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工程

中國工程學會會刊

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總編輯　周厚坤　　總務　楊錫鏐

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插圖:

正文:

中國工程學會發行

中國工程學會會章摘要

第二章　宗旨　本會以聯絡工程界同志研究應用學術協力發展國內工程事業爲宗旨

第三章　會員

(一)會員　凡具下列資格之一由會員二人以上之介紹再由董事部審查合格者得爲本會會員

(甲)經部認可之國內外大學及相當程度學校之工程科畢業生并確有二年以上之工程研究或經驗者

(乙)曾受中等工程教育并有六年以上之工程經驗者

(二)仲會員　凡具下列資格之一由會員或仲會員二人之介紹並經董事部審查合格者得爲本會仲會員

(甲)經部認可之國內外大學及相當程度學校之工程畢業生

(乙)曾受中等工程教育并有四年以上之工程經驗者

(三)學生會員　經部認可之國內外大學及相當程度學校之工程科學生在二年級以上者由會員或仲會員二人之介紹經董事部審查合格者得爲本會學生會員

(四)永久會員　凡會員一次繳足會費一百元或先繳五十元餘數於五年內分期繳清者爲本會永久會員

(五)機關會員　凡具下列資格之一由會員或其他機關會員二會員之介紹並經董事部審查合格者得爲本會機關會員

(甲)經部認可之國內工科大學或工業專門學校或設有工科之大學

(乙)國內實業機關或團體對於工程事業確有貢獻者

(八)仲會員及學生會員之升格　凡仲會員或學生會員具有會員或仲會員資格時可加繳入會費正式請求升格由董事部審查核准之

第四章　組織　本會組織分爲三部(甲)執行部 乙)董事部(丙)分會(本總會事務所設於上海)

(一)執行部　由會長一人副會長一人書記一人會計一人及總務一人組織之

(三)董事部　由會長及全體會員舉出之董事六人組織之

(七)基金監　基金監二人任期二年每年改選一人

(八)委員會　由會長指派之人數無定額

(九)分　會　凡會員十人以上同處一地者得呈請董事部認可組織分會其章程得另訂之但以不與本會章程衝突者爲限

第六章　會費

(一)會員會費每年國幣五元入會費二十元　(二)仲會員會費每年國幣三元入會費六元

(三)學生會員會費每年國幣一元　(四)機關會員會費每年國幣十元入會費二十元

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	(副會長)	董登山	山西軍人工藝實習廠計核處
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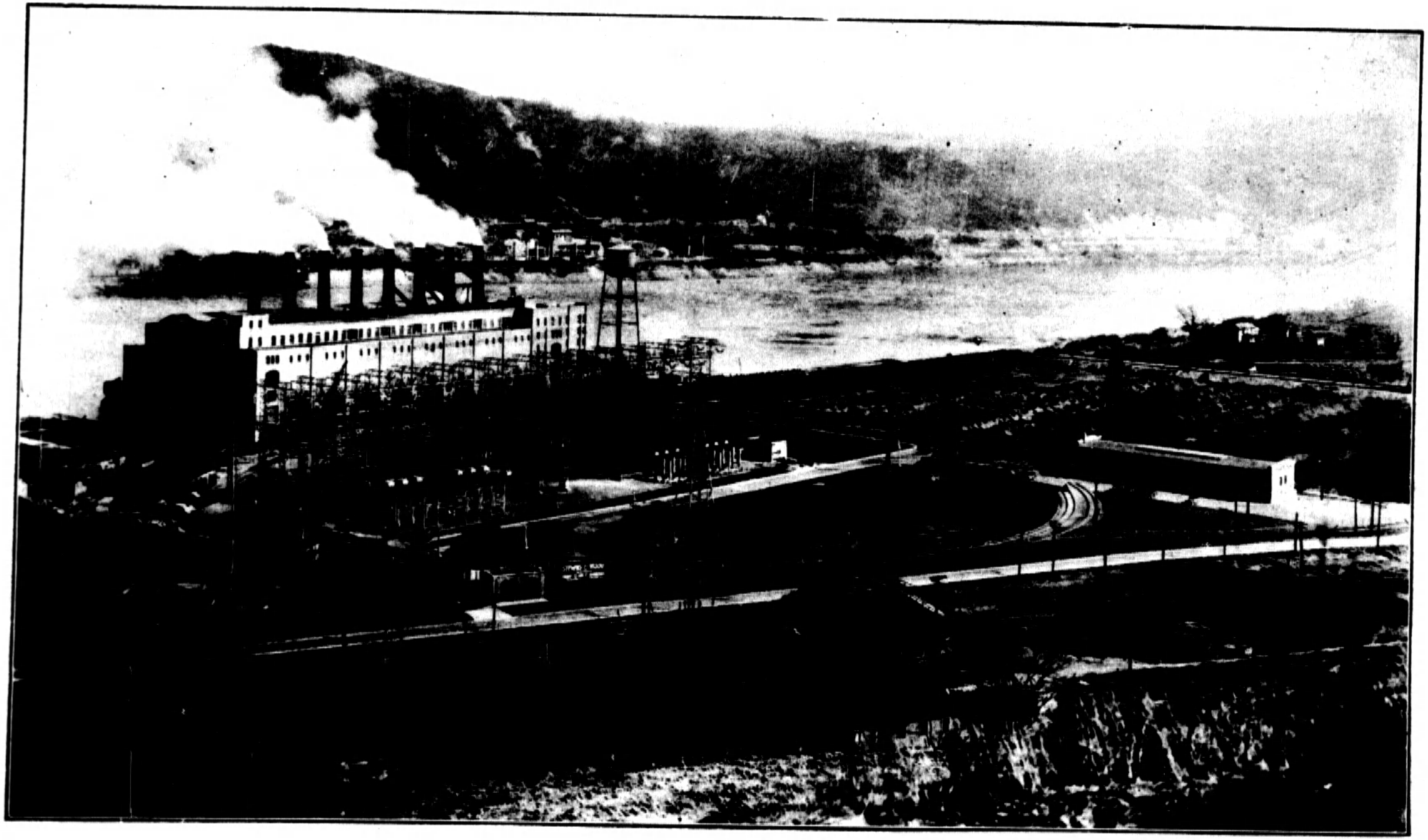

英國多倫多(Toronto)電廠全景

此廠在沃海沃省,係班沃公司電力系(Penn-Ohio System)主要電廠.有 35,000 kw 發電機四部,共有發電量 140,000 kw.鍋爐八座,全用粉煤.鍋爐電機,同在一室.廠後爲分電站,發電機電壓 11,000 弗打,傳遞電壓爲 132,000 弗打.廠右屯煤場,能儲煤三十萬噸.左方隙地,備將來擴充用.前臨巨川,係沃海沃河,水量充足,爲此廠定址於此之主要原因.

十八年八月陳宗漢記

研究以何者爲急

著者: 周厚坤

今日盛倡研究,然研究題目,往往固事高深,不切實用,夫爲個人或機關宣傳起見,計實無善於此.又在經濟敷餘諸國,沓百十碩彥於一堂,躋蹌而爲高深之研究,推翻科學某例,另定科學新例,其光前裕後,爲國增輝,計亦無善於此.但以民窮財盡之中國,國家費此鉅款,而爲此與民生無關之研究,宜乎否乎?

先其所急,爲辦事最要方針.一人之事,一家之事,與一國之事,均不能逃此定例.而今之青年與從政者,往往固爲高深,藉以表示一己智識之高,與目光之遠,其結果則費去鉅欵,一事無成,而我小民苦矣.(日本工業之進步,在工程師能於淺易處着力).

科學研究,原有兩種;一曰商業化的研究, Commercial Research 一曰基本的研究. Fundamental Research 二者爲相對之名詞,前者側重應用科學,後者側重理論科學.辦理前者,如各廠家自備之研究所,目下盛行美國,而美國政府之標準局 Bureau of Standards 從旁贊助之,又如英國政府之燃料研究所 Fuel Research Board, 亦係同一性質.辦理後者,如各國大學之研究科,及英國之物理研究所 Physical Laboratory 對於理論科學,與以甚深之研究,往往以一物象之發現,而推翻已有之科學定律焉.

兩種研究,均須人才,設備,經費,以中國目下之民窮財盡,應何適從乎?余曰當以前者爲要,請申述之.

我國進口貨,常超過出品貨,其原因有二:(一)因該項出品於技術上經濟上非我國所能製造者,如薄鐵皮 Tinplate Galvanized Sheets 之製造,用連續法,(Continuous Process)而成本大輕,質地大佳,然該項設備,係屬專利,他人不許仿

造,即能仿造,而資本又須六七千萬,故薄鐵皮一物,萬無自製之可能.又如汽車之製造,用種種特別機器,出貨多,成本輕,資本亦須雄厚,我國亦無自行製造之可能.(二)因外貨裝璜美麗,而國人樂用外貨.關於前(一)者,目下自無補救之法.關於後(二)者似應急起直追,研究改良之法,所謂商業化的研究是也.

試至書肆中,購一瓶墨水,洋貨墨水之瓶,光淨無泡,印刷精良,往往爲顧客所歡迎,雖貴亦有人買.乃觀同一櫃中之國貨墨水,則裝在不純之玻璃瓶內,滿身氣泡,木塞之惡劣,更不可名狀.實則中盛之墨水,質地並不較外貨爲劣,但因瓶器之欠佳而無人過問,因無人過問,而不得不廉價,因廉價而外觀之瓶與內盛之墨水,不得不更形惡劣,藉輕成本,循環不斷,而國貨墨水不可用矣.補救之道,先在玻璃瓶之改良.第一步爲鐵模之改良,第二步爲配合玻璃原料化學成分之改良,第三步爲吹做之改良,第四步爲專燒 Annealing 之改良,第五步爲檢查之嚴密.凡此種種,無須超等人才,特別設備,與鉅額經費,研究一有所得,立即可用於已有之玻璃廠中,國貨墨水,立即足以代替外貨墨水,其功効之顯着,不必如基本研究 Fundamental Research 之待數年,或數十年,而後可以應用也.墨水瓶如是,化裝品之瓶亦復如是.

又如裝食物及他物之洋鐵罐,夫以同一餅乾之匣,而外貨裝璜極佳,國貨比之望塵莫及.實則國貨之餅乾,未必較外貨爲劣,徒以裝璜欠佳,售價乃不得不折.補救之法,第一步爲鋼模之改良,第二步爲石印之改良,第三步爲烘焙之改良,第四步爲捲邊之改良.鋼模爲鐵罐之根本,倘用好鋼及好工,本可沖二萬只而即鈍者,可沖三四萬只,成本旣輕,出貨又好.試將洋貨國貨兩兩比較,即知洋貨鐵罐,每只一樣,並無高低不平之弊,即因鋼模較好之故.第二步石印之改良,尙不甚難.第三步烘焙之改良則大有研究之餘地.余在某廠,見其烘房,係用水泥.但自鍋爐至烘房之汽管,長數百尺,一無包扎,烘房之上下左右前後,並無留熱材料. Insulating Material 而汽管有直接按置於水泥地

上者,其導熱之力可知.惟最可痛心,則爲用過之汽,任其放走,並不回爐,無怪其燃料費用之大.第四步捲邊之改良,則爲設備與人工問題.凡此種種,一如玻璃之改良研究有得,即可於洋鐵罐廠中應用,不必如基本研究,固爲高深,可望而不可及也.

