulation of reactive power. They are thus deeply welcomed by mass consumer. In addition, brushless machines have been produced in several provinces, such as, Zhejiang and Sichuan Provinces, etc. The speed governors produced by the Manufacturer of Controlling Equipment of Hydroelectric Machineries in Tianjin have gained much fame throughout China.

Investigations made on small hydroelectric machines and equipments after long periods of operations revealed the fact that our equipments are of simple and reasonable construction and of good quality. In the attached tables, you will find a number of hydroelectric stations of our country which have been in operation for many years and still show excellent operating records. (refer to tabl 4).

### **(III) Major Small Hydroelectric Machines and Equipments for Your Selection**

In recent years, the production of small hydroelectric machines and equipments in our country has been developed very rapidly. Nowadays the annual productive capability has exceeded a million kw. Besides the turbine and generator, whole sets of equipments of a station can be supplied on requests. Although our products are mainly for markets at home, but a certain amount is reserved to meet needs abroad. Our service items include: river projects planning, exploration and surveying, designing, construction, installation, testing and, in fact, the whole engineering project from design to operation. We are ready to render service at any time.



Table 1 The Serial Numbers of Various Types of Hydraulic Turbines

No.	Type	Operating Range		
		Head (m)	Flow (m <sup>3</sup> /s)	Capacity (kw)
1.	ZD <sub>70</sub> -LM-40,60,80,100,120	3.5-7	0.56-8.6	12-400
2.	ZD <sub>70</sub> -LMY-100,120	2.7-7	2.96-8.6	55-400
3.	ZD <sub>300</sub> -LMY-40,60,80	4-14	0.4-3.99	12-400
4.	HL <sub>200</sub> -WJ-25,30,35,42,50,60	3-29.7	0.235-2.45	12-500
5.	HL <sub>220</sub> -WJ-42	24-50	0.95-1.375	200-500
6.	HL <sub>110</sub> -WJ-30,35,42,50,60	20-70	0.159-1.07	20-600
7.	CJ <sub>22</sub> -W-45/1 × 4.5	50-220	0.0709-0.4012	55-630
	CJ <sub>22</sub> -W-55/1 × 7	-	-	-
	CJ <sub>22</sub> -W-55/1 × 5.5	-	-	-
	CJ <sub>22</sub> -W-701 × 9	-	-	-
8.	XJ <sub>13</sub> -W-25/1 × 7	36-180	0.089-0.246	18-160
	XJ <sub>13</sub> -W-32/1 × 7	-	-	-
	XJ <sub>13</sub> -W-32/1 × 9	-	-	-
9.	XJ <sub>02</sub> -W-40/1 × 9	90-120	0.257-0.386	200-320
	XJ <sub>02</sub> -W-40/1 × 11	-	-	-
	XJ <sub>02</sub> -W-50/1 × 12	-	-	-
10.	HL <sub>210</sub> -LJ-230	28	38	7800
11.	HL <sub>200</sub> -WJ-60	28	2.45	550
12.	HL <sub>260</sub> -WJ-71	22-30	3.05-3.56	550-870
13.	HL <sub>200</sub> -WJ-84	18-32	3.72-5.1	550-1360
14.	HL <sub>260</sub> -LJ-100	19-28	5.6-6.4	870-1360
15.	HL <sub>210</sub> -LH-120	21-37.5	8-11	1360-3400
16.	HL <sub>210</sub> -LH-140	16.5-35	9.8-14.3	1360-4210
17.	HL <sub>210</sub> -LH-180	21.4	18.5	3400
18.	HL <sub>210</sub> -LJ-225	33	36.4	10500
19.	HL <sub>230</sub> -LJ-200	42	28.8	10410
20.	HL <sub>270</sub> -WJ-50	38-60	1.76-2.21	550-1090