余所言之玻璃,及洋鐵罐,因兩者係盛物之器 Coutainers 爲商品不可少之物,引此以作標榜.其實洋貨之須仿造者,與國貨之須改良者,何止千百?均須依照商業化的原理而研究之,事非容易.普通廠家既缺資本,又乏人才,難自舉辦.倘用顧問工程師制,則廠家或畏其取費之昂,或慮其効用之微,不敢過問.倘恃公共機關,如工程學會,則會員俱有職業,無此時間,無此精神,專辦此事.無已則由政府之提倡,如美國之標準局, Bureau of Standards 對於國內應行改良之工業,爲種種之研究,(均切實用)作爲報告,公之於世,該國工業,受益實多.我國現有之研究院,側重理論,自無餘暇或餘欵,爲商業化之研究,則此事應由工商部另立機關爲之.兩者並不抵觸,但須認定目標,本機關之唯一職務,非空言性質,而係工作性質,非消極的調查統計與試驗樣本,而爲積極的指示錯誤,與指導改良.其研究場所,或在自設小型之廠,(不到萬元)或即在廠內,從事研究,所得成績,作爲報告,公之於世.若是公家所費有限,而工商受益甚大.質諸當道,以爲何如?

編輯部啟事

敝刊出版以來,屢荷投稿諸君惠寄大作,光篇宏幅,欽感無涯.惟因排校欠精,錯繆難免,殊用歉仄.除請排校人員格外注意外,嗣後來稿亦請抄繕清楚,加註新式標點.若稿件原係印刷品,更祈精細校閱,以免魯魚亥豕,是爲至幸!此啟.

全國無線電台呼號調查表

著者：惲震

全國電台呼號調查表

呼號	電台地點	電力	波長	主管機關	備註
XGA	瀋陽	10kw.	14m.29m.38m.	東北無線電監督處	
XGB	上海	250w.	26m.32m.	建委會	
XGC	〃	100w.	27m.	〃	
XGD	〃	100w.	29m.	〃	
XGE	安慶	100w.	40m.	〃	
XGF	瀋陽	300w.	42m.	東北無線電監督處	
XGG	〃	250w.	45m.	〃	
XGH	甯波	100w.	34m.72m.	建委會	
XGJ	杭州	500w. 100w.	600,900,1200 37m.72m.	〃	
XGK	上海	20kw.	16.04m.	〃	國際大電台在籌備中
XGL	〃	20kw.	37.64m.	〃	〃
XGM	〃	500w.	18m.	〃	中非國際電台
XGN	〃	20kw.	18.30m.	〃	國際大電台在籌備中
XGO	〃	20kw.	39.58m.	〃	〃
XGP	〃	500w.	21.6m.	〃	中非國際電台
XGQ	〃	100w.	34m.64m.	〃	
XGR	蕪湖	100w.	41m.75m.	〃	
XGW	上海			〃	稽察電台
XGX	〃	50w.	370m.	新新公司	廣播電台
XGY	杭州	500w.	315m.	浙江省政府	〃
XGZ	南京	500w.	495m	中央黨部	〃
XHA	北平	100w.	35.2m.	建委會	
XHB	天津	250w.	27m.37m.	〃	

呼號	電台地點	電力	波長	主管機關	備註
XHC	濟南	100w.	26m.28m.	建委會	
XHD	青島	100w.	28m.52m.	,,	
XHF	太原	100w.	36m.	第三集團軍	
XHT				交通處	
XH1				,,	
XH2				,,	
XH3				,,	
XH4				,,	
XH5				,,	
XH6	上海	500w. 100w.	36m.	,,	舊呼號爲XN3
XH7				,,	
XH8				,,	
XH9				,,	
XIA	廈門	100w.	28m.	建委會	
XIB	福州	100w.	34m.82m.	,,	
XID	廣州	100w.	52m.	,,	
XIF	,,	500w.	26m.	,,	
XIG	汕頭	100w.	31m.	,,	
XJA	漢口	250w.	37m.	,,	
XJB	,,	100w.	31.5m.	,,	
XJC	宜昌	250w.	40m.	,,	
XJD	漢口	100w.	32m.	,,	
XJM	蘭州		47m.	第二集團軍	
XKA	惠州	50w.	41m.	第八路總指揮部	
XKB	北海	100w.	47m.	,,	
XKC	汕頭	250w. 100w.	900m. 51m.	,,	
XKD	海口	100w.	49m.	,,	
XKF	虎門	15w.	52m,	,,	
XKF	開封	50w.	48m.	第二集團軍	
XKG	肇慶	500w. 100w.	900m. 52m.	第八路總指揮部	

呼號	電台地點	電力	波長	主管機關	備註
XKH	韶州	100w.	50m.	第八路總指揮部	
XKI	江門	50w.	49m.	,,	
XKJ	高州	250w. 100w.	850m. 46m.	,,	
XKK	汕尾	50w.	54m.	,,	
XKM	中山	50w.	41m.	,,	
XKN	台山(新昌)	50w.	47m.	,,	
XKO	南京	120w.	36m.	海軍部	
XKO	九江	15w.	45m.	第八路總指揮部	在廣東三省水附近
XKP	嘉積	15w,		,,	
XKS	南甯		35.5m.	廣西省政府	
XKNG	,,	500w.	1200m.	,,	
XLA	南京	100w.	34m.42m.53m.	建委會	
XLB	,,	100w.	36m.64m.	,,	
XLC	上海	100w.	32m.	,,	
XLD	蚌埠	100w.	35m.	,,	
XLF	屯溪	100w.	39.25m.	,,	
XLG	上海	500w.	16m.22m.	,,	
XLH	,,	250w.	22m.28m.	,,	
XL1A	南京	100w.	45m.60m.	財政部	
XL1B	上海	250w.		,,	
XL1C	南昌	100w.		,,	
XL1D	北平	150w.	40m.62m.	,,	
XL1E	漢口	150w.		,,	
XL1F	濟南			,,	
XL2A	南京	100w.	36m.	第三集團軍	
XL2B	上海	100w.	37m.	,,	
XL2C				,,	
XMNB	同華輪			招商局	
XNA	廣州	8kw.	1750m.5000m.	第八路總指揮部	
XNAA	元大輪		600m.	元一公司	

呼號	電台地點	電力	波長	主管機關	備註
XNAB	華強輪		1200m.600m.	華安輪船公司	
XNAC	和興輪		48m.600m.	肇興輪船公司	
XNAD	肇興輪		48m.600m.	,,	
XNAE	同安輪		48m.600m.	,,	
XNAF	聯興輪		48m.600m.	,,	
XNAG	裕興輪		48m.600m.	,,	
XNAH	北華		48m.600m.	直東輪船公司	
XNAI	北泰		48m.600m.	,,	
XNAJ	北平		48m.600m.	北方輪船公司	
XNAK	北晋		48m.600m.	,,	
XNAL	s/s Saucy		600m.	德豐拖駁公司	
XNAM	s/s St. Dominic		600m.	,,	
XNAN	s/s St. Sampson		600m.	,,	
XNAO	s/s St. Aubin		600m.	,,	
XNAP	華安輪		48m.600m.	常安輪船公司	
XNAQ	源安輪		48m.600m.	源安輪船公司	
XNAR	北昌		48m.600m.	直東輪船公司	
XNAS	北康		48m.600m.	北方輪船公司	
XNAT	通濟		50m.600m.	通濟輪船公司	
XNAV	公平			招商局	
XNAW	新銘輪		48m.600m.	,,	
XNAY	廣大輪		48m.600m.	,,	
XNB	廣州	400w.	38m.	第八路總指揮部	
XNB	同安軍艦			海軍部	
XNBD	中和輪		600m.	華通輪船公司	
XNBE	毓濟輪		600m.	毓大輪船公司	
XNBF	福泰輪		600m.	福泰輪船公司	
XNBG	和順輪		600m.	大通輪船公司	營口
XNBH	華陽輪	150w.	48m.600m.	招商局	
XNBI	日昌輪			日昌輪船公司	

呼號	電台地點	電力	波長	主管機關	備註
XNBJ	華恒輪		48m.600m.	新華輪船公司	
XNBR	廣利輪			招商局	
XNBU	甯興輪			甯興輪船公司	
XNBV	萬象輪		48m.600m.	三北輪船公司	
XNBY	新甯紹		48m.600m.	甯紹輪船公司	
XNBZ	甬興輪		48m 600m.	,,	
XNC	永績軍艦	3kw.	450m.600m.	海軍部	
XNCL	廣太輪		48m.600m.	招商局	
XND	富錦	1kw.	2000m.	東北無線電監督處	
XNC	廣州	200w.	45m.	第八路總指揮部	
XNF	中山軍艦			海軍艦	
XNH	黑河	100w.	700m.	東北無線電監督處	
XNK	南京	500w.	36.6m.	交通處	已改換呼號
XNK	海拉爾	100w.	700m.	東北無線電監督處	
XNL	福安軍艦			海軍部	
XNO	豫章軍艦	1kw.	450m.600m.	,,	
XNP	廣州	500w.	950m.	第八路總指揮部	
XNS	甯夏	50w.	48m.	第二集團軍	
XNY	永健軍艦	3kw.	450m.600m.	海軍部	
XN1	上海製造廠			建委會	試驗電台
XN2	南京			交通處	已改換呼號
XN2A	,,	250w.	355m.	,,	
XN2B	,,	100w.	43.5m.	外交部	
XN2C	,,	100w.	37m.	軍官學校	
XN3	上海	100w. 500w.	36.6m.	交通處	已改換呼號
XN3A	,,	100w.	41.4m.	外交部	
XN4	漢口	100w.	43m.68m.	交通處	已改換呼號
XN5	洛陽	250w.	42m.	第二集團軍	
XN9	太原	100w.	37m.	第三集團軍	
XN9A	北平	100w.	35m.	平津衛戍司令部	

呼號	電台地點	電力	波長	主管機關	備註
XN9B	天津	50w.	38m.	平津衛戍司令部	
XN9C	太原	100w.		第三集團軍	
XN9D	北平			,,	
XOA	楚泰軍艦	1kw.	450m.600m.	海軍部	
XOB	上海	500w.	42m.600m.	,,	
XOC	武昌	5kw.	1200m.3600m.	交通處	
XOD	楚同軍艦	1kw.	450m.600m.	海軍部	
XOF	烟台	5kw.	600,1200,1600m.	交通部	
XOF	延吉	100w.	700m.	東北無線電監督處	
XOG	楚觀軍艦	1kw.	450m.600m.	海軍部	
XOH	哈爾濱	5kw.	1300m.	東北無線電監督處	
XOHB	,,	100w.	47m.	,,	
XOJ	營口	1 5kw.	600m.	,,	
XOK	長春	2kw.	1150m.	,,	
XOKB	吉林	100w.	700m.	,,	
XOL	武勝軍艦	1kw	450m.600m.	海軍部	
XOM	瀋陽	10kw.	3300m.	東北無線電監督處	
XOMS	,,	500w.	1100m.	,,	
XON	楚謙軍艦	1kw.	450m.600m.	海軍部	
XOO	滿洲里	100w.	700m.	東北無線電監督處	
XOP	包頭	500w.	900m.		
XOP	密山	100w.			
XOQ	大沽	2.5kw	600m.1200m.	平津衛戍司令部	
XORT	青島		42m.		
XOS	綏芬河	100w.	700m.	東北無線電監督處	
XOT	龍江	1kw.	1025m.	,,	
XOU	楚豫軍艦			海軍部	
XOV	天津	500w.	750m.1500m.	天津警備司令部	
XOV2	,,	50w.	34m.	,,	
XOW	福州	5kw.	600,900,37m.	福建省政府	
XOY	延吉	300w.	850m.	東北無線電監督處	

呼號	電台地點	電力	波長	主管機關	備註
XOZ	葫蘆島	1.5kw.		東北無線電監督處	
XO1	長沙	100w.	38m.	交通處	
XO2	南昌	100w.	36m.	江西省政府	
XO2A	贛州	100w.	35m.	,,	
XO3	廣州	100w.	43m.	第八路總指揮部	
XO4	南京				前馮玉祥行營電台
XO5	梧州	100w.	45m.83m.	廣西省政府	
XO6	貴陽	120w.	41m.	貴州省政府	
XO7	重慶	150w.	49m.	劉湘軍部	
XO7A	,,			,,	
XO8	漳州	100w.	36m.	獨立第四師	
XO9		100w.	37m.	蔣總司令行營	現停辦
XPF	通濟軍艦	1.5kw.	600m.800m.	海軍部	
XPG	上海	100w.	48m.	海岸巡防處	
XPI	東沙島	100w. 1kw. 2.5kw.	45m. 600m. 1450m.	,,	
XPK	北平	5kw.	1620m,2650m.	平津衛戍司令部	
XPL	平涼		47m.	第二集團軍	
XPL	甘露測量艦	1kw.	600m.	海道測量局	
XPM	北平	100w.		省政府	現停辦
XPN	坎門	150w.	50m.	海岸巡防處	
XPO	建康軍艦	1kw.	450m.600m.	海軍部	
XPP	廈門			,,	
XPR	,,	150w. 1kw.	45m. 600m.	海岸巡防處	
XPW	福州	100w.	37m.	海軍部	
XPZ	嵊山	150w.	48m 600m.800m.	海岸巡防處	
XP1	鄭州	50w.	36m.	第二集團軍	
XQA	靖安軍艦	1.5kw.	600m.800m.	海軍部	
XQC	江貞軍艦	1kw.	600m.800m.	,,	
XQI	柳州	500w.	1600m.	廣西省政府	

呼號	電台地點	電力	波長	主管機關	備註
XQJ	梧州	500w.	900m.1500m.	廣西省政府	
XQL	張家口			平津衛戍司令部	
XQM	昆明	50kw.	10,500m.	雲南省政府	
XQM2	,,		36m.	,,	
XQU	江元軍艦	1kw.	450m.600m.	海軍部	
XQZ	南京	250w	41m.	行政院	
XQ1	成都	250w	38m.	鄧錫侯軍部	
XQ1A	,,	250w	36m.	川康邊防總指揮部	
XQ1B	遂甯			鄧錫侯軍部	
XQ2	潼川	250w	36m.	田頌堯部	
XQ5	涪州	250w	38m.	郭汝棟軍部	
XQ7		100w	42m.	唐生智軍部	
XQ7A				,,	
XQ7B				,,	
XQ8				魯滌平軍部	
XQ9				,,	
XRA	威勝軍艦	1½kw.	450m.600m.	海軍部	
XRA	上海	250w.	42.9m.	交通部	
XRA2	,,	50w.	37.2m.	,,	
XRA3	,,	250w.		,,	
XRA5	,,			,,	
XRB	德勝軍艦	1½kw.	450m.600m.	海軍部	
XRB	南京	250w.	50m.80m.	交通部	
XRB2	,,		35.5m.	,,	
XRC	聯鯨軍艦	1½kw.	450m.600m.	海軍部	
XRC	重慶		39m.	劉湘軍部	
XRD	東山		800m.		
XRD	蕪湖		49m.	交部通	
XRE	宜昌		36m.	,,	
XRF	上海	1kw.	24m.	,,	國際電台
XRG	庫倫	25kw.	1000m. 4000m.		

呼號	電台地點	電力	波長	主管機關	備註
XRH	漢口	250w.	40.5m.	交通部	
XRJ	重慶		43.5m	”	
XRJ2	”			”	
XRK	喀什噶爾	25kw.	5000m.	新疆省政府	
XRL	安慶		46.1m.	交通部	
XRL	公勝軍艦	50w. 150w.	31m. 600m.800m.	海軍部	
XRM	迪化	25kw	3000,4000m.	新疆省政府	
XRN				交通部	
XRO	青島		43m.	”	
XRO	揚子砲艦			財政部	
XRP	北平			交通部	
XRQ	濟南		48m.	”	
XRS	萬縣			”	
XRT	青島	12kw.	600,1200m.	”	
XRU	崇明	15kw.	62m.	”	
XRV	天津		38m.	”	
XRX	杭州	250w.		”	
XRY	洛陽	5kw.	1200,1600m.		
XRZ	廣州		31m.	交通部	
XRZ	江鯤軍艦	250w.	45m 600m.800m.	海軍部	
XSA	西安		40m.	第二集團軍	
XSE	索倫	100w.	700m.	東北無線電監督處	
XSF	應瑞軍艦	500w.	600m.800m.	海軍部	
XSG	吳淞	100w. 5kw.	60m.48m. 600m.800m.	建委會	
XSH	上海	500kw.	600m.	交通部	
XSJ	華安軍艦	500w.	450m.600m.	海軍部	
XSJA	新甯興輪		48m.600m.	三北輪船公司	
XSK	普安軍艦	500w.	450m.600m.	海軍部	
XSN	西寧		48m.	第二集團軍	
XSU	崇明	500w.	600m.	建委會	停辦

呼號	電台地點	電力	波長	主管機關	備註
XSVA	衡山輪		48m.600m.	三北輪船公司	
XSW	海籌軍艦	1.5kw.	600m.800m.	海軍部	
XSY	海容軍艦	1.5kw.	600m.800m.	,,	
XS1	萬縣		52m.	劉湘軍部	
XS2	成都	15w.	35m.	劉文輝軍部	
XTY	太原	7.5kw.		第三集團軍	
XT3	,,	100w.	35m.	,,	
XT4	歸化	50w.	35m.	,,	
XT7	北平	150w.	35m.	,,	
XT8	張家口	100w.	35m	,,	
XUAB	東豐輪		50m.600m.	國民航業公司	
XUAC	元利	250w.	300m 600m.	元亨船務公司	
BTF	甯夏	500w.		第二集團軍	
XMC	上海			招商局	
XFA	開封			第二集團軍	
XFB	孫良誠行營			,,	
XFF	鹿鍾麟行營			,,	
XFH	劉鎭華行營			,,	
XFN	石友三行營			,,	
XFU	韓復渠行營			,,	
XYZ	北平雙橋	500kw	7500m 16000m	中日共管	

THE HEAT TRANSMISSION TESTS OF A LOCOMOTIVE FEEDWATER HEATER

著者: 鄭 泗 (SZE CHENG)

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I. Introduction. The transmission of heat through tubes or plates from wet vapor or condensing steam to water has been investigated by many physicists from Poisson in 1835, Peclet in 1841 and Joule in 1861 down to the present time. The earliest statement of the law of heat transmission in solids was made by Newton in 1690, while most of the mathematical work has been based on Fourier's classic published in 1882. By 1870 the existence of the gas film on the steam side of the tubes was suspected. The existence of water film was suspected as early as 1861.

Since 1880 there have been attempts to ascertain the laws of heat transmission for condenser practice by many investigators, such as Werner and Wagemann in 1883, Ser in 1887, Richter in 1899, and Hepburn in 1901. The later experiments including those of G. A. Orrok, have worked with actual machinery along what might be termed commercial lines.

The present status of the transmission of heat through metallic tubes from condensing steam to water according to various authorities may be stated as follows.

According to Joule, Rankine and most of the experimenters, the quantity of heat transmitted by a unit of surface in a unit of time is proportional to the temperature difference between the media on the different sides of the tube.

According to Werner, Grashof and Weiss, the quantity of heat transmitted by a unit of surface in a unit of time is proportional to the square of the temperature difference between the media on the different sides of the tube.

According to Joule and Ser, the quantity of heat transmitted is proportional to one-third power of the water velocity. According to Hagemann and Joss, the quantity of heat transmitted is proportional to one-half power of the water velocity. According to Stanton, the quantity of heat transmitted is proportional to the first power of water velocity.

According to Hausbrand and Ser, the quantity of heat transmitted is proportional to one-half power of the steam velocity. According to Jordan. the quantity of heat transmitted is proportional to the mass flow of steam.

According to Bourne, Smith, Weighton, Morrison, McBride, the quantity of heat transmitted is greatly affected by the amount of non-condensible vapors (such as air) on the steam side of the tube.

If K is equal to the coefficient of heat transmission, which is the amount of heat transmitted per square foot of heating surface per degree difference in temperature F. per hour, and V is equal to the velocity of water, the relation of K and V given by various authorities from the average of the experimental values is as follows.

Ser	$K = 520 \sqrt[3]{V}$.
Josse	$K = 487 \sqrt[3]{V}$.
Weighton	$K = 430 \sqrt[3]{V}$.
Stanton	$K = 340 \sqrt[3]{V}$.
Joule	$K = 315 \sqrt[3]{V}$.
Clement & Garland	$K = 270 \sqrt[3]{V}$.
Hepburn	$K = 419 \sqrt{V}$.
Hagemann	$K = 282 \sqrt{V}$.
Allen	$K = 220 \sqrt{V}$.
Orrok	$K = 308 \sqrt{V}$.

It will be seen that the statements and the formulas for this type of heat transmission are quite diversified.

Besides, the results derived from the experiments made for the condensers are not strictly applicable to locomotive feedwater heaters for the following reasons:—

(1) The pressure in the locomotive exhaust passage is very near to the atmospheric pressure. Therefore, the leakage air amounts to nothing and the amount of air in the steam or water is of small magnitude as to have practically no influence on the average results of heat transmission.

(2) The temperature of the warm water in condenser practice is lower than the temperature in feedwater heater practice. Hence the range of temperature is not satisfactory for comparison with that in locomotive feedwater heater practice.

(3) In designing condenser, the hot well temperature is to be as low as desirable, while in designing a feedwater heater, the outlet temperature of the hot water is to be as high as desirable.

(4) The body of the feedwater heater is generally protected against radiation by lagging. But in the condenser there is no lagging and radiation is desirable as it reduces the temperature of the water and the pressure of the exhaust steam.

Consequently, it seems proper to present the heat transmission tests of a locomotive feedwater heater by the writer in the University of Illinois, U. S. A.

II. Theory of Heat Transmission. In order to derive the theory of heat transmission the statement made by Prof. Obsborne Reynolds may be introduced: "The heat carried off by air or any fluid from a surface, apart from the effect of radiation, is proportional to the internal diffusion of the fluid at and near the surface, that is, proportional to the rate at which particles or molecules pass backwards and forwards from the surface to any given depth within the fluid."

This assumption is fundamenally based on the molecular theory of fluids. The rate of this diffusion is probably dependent upon two things: (1) The natural internal diffusion of the fluid when at rest. (2) The eddies caused by visible motion, which mixes the fluid up and continually brings fresh particles into contact with the surface.

Conversely, when heat is given off from a fluid to a surface, it may also be stated that the rate of heat given off is proportional to the internal diffusion of the fluid at and near the surface.