No.	Type	Operating Range		
		Head (m)	Flow (m <sup>3</sup> /s)	Capacity (kw)
21.	HL <sub>220</sub> -WJ-60	30-64	2.24-3.28	550-1710
22.	HL <sub>220</sub> -WJ-71	33-60	3.32-4.52	870-2140
23.	HL <sub>220</sub> -WJ-84	35-65	4.78-6.18	1360-3400
24.	HL <sub>220</sub> -LJ-100	27.3-57.8	5.9-8.52	1360-4210
25.	HL <sub>220</sub> -LJ-120	46	11	4210
26.	HL <sub>220</sub> -LJ-140	52-61	15.8-17.6	6810-9150
27.	HL <sub>200</sub> -LJ-100	76-84	8.4-8.6	5240-6600
28.	HL <sub>200</sub> -LJ-140	76	14.5	9150
29.	HL <sub>160</sub> -WJ-50	54-74	1.23-1.44	550-870
30.	HL <sub>160</sub> -WJ-60	50-105	1.71-2.4	690-2080
31.	HL <sub>160</sub> -WJ-71	72-115	2.88-3.65	1710-3400
32.	HL <sub>160</sub> -WJ-84	66-89	3.85-4.45	2140-3400
33.	HL <sub>160</sub> -LJ-100	98-115	6.65-7.15	5350-6600
34.	HL <sub>120</sub> -LJ-120	180	6.8	10410
35.	HL <sub>110</sub> -WJ-50	80-92	0.85-0.91	550-690
36.	HL <sub>110</sub> -WJ-60	64-140	1.07-1.62	550-1710
37.	HL <sub>110</sub> -WJ-71	90-140	1.82-2.28	1360-2660
38.	HL <sub>110</sub> -WJ-100	165	4.78	6280
39.	HL <sub>100</sub> -WJ-65	175-230	1.5-1.7	2140-3190
40.	HL <sub>100</sub> -WJ-71	255	1.925	4210
41.	HL <sub>100</sub> -WJ-88	180-225	2.71-3.2	4210-6250
42.	ZD <sub>760</sub> -LH-180	5-6.7	14-15.8	550-870
43.	ZD <sub>760</sub> -LH-200	4.2-8	16.4-20.5	550-1360
44.	ZD <sub>760</sub> -LH-250	5.2	27.6	1090
45.	ZD <sub>560</sub> -LH-100	12-15	5.53-5.5	550-690
46.	ZD <sub>560</sub> -LH-120	9.5-13	6.61-8.18	550-870
47.	ZD <sub>560</sub> -LH-140	7.7-16	8.81-12.6	550-1710
48.	ZD <sub>560</sub> -LH-180	6.5-14.5	13-19.5	720-2140

No.	Type	Operating Range		
		Head (m)	Flow (m <sup>3</sup> /s)	Capacity (kw)
49.	ZD <sub>300</sub> -LH-250	10-11	31.6-37.6	2660-3400
50.	ZD <sub>600</sub> -LH-330 (or ZZ <sub>600</sub> -LH-330)	6.2	46.5	2660
51.	ZD <sub>300</sub> -LH-330 (or ZZ <sub>300</sub> -LH-330)	11.2	69.6	6600
52.	ZD <sub>400</sub> -LH-300 (or ZZ <sub>400</sub> -LH-300)	18.5	62	9220
53.	GD <sub>103</sub> -WP-275	4.9	42.5	1710
54.	GZ <sub>003</sub> -WP-300	6.3	50	2660
55.	GZ <sub>004</sub> -WP-410	5.5	97	4210
56.	GZ <sub>005</sub> -WP-550	6.2	205	10410
57.	CJ <sub>22</sub> -W-70/1 × 7	260-350	0.26-0.31	550-870
58.	CJ <sub>22</sub> -W-70/1 × 9	185-220	0.37-0.39	550-690
59.	CJ <sub>22</sub> -W-92/1 × 11	138-256	0.496-0.65	550-1360
60.	CJ <sub>22</sub> -W-110/1 × 12	218-345	0.762-0.984	1360-2660
61.	CJ <sub>22</sub> -W-115/2 × 11.5	210-285	1.29-1.5	2140-3400
62.	CJ <sub>22</sub> -W-115/1 × 9	400	0.532	1710

Table 2 Capacity of Hydroelectric Generators (Kw)

Speed (RPM)	1500	1000	750	600	500	428	375	300	250	214	187.5
No. of Poles											
Support No.	4	6	8	10	12	14	16	20	24	28	32
36.8	18 26	12 18									
42.3	40 55	26 40									
49.3		55 75	40 55								
59		100 125 160	75 100 125								
74		20 250	160 200	125 160							
85		320 400	250 320	200 250	160 200	125 160					
99		500 630 800 1000	400 500	320 400	250 320	200 250	160 200	125 160			
118		1000	630 800 1000	400 750 800	320 500						
143		1600	1250	800 1250	500 630 750 800						
145			1250 1600	1000 1250	630 1000		320 500 630				
148	3200 4000 5000 6000	2000 2500 3200									
173			1600 2000	1600 2000 2500	1250 2000 1800 2500						
215			6000	3200 4000 5000	3200 4000	800 2000	800 1000 1250		350 1250 1800	800	
260			6300	5000		3200	2500	1250 1800 2000	1000		
280											650
330									5000 6300	4000	2500 3200

Table 3 Types of Governors For Hydroelectric Generating Units

Type	Regulating Capacity (kg.-m.)	Remarks
TT-35	35	
TT-75	75	
TT-150	150	
TT-300	300	
XT-300	300	
XT-600	600	
XT-1000	1000	
YT-3000	3000	
YT-1800	1800	