Let H be the total heat transmitted between two liquids separated by a metal wall per hour, B.t.u.

t_m be the mean temperature difference between the two kinds of the fluids, deg. F. The method of computation may be found in Appendix I.

K be the coefficient of heat transmission, B.t.u. per sq. ft. per deg. F. per hour.

S be the heating surface of the metal wall, sq. ft.

By definition, $H=K\times S\times t_m$ .... (1)

The coefficient of heat transmission K, is the amount of best transmitted per unit of heating surface per unit of mean temperature difference per unit of time. It is a measure both of rates of diffusion of the two liquids and of the conductivity of the metal. The conductivity of a metal is constant if the condition of the surface is in the best condition. Hence the rate of diffusion is to be examined.

The first of the two causes mentioned before for the rate of diffusion is independent of the velocity of the fluid, but dependent upon the nature of the fluid. In the case of two kinds of liquids separated by a metal wall, this cause will be proportional to the relative amount of the two kinds of fluids. Let the relative amount of the two kinds of fluids be *R*. Then the first cause of diffusion is equal to function of (R), or

FIRST CAUSE OF DIFFUSION$=f(R)$,

where *f* is sign of "function of."

The second of the two causes, the effect of eddies, arises entirely from the motion of the fluid, and is proportional to the velocity with which it flows past the surface. Let V_1, and V_2 be the velocity, ft. per sec. for the two kinds of fluids separated by a metal wall, respectively. Then the seccond cause is the function of V_1 and V_2, or.

SECOND CAUSE OF DIFFUSION$=f\ (V_1,\ V_2)$

But the rate of diffusion is the combination of the two causes, and (K) is a measure of the rate of diffusion. Therefore,

$K=\text{constant}\times f\ (R,\ V,\ V_2)$ ....(2)

where the constant includes the conductivity of the metal, and of liquid films, as well as the values of the densities.

In the closed type feedwater heater ordinarily applied on a locomotive, the water flows in tubes and the steam is contained in a large space surrounding the tubes. Thus the water velocity is considerable and the velocity of the exhaust steam is negligible. In this case, the effect of the steam velocity on the coefficient of heat transmission may be neglected. Let V equal to the velocity of the feedwater. Then from equation (2) by Omitting the steam velocity, the coefficient of heat transmission in the exhaust steam heater with water tubes is equal to

$$K = \text{constant} \times f(R,V) \quad \text{.............................} \quad (3)$$

By referring to the assembly of formulas on page 327, it will be seen that the effect of R on the coefficient of heat transmission has never been considered.

III. The Tests. A series of tests in connection with a closed type heater was made by the writer at the University of Illinois, Locomotive Laboratory, during July, 1925. The object of these tests was threefold:

(1) To determine the valuse of K under the test conditions.

(2) To determine the effect of the velocity of the flow of feedwater on the coefficient of heat transmission.

(3) To determine the variation of heat transfer with variation of the ratio of exhaust steam and water, by weight.

(A) Description of Apparatus

(1) The heater tested was an Elesco locomotive feedwater heater. The exhaust steam is admitted to the heater at the top and surrounds the tubes which contain the feedwater. The condensate passes out through the drain at the bottom. The water passes length-wise through the heater four times before it is delivered to the boiler.

One of the most important features of the heater consists of the agitators, one of which is contained in each of the tubes in the body of heater. The function of the agitators is to agitate the water as it passes through the tubes so that every particle of it will come in contact with the hot tubes and absorb all the heat possible from the exhaust steam on the outside of the tubes. (see Fig. 2, p. 331).

(2) An ordinary reciprocating pump was used during these tests. It had a 5 in. suction and 4 in. discharge. The maximum capacity of this pump was 225 gal. per min. against 50 lb. pressure.

(3) The diameter of the water inlet and outlet pipes of the heater are 2–1/2 in. The diameter of the condensate pipe is also 2–1/2. in. The steam was taken from the laboratory high pressure main and reduced in pressure by throttling. The two four-in. pipes of the heater for the exhaust steam unite in a piece of a 6 in. vertical pipe. Connected to the bottom of the 6-in. pipe is a 2-in. pipe through the steam comes to the heater. (see Fig. 1,).

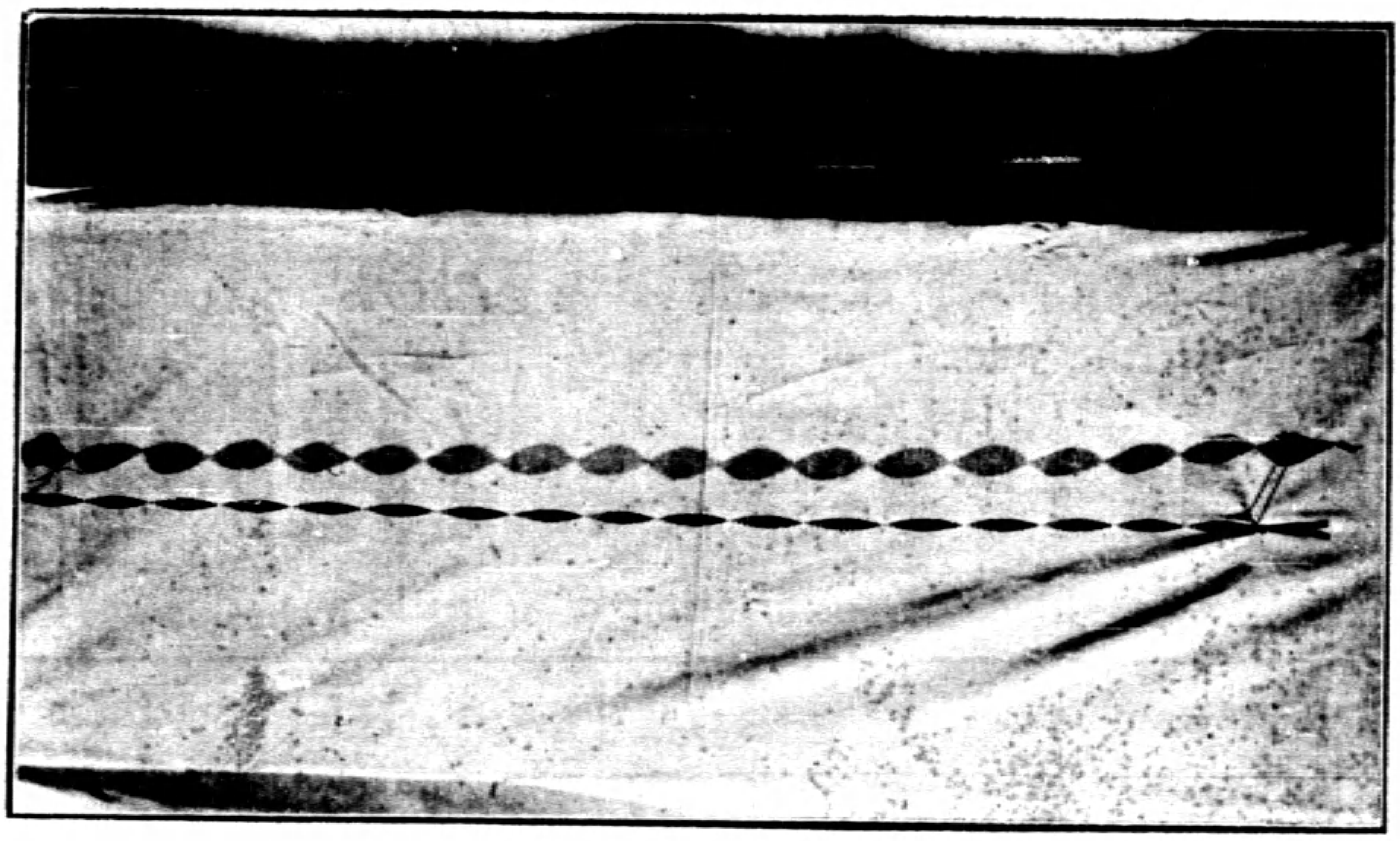


FIG. 1. GENERAL ARRANGEMENT.

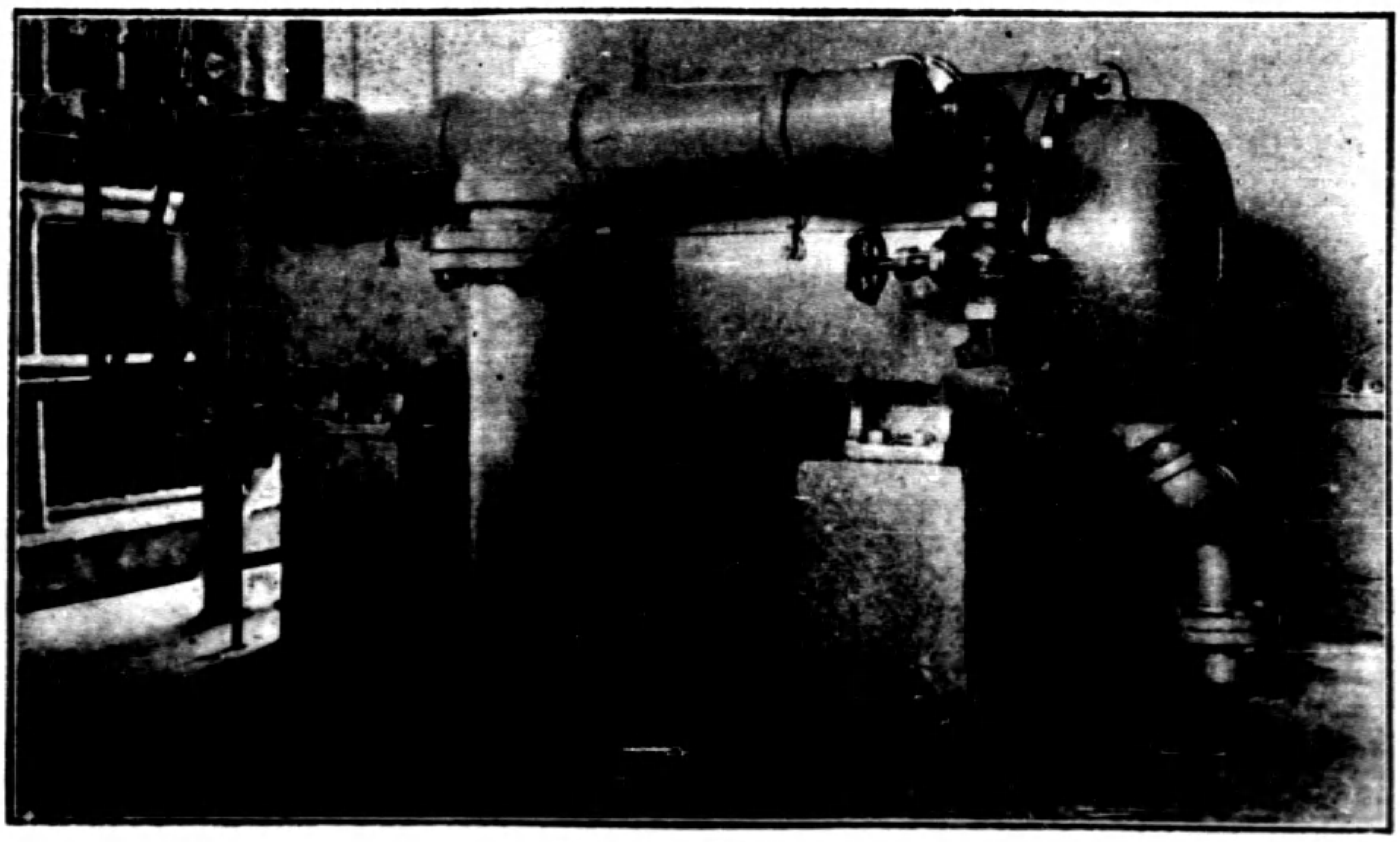


FIG. 2. AGITATOR.

(4) The amount of feedwater was measured by delivering the outlet water to overhead weighing tanks. Two feedwater tanks were used alternately. Each tank has a capacity of 2000 lb.

The amount of condensate was determined by delivering the condensate into the tanks placed on platform scales.

The temperature of the condensate was determined by a mercury thermometer placed in a U-shaped bend in the condensate pipe.

The temperature of the inlet and outlet water were measured by mercury thermometers inserted in the lines entering and leaving the heater.

The steam pressure in heater was measured by a pressure-vacuum gage.

(B) RESULTS OF TESTS

The curves in Fig. 3, show the variation of K, the coefficient of heat transmission, with the velocity of feedwater in the heater, V. The general equation for K is

$$K=av^{n} \quad \ldots\ldots (4)$$

where a has the values shown in the following table, and plotted in Fig. 4, and where the exponent n is equal of 0.889.

TABLE 1.—Variation of a with R.

R, per cent.	4	5	6	7	8	9	10
Values of a	44	55	68	83	100	120	142

From Fig. 4, the relation of a with R is determined thus,

$$a=21.3\ e^{(0.19R)} \quad \ldots\ldots (5)$$

By combining equations (4) and (5), the expression for K becomes

$$K=21.3\ e^{(0.19R)}\ V^{(0.889)} \quad \ldots\ldots (6)$$

In equation (6), the value 21.3 is a constant, and e is the base of natural logarithm, and, $e^{(0.19R)}\ V^{(0.889)}=f(R,V)$ .... (7)

Hence equation (6) becomes $K=\text{constant}\times f\ (R, V)$ .... (8) which is the same as the equation (3), p. 330.

Therefore, the tests show that the coefficient of heat transmission is a function of both R and V

In equation (6), $R=\dfrac{\text{weight of steam condensed per hour}}{\text{weight of feedwater per hour.}}\times 100.$

V=Velocity of feedwater, ft. per sec.

K=B.t.u. per sq. ft. per deg. F. per hour.

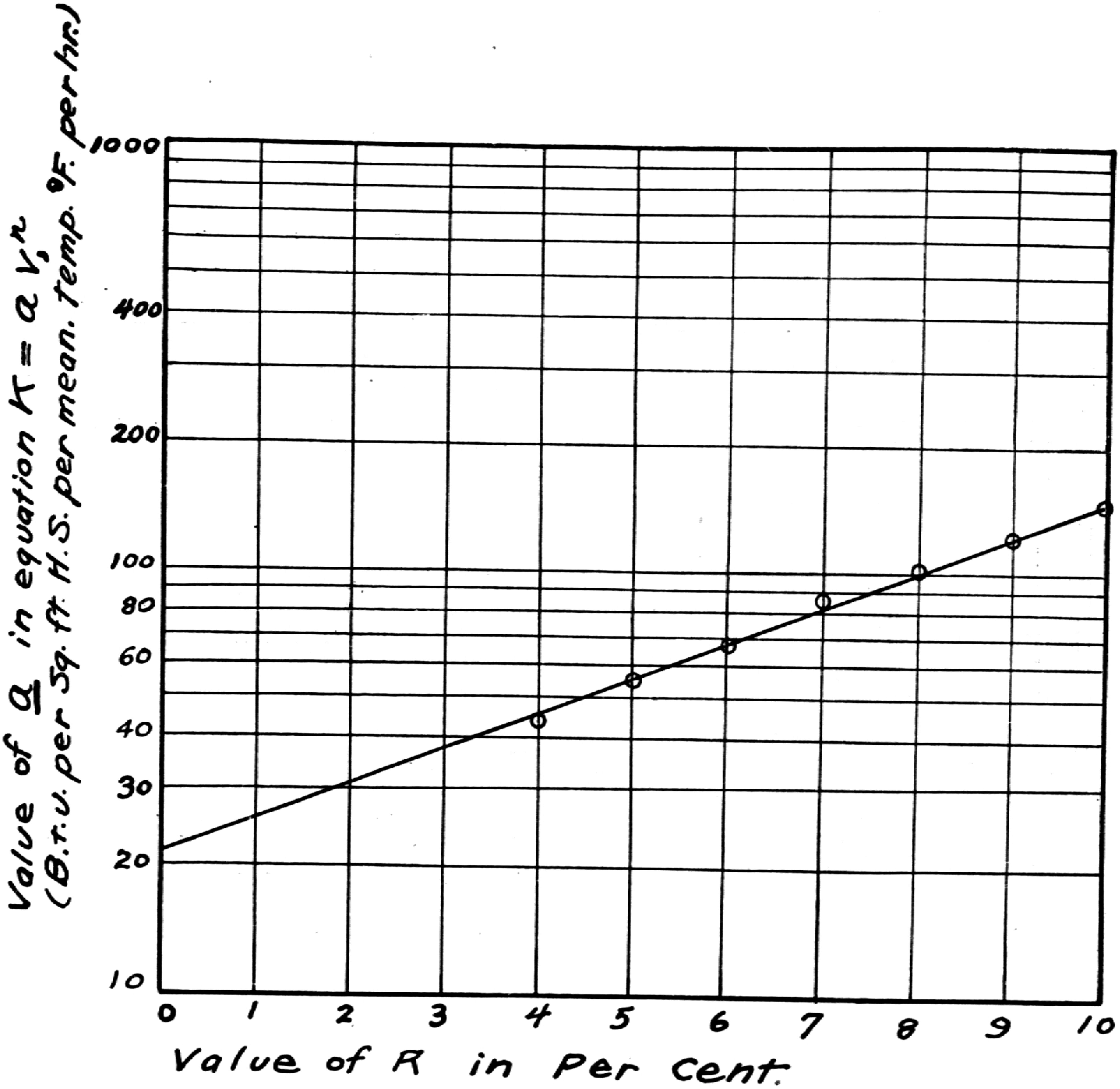


Fig. 4 Relation of a and R.

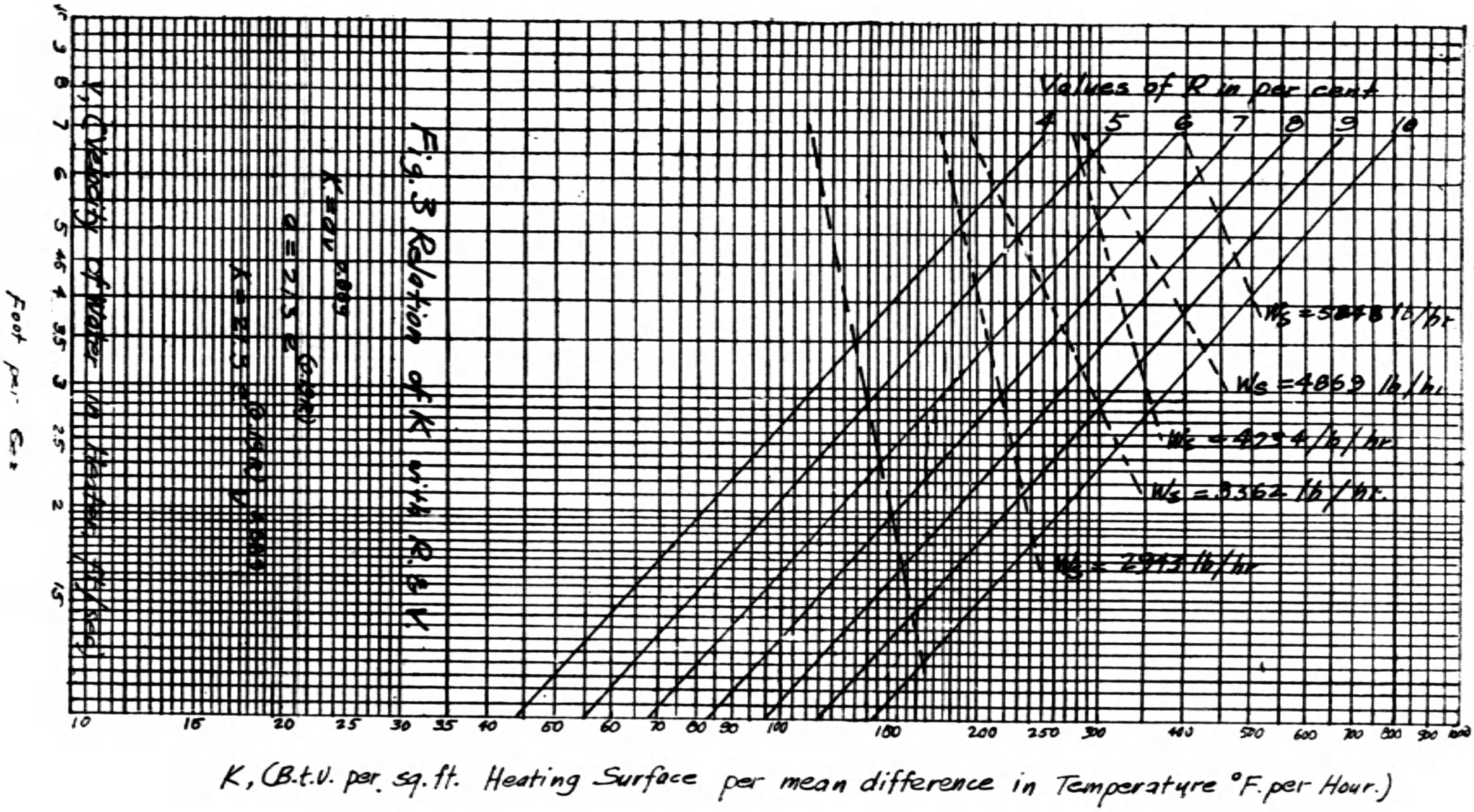


Fig. 3 Relation of K with R & V
V, Velocity of Water in Heater, ft/sec
foot per sec
Values of R in per cent
Ws = 4869 lb/hr
Ws = 2913 lb/hr
K, (B.t.u. per sq. ft. Heating Surface per mean difference in Temperature °F. per Hour.)

APPENDIX I

Experimental Results

In July and August, 1925, a series of tests on a locomotive feedwater heater of the closed type was made by the writer in the locomotive Laboratory at the University of Illinois, U. S. A., for the Master Degree Thesis. Acknowledgment is here made of the services of Mr. H. R. Higgins, Mechanician, who assisted in installing and handling the equipment and testing apparatus.

Part of the original data and results in the writer's thesis is shown in Table 2. In general, each value is the average of three determinations.

1. Data and Results.

Heating Surface of the Feedwater Heater under Test.

Total length of each tube=57 in.

Effective length of each tube=54 in.

Total number of tubes=184.

Number of passes=4.

Outside diameter of tube=5/8 in.

Heating surface per ft. length of tube=0.164 sq. ft.

Total heating surface of the tubes =135.8 sq. ft.

Cross-sectional Area of One Pass.

Number of tubes in one pass=46.

Inside diameter of tube=1/2 in.

Cross-sectional area of one pass=0.0628 sq. ft.

The List of Symbols for Tables

W_w, weight of feedwater through heater, lb. per hour.

W_s, " " condensed steam, lb. per hour.

V, velocity of water in heater tubes, ft. per sec.

t_c, temperature of condensate, deg. F.

t_1, temperature of inlet water, deg. F.

t_2, " " outlet " " "

t_r, temperature rise of water in heater, deg, F. $= t_2 - t_1$.

p, steam pressure at heater, lb. per sq. in.

H, total heat transmitted per hour, B.t.u.

H_t, heat transmitted per sq. ft. heating surface per hour.

K, heat transmitted per deg. F. in temperature per sq. ft. of heating surface per hour.

R, ratio of W_s/W_w in per cent.

The data and results are shown in Table 2

TABLE 2. Heat Transmission in Heater

Test No.	W_s lb./hr.	W_w lb./hr.	t_s deg. F.	t_1 deg. F.	t_2 deg. F.	t_r deg. F.	p lb./sq. in (Gage)
6	1992	41,616	172.6	77.3	126.7	49.4	1.6
7	1956	33,882	175.7	78	138	60	1.6
8	2130	63,276	168.7	78.3	113.8	35.5	1.7
9	1968	74,296	165	80.7	108	27.3	1.5
10	1860	88,736	161.5	82	105.5	23.5	1.55
Average	1981						
11	2880	40,818	190	80.7	152	71.3	2.2
12	2910	60,120	184	80.8	131.3	50.5	1.8
13	2910	70,914	180.7	84.3	124.3	40.0	1.9
14	3072	90,996	178	86	117	31.0	1.65
Average	2943						
16	3108	30,378	208.7	83	189.7	106.7	2.2
17	3714	49,782	193	83.5	154.	70.5	2.3
18	3420	57,804	192.3	83.8	143.7	59.9	2.4
19	3462	71,958	188.6	84.7	134.3	49.6	2.5
20	3108	78,645	185.5	85.5	127.2	42.0	2.5
Average	3362						
21	4080	45,600	205	81	170.1	89.1	2.5
22	4350	59,508	197.7	81.3	150.3	69.0	2.5
23	4140	73,122	196.3	82.2	141.3	59.1	2.5
24	4368	87,168	194	84	133	49.0	2.5
Average	4234						
25	4890	60,228	199	74.7	154.5	79.8	2.5
26	4920	69,966	197	75.3	145	69.7	2.1
27	4932	83,978	196	76	133.5	57.5	2.3
28	4734	43,206	212	77.3	186	108.7	2.5
Average	4869						
32	5766	57,690	212.3	76.8	177.3	100.5	3.0
33	5875	71,598	208.7	78.7	160.7	82	3.0
34	5904	83,400	204	80.5	151.5	71.0	3.0
Average	5848						

TABLE 2.—Continued.

Test No.	H. 1000 B. t. u.	Ht B. t. u./sq. ft./hr.	V. ft./sec.	R. %	K. (B. t. u. per sq. ft. per deg. F. per hour.)
6	2055	15,120	2.98	4.79	134
7	2080	15,310	2.4	5.77	144.4
8	2250	16,590	4.48	3.37	135.8
9	2030	14,950	5.26	2.65	122.5
10	1970	14,500	5.93	2.22	118
11	2910	21,430	2.89	7.05	218
12	3040	22,400	4.26	4.84	204
13	2818	20,700	5.02	4.11	185.8
14	2820	20,900	6.44	4.38	180.2
16	3210	23,650	2.15	10.25	345.8
17	3510	25,900	3.53	7.45	270.5
18	3460	25,500	4.09	5.91	247.5
19	3560	26,200	5.09	4.82	242
20	3260	24,000	5.57	3.95	214.5
21	4060	29,900	3.23	8.94	344.5
22	4110	29,600	4.22	7.31	302
23	4325	31,850	5.18	5.65	301.5
24	4275	31,500	6.18	5.01	287
25	4800	35,400	4.26	8.1	352.5
26	4875	35,900	4.95	7.04	342
27	4830	35,600	5.94	5.88	316
28	4700	34,600	3.06	10.94	455
32	5800	42,700	4.09	10.00	502
33	5880	43,300	5.07	8.2	450
34	5910	43,500	5.9	7.1	430

The plotting of equi-R curves, shown in Fig. 3, is done by using the relation between V and R, which is plotted in Fig. 5, p. 336. The curves in Fig. 5 are drawn from the values given in the above table.

2. Methods ot Computation. The methods of computation may be formulated in the following manner.

$$H = W_w\ (t_2 - t_1).$$

$$H_t = \frac{H}{135.8}.$$

$K = \frac{W\ \ t}{135.8} \times \frac{1}{t_m}$ Because $t_m = \frac{t_r}{\frac{t_2 - t_1}{t_s - t_2}}$, where t_s = temperature of steam, deg. F., corresponding to p. Therefore,

$$K = 0.01698\ W_w \log_{10.} \frac{t_2 - t_1}{t_s - t_2}.$$

$$V = \frac{W_w}{14{,}110}.$$

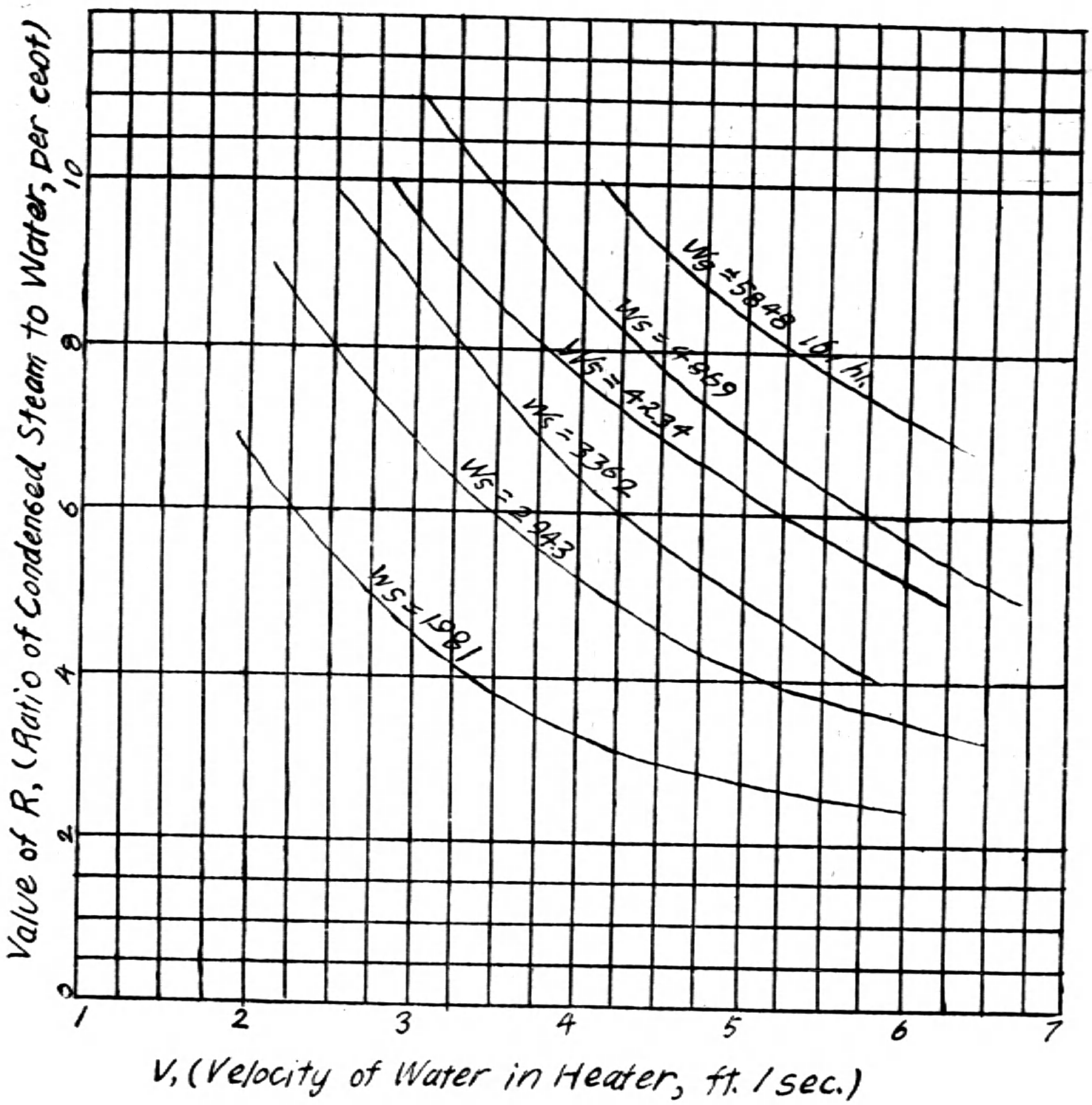


Fig 5　Relation of R with V in the Test.

APPENDIX II

The Analysis of Results of an Earlier Experiment

Most of the reported data from tests on condensers are not comparable with the tests made by the writer on account of important differences in working conditions—such as small values of *R*, small temperature rise, and effect of air in condensers. The only available closed feedwater heater tests were those of J. K. Clement and C. M. Garland, Bulletin 40, of University of Illinois.

In Bulletin 40, the heater consists of a water tube placed in a steam jacket. The water tube used is a *single* 1-in. Shelby colddrawn *steel* tube 6 ft. 7–1/4 in. long. The steam "bubbled up through the water in the jacket" and around the tube and is maintained at *constant temperature.*

But in the writer's tests, the heater consists of *four* passes with *46 copper* tubes containing *agitators* in each pass and the total length of the tube in one pase is 4 ft. 9 in. The steam comes from the *top* and *side* and is gradually condensed.

As both the material of the tube in the two heaters and the construction of the two heaters are not the same, it will be very easy to draw the conclusion that the results of the tests of the two heaters will be quite different. But the purpose of the present analysis is to find out effect of the ratio *R* on the coefficient of heat transmission from the results of Clement and Garland. The results of Clement and Garland are rearranged and reproduced in Table 3, and plotted in Fig. 6, p. 338.

TABLE 3.

Deduction from Clement and Garland's Results

Series No.	Test No.	$R = W_s / W_w$ per cent.	V ft. per sec.	K, B.t.u./sq. ft. per hr. per deg. F.
A	6	1.8	7.43	503
A	7	2.1	6.97	480
B	2	2.15	12.37	658
C	2	2.19	15.50	741
		Average = 2.06		
A	8	2.7	4.11	430
C	3	2.87	11.43	725
D	2	2.97	14.05	790
		Average = 2.84		
A	10	5.12	1.48	319
B	8	4.9	3.89	514
		Average = 5.01		
B	10	10.3	1.45	480
C	7	10.5	2.19	574
		Average = 10.4		

From Fig. 6, p. 335, $K = a\ V^{0.508}$, where *a* has the following values.

Values of R=2.06 2.84 5.01 10.4

Values of a=184 210 259 392

From Fig. 7, p. 336, $a = 169\ e^{(0.81R)}$

Therefore, in Clement and Garland's tests, $K=169\ e^{(0.81R)}\ V^{0.508}$. By comparing with equation (6), p. 332, it will be seen the coefficients and exponents are not the same, which is expected. But the derivation does show that the ratio R has influence on the value of K.

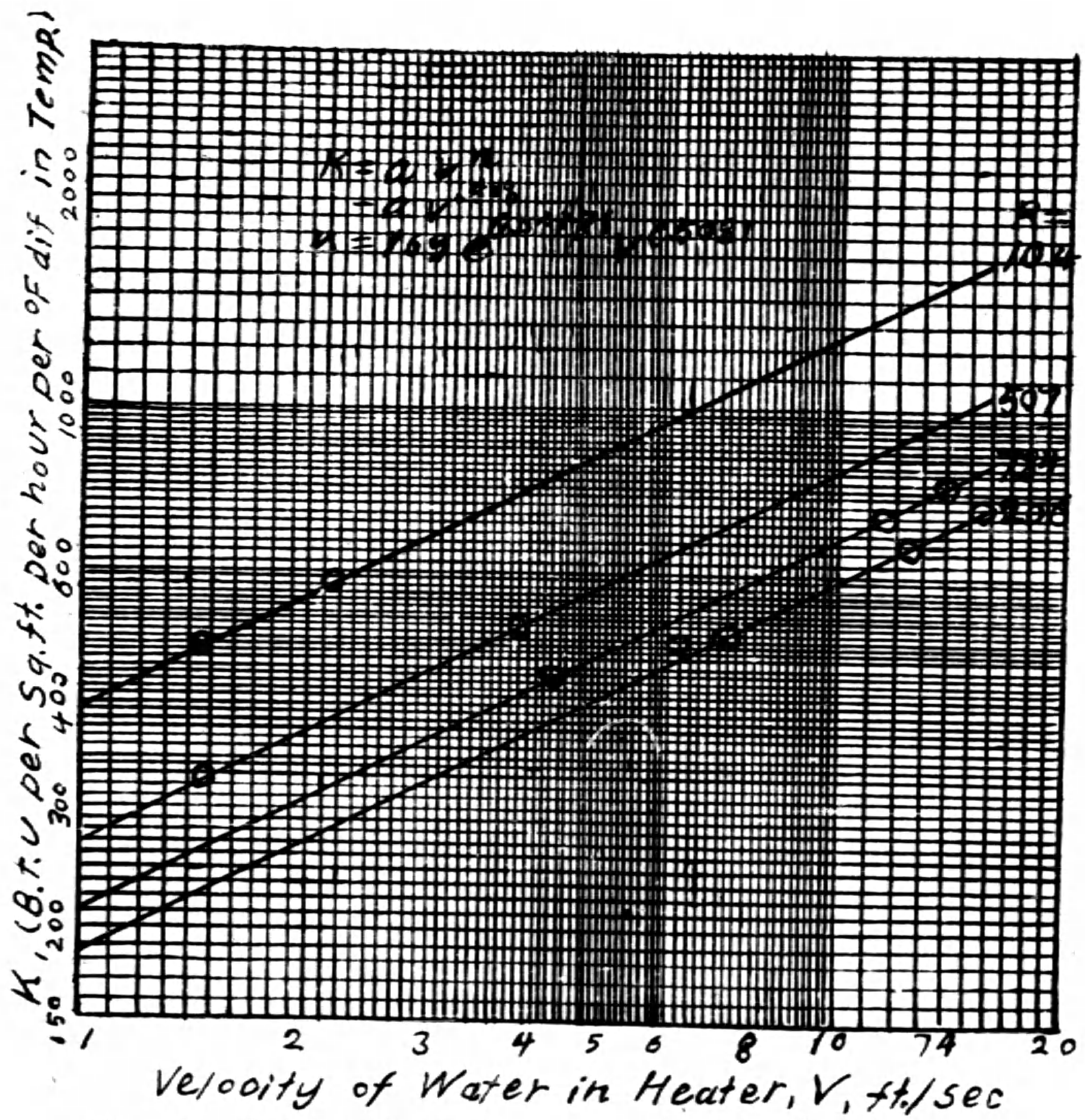


Fig. 6 Deduction from Clement's Results

$$K = aV,^{0.508}$$
$$a = 169e^{0.081R},$$
$$K = 169e^{0.081R}V^{0.508}.$$

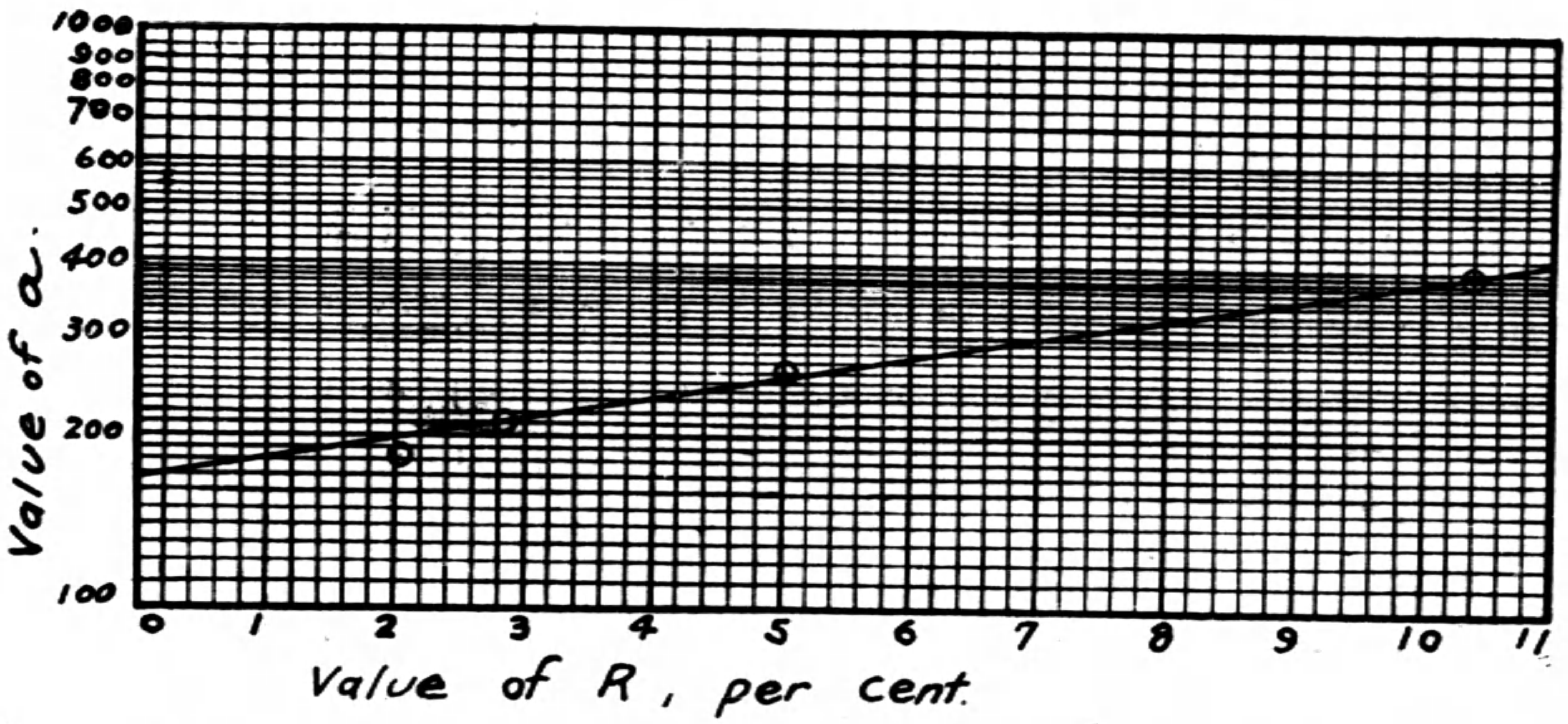


Fig. 7 Deduction from Clement's Results.

A New Large Power Station with Diesel Engines.—The large Australian mining companies, which work several lead, zinc and silver mines at Broken Hill in New South Wales, have placed an order with Sulzer Brothers, Winterthur, for six large Diesel engines which will be installed in their new power station at Broken Hill. The most important Diesel engine builders in the world submitted tenders for this plant, and these six engines were ordered from Sulzer Brothers because the good experience which an associated company has had with Sulzer engines in other works. Hitherto electric energy has been generated separately at each of the mines by steam plants, but it will now be generated for all the mines in the new large power station.

(見第350頁)

參加萬國工業會議之感想

著者: 宋希尚

希尙此次奉派赴日本,出席萬國工業會議及世界動力會議,除將經過情形,另繕報告外,草此一篇,聊表個人之感想也爾!

(一) 關於會議方面 日政府對於此次會議,籌備經營,頗費苦心,故終得良好之結果.其目的,雖曰欲求實業之發展,端賴工學之進步.原科學本無國際制限之可言,乃聯合世界之專家,各本其學術經驗之所得,以求互利,以謀進步.然實則借此會議,以昭示於世界各國,日本六十年來,應用科學至何程度,是否出而合轍自東亞文明自負之概也.故凡參觀旅行,會場佈置,會議預備,及辦事之敏捷,招待之周到,無不有整個有系統的組織.其執事人員,小心翼翼,維敬維恭,對於美人尤表好感,蓋當時方有五千萬元借款之進行也.開會時,由總裁日本皇弟秩父宮雍仁親王親致訓詞,全場肅立,以日語發言.對於首相會長及其他之申請演說者,端坐頷首,皇族尊嚴,有足多者,在素具自由平等之美人視之,當別有感想也.此次各國之參加與會者,凡二十餘國.工程家之出席者,五百九十餘人.我國之派往出席者,與私人參加者,亦六十餘人日本工程家之參列者,達二千四百餘人.合異性隨伴赴會者共計三千二百餘人.青年白髮,鬢影釵光,擠於一堂,誠爲空前之國際盛會,無怪每次跳舞會中,摩肩接背,大有人滿之患.各國參加之工程專家,皆年高望重之流.所提論文,多本於個人經驗之所及,均有相當之價值.論文共計七百八十餘篇.日本三百七十餘篇爲最多,美國九十餘篇次之,英意八十餘篇,德國五十餘篇,我國共計十餘篇,中有數篇爲外人之服務中國者.所作論文性質,則就類別分爲十二組,以第一組鑛冶工程者爲最多,計一百二十餘篇.屬於運輸及鐵道工程次之,又次爲電,爲材料,爲機械,爲化學等.而第四組公用工程,包含水

利工程,共計六十餘篇.每組論文分上午下午宣讀,事先均有支配公佈.以時間關係,故每讀一文,僅限二十分鐘,祇有簡單質疑之機會,而無深長討論之餘地.某工程司曾私告余曰,此活動留音機,應時而止,似可憾也.某日因討論『壩之安全』, Safety of the dam 各國工程家相繼發言,皆各本其平日築壩已有之經驗.主席因時間關係,不得不起而制止,以書面發表,附載專刊爲約,蓋文多時促實無他法,可資調劑.此外尤足注意者,即數千工程家中異性者,僅美國一人.其所研究者,爲科學管理.是知女子之對於科學研究,尙在萌芽時期.甚望極力提倡,使智識立於平等地位.次爲論文宣讀時,日本各大學校選派高級學生,參列旁聽,環牆鵠立,室爲之滿.秩父宮雍仁親王亦曾來會參加旁聽,可見日政府對於科學之獎勵,而各學生研究工業之志願爲不弱也.

(二)關於水利工程方面　余曾參觀東京郊外之荒川,(整理費計需五千五百萬日金),及大阪之淀川整理工程,頗見日本治水工程之成績.蓋日本爲一島國,四面環海,地狹人稠,民食維艱,不得不於無可設法之處,闢可以推廣之路.人民食料,全恃農產,而其農產旣受天然地積之限制.又時受海水之侵凌,故其努力水利工作,爲事實上所不可或緩.溯一八九六年之大水災,計被災面積,爲一百九十萬英畝,損失額至一萬三千七百七十餘萬日金之巨.經此浩刼,政府有鑒水利之不可不究,遂於是年公佈河法,以整理水利.凡河之屬於縣與州者,則其整理維護,由縣政府或州政府各直接主持.河之跨及數州者,則由中央政府負責.此法公布,則各州縣得各視其利害之疏密,財力之所及,分頭孟晉,務使各州縣境水利暢達,圖免水患.玆調查一九二二及一九二三兩年各州縣分擔經費支出之統計表如下:

經費負擔者	一九二二年	一九二三年
州	二九,〇〇二,六九三	二六,四六六,二七六
縣	三一三,二九六	
城市	一〇六,七九六	一,三四四,二六一

鄉鎮	六,六九六,一二六	四,一六五,四一九
地方團體捐助	一,五六四,五一六	一,一九九,一八二
共計	三八,六四〇,四二七	三三,一七五,二三八

至一九一七年止,統計河之巳治者,大河三二處,支流四七處,小河二三處.在最近十八年中,政府治理之河,計二十,共需日金一萬七千六百七十四萬元.因水之利農產,歲收每年增至四千三百萬元.其餘未整理者,現正着手進行,使有水之利,無水之患,用有限之金錢,收無窮之利益,國計民生,胥臻裕如.至其人民,則農墾之精勤,土壤之培養,山坡水陬,凡可事耕種之處,莫不從事墾植.故河無淤塞,地不荒棄,舉國之內,皆成膏壤.近年來頗感受地域之限制,苦無發展之餘步,漸將天然蓄水湖泊,以人力經營,使成墾植之場,頗收美滿之效果.如茨城縣長井戶沼及大小沼農墾合組所等計劃,均以湖泊放墾,以抽水器調濟水量,使無水旱之患.最近正在設計,擬將一大湖放墾,另闢運河,以排洩大湖平日所蓄之水量,使不受無湖之影響,復將開河所得之土,以火車運載,填置海濱,築圍成田.一舉而數利得,不獨與水爭地,直以人力造地,日人之苦心經營也如是!

回顧我國地大物博,河流之縱橫,港灣之交叉,流沙淤積,蕩地荒蕪,或坍或漲,一聽自然,以天富之農田,任彼逆潮所衝盪,鹹水所倒灌,放棄利藪,於斯爲甚.况河流經過之區,瀕海之地,俱是沃野.即以揚子江上下游論,各省縣受江之利者固多,而受江之患者,亦正不少.下游自江陰以下,如通州,如皋,崇明,海門,常熟,寶山等縣,或瀕江或臨海,夏秋之交,潮汛泛濫,沿江各區,田禾湮沒,堤岸坍削,習其常事.江陰地握揚子江之咽喉,其河底又爲天然之石層,以形勢言,實可劃江而治.昔者曾有下游治江之議,連合下游兩岸九縣,以圖江水之治,止其坍削,固定河床,置之軌上.因整理而得之利,遠過於所需之費,而下游一段之江,因之大治.奈九縣人士,囿於私見,事不果行.今則各縣各有保坍會設立,以維護各縣沙洲及塘工堤岸.惟各縣之經費有限,遂致顧此失彼,東保

西坍.且縣自爲政,財力單薄,故雖勉力維持一部分之坍削,總未有整個完善之計劃.長此蹉跎,殊可惜也!再以中部揚子江支流金水而言,則金水之整理與否,與其流域人民實有切膚之利害在也.本會於金水測勘研究,歷時數載,整理計畫,籌之已熟.夫費百萬元整理之費,以造成百萬畝膏腴之田,既擋江水之倒灌,復籌金水之灌溉航運.利之所在,不言可喻.較之日本範水積沙,涸湖成田,以人力造成沃壤,其暴棄爲何如耶?深望時局甯定,得地方政府之協助合作,使本會整理計畫,得以實現跂予望之.

(三) 關於日本科學著述方面　日本之丸善,一科學書籍之大學府也.除普通書外,關於工程科學等書,莫不羅列完全.世界各國,苟有新出有價值之書,不旋踵而流傳至境矣.蓋不獨該社派有專員,專事搜集,即駐在各國之外交官,與政府派赴留學者,均負有介紹新智識之使命.而日本學者,經政府獎勵,僉能盡心翻譯各國之專門著述.一經譯出,各學校遂爭先購置,以供參考.至國內之著述專家,則博覽詳採,瀏覽羣書,凡著一書,經幾許之考究,而後着筆.會精聚神,使人讀其書,勝讀各國各種之書,易知其梗概焉.故自明治維新以還,數十年間,科學昌明,能躋於世界平等之域者,著述之功,有足多也.即以此次第四組論文而言,因日本有地震之災,其工程家對於建築設計,無不加以精密研究,如何可以防範地震之影響,遂於鐵筋混凝土建築之學,發明若干新公式,僉認爲日本對於學術界,有價值之貢獻.又如日本濱海之區,其海岸每爲海浪所冲削,黃金之土,豈容放棄.故對於禦浪工程,尤爲注意.帝國大學某水力教授,於授課之餘,在海濱設立研究站,專研海浪起伏,各時各地冲擊之力.依據試驗,證以學理而倡立公式,聞已研究數年矣.現尚在繼續研求中.此可見其科學之前進,殊不欲事事仰人鼻息也.

(四) 關於東京橫濱復興方面　一九二三年日本大地震,東京橫濱諸市,俱遭巨刦.人烟稠密,商賈輳輻之區,一變而爲頹垣瓦礫之場,國家與人民之損失,不知幾千百萬.不圖日政府於五年短時期內,極意經營,盡力建設,將不

可收拾之殘破都市,煥然爲之一新.建築工程,均應用各種最新科學方法,故一切建築物,較前益臻完善.其毅力之堅,進步之速,上下合作之精神,有足多讓.時方有復興展覽會之開幕,自地震起至現在止,各種工作之進行經過,設施,統計等,莫不詳盡無遺,恍如置身在復興時期之過程中,益可想見其耐勞耐苦之成績矣.

我國定都南京,三年於茲.首都爲首善之區,觀瞻所集,建築工程,尙在幼稚.故道路崎嶇,兀突不平,除中山路業已築成外,其他市政,猶待進行.而自來水尤關市民生命,乃一不可或緩之事,因礙於經費之難籌,尙未舉辦.益之國是糾紛,軍事頻興,建設之費,每消耗於無謂之戰爭中,可以慨惜!然從樂觀而言,東京不過以五年之短期,卽可造成此燦爛之局面,苟大局佇定,假我此期,努力建設,安知未來之南京,不能與當今之東京相頡頏耶?

(五) 關於費禮門之談話 曩環遊歐美時,參觀各國水利工程,凡負水利界時望之工程師,均相晉接.此次與會者數人,不期而遇,久別重逢,引爲快事,美人費禮門博士.前赴美時,極承指示照拂,相違已八年矣.皤然老翁,攜夫人女公子相偕,精神健旺,一如往昔.見時握手歡笑曰,我耳聰目明,尙能閱報章,聽有聲電影,別來修養殘軀,成績似尙不惡,今年已度七十六矣,大約尙有十年可供世用.但子則鬚髭加強,已非當年.回顧其夫人,則雞皮鶴髮,女公子則丰頎修長,無昔日膝下依依之態,頗令人有歲月不居之慨.余告以一別八年,一事未成,雖有爲國效力之願,迄無切實做事之機.設計劃而效同畫餅,談工程於字裏行間,蹉跎歲月,惟有渴望將來耳,相與太息.彼年來提倡國立水工試驗場,奔走呼號,不遺餘力.蓋此場爲昌明水工學惟一引導,世界各國惟德僅有,已著成效,惜附設大學校中,規模不宏,徒負研究而不能造偉大之貢獻.美爲世界先進之國,尤具好勝之精神.故彼主張以三百萬金創設一完備之場.小可以助本國水利問題之解決,大可以促進世界科學之進步,著有專書,旁引遠證,尤舉中國對於水利工程,特創設河海專校,以研究水學,以培植人

材為世界各國所未有,中國乃科學幼稚之國,其目光所及如此,況美國科學昌明,獨於水工試驗場,不能步德後塵,發揚光大,認為美人之恥.故其言論頗引起全美工界之注意.此項議案,雖經下議院通過,但因軍界工程師(美國工程界,暗分兩派,河港工程,大多由軍界工程師主持).發生疑忌,致在上議院否決.然彼仍振作精神,努力不懈,謂在本年議會,當再提出,期於通過.嗣聞河海工科大學,業已取消,併入中央大學之工學院,不勝惋惜.再謂老友如張季直先生尚在,則為世界研究學術前途計,當來華力勸恢復,或主擴大辦理學校為經費所束,則可設法籌措,不惜資助以獎勵水利人材.可見費氏熱心任事,及其提倡學術之精神,深為欽佩.查河海工大成立於民國四年,張氏因鑒於中國水利事業自大禹以後,迄未整治,加以科學發達,急須追踪,故創此專校,原為導淮儲才,及養成中國水利人材之備.每年經費,由直,魯,蘇,浙四省分擔.先後畢業者,約百餘人.革新後,因採用大學區制,故將各專門學校一例歸併.現因試用不良,仍將分設專校.經此一併一分之後,教育方針,此後當可確定.但不知水利未興之國,待治待理之河,不勝枚舉,而需用水利人材,實有供不應求之勢.河海大學,雖為世界所僅有,能否應時勢之需用而復活,實與中國水利前途有莫大之關係也.

綜上以觀,我國建設事業,凡百待舉.就目下情況而言,除古代遺蹟,如長城,運河等工程,因歷史上之關係,可供憑弔太息外,對於二十世紀應有之物質建設,足以昭示世界者,實無可紀之事績.故此次我國代表演說詞中,惟有以古自誇,以新自期.鑒工程之幼稚,科學之落後,未能有所發輝,以揚國家之光榮.若能政局救平,待整以暇,假以五年十年之期,從容建設,則新中國之締造,亦意中事.微聞同時在日本西京所開太平洋會議,中日兩方因滿州問題,引起劇烈之爭論.日人且謂為維持太平洋和平起見,滿州應予日人種種之便利.我方代表,據理力爭.每當日人理曲語塞時,輒以我國內亂相尋,不能自治,外強中乾,曷不以競勝外交之熱忱,歸向本國政府力爭息爭耶?時方西北有事,消息傳來,授人藉口.噫!弱國無外交,內亂直自殺耳!

中國今日建築公路工程之意見書

著者: 黃寶潮

序言

國家之富强,民族之文化,繫乎交通之發達,至重且大.試觀歐,美列强,交通方法,未有不周密靈便者.我國路政不修,交通困難,馴至伏莽潛滋,進剿不易.工商實業,末由發展.文化宣傳,末由普遍.凡我國民,莫不引爲大憾,而謀所以補救.補救之方法謂何?曰建築多數之公路,實現 總理擬築一百萬英里碎石路之計劃是也.惟建築多數之公路,實行 總理之碎石路計劃,需費必多.是否現在中國各省縣之財力所能擔任,爲亟須研究之問題.爰就實施工程研究所得,擬就意見書,尙祈我國建設同志,共同討論焉.

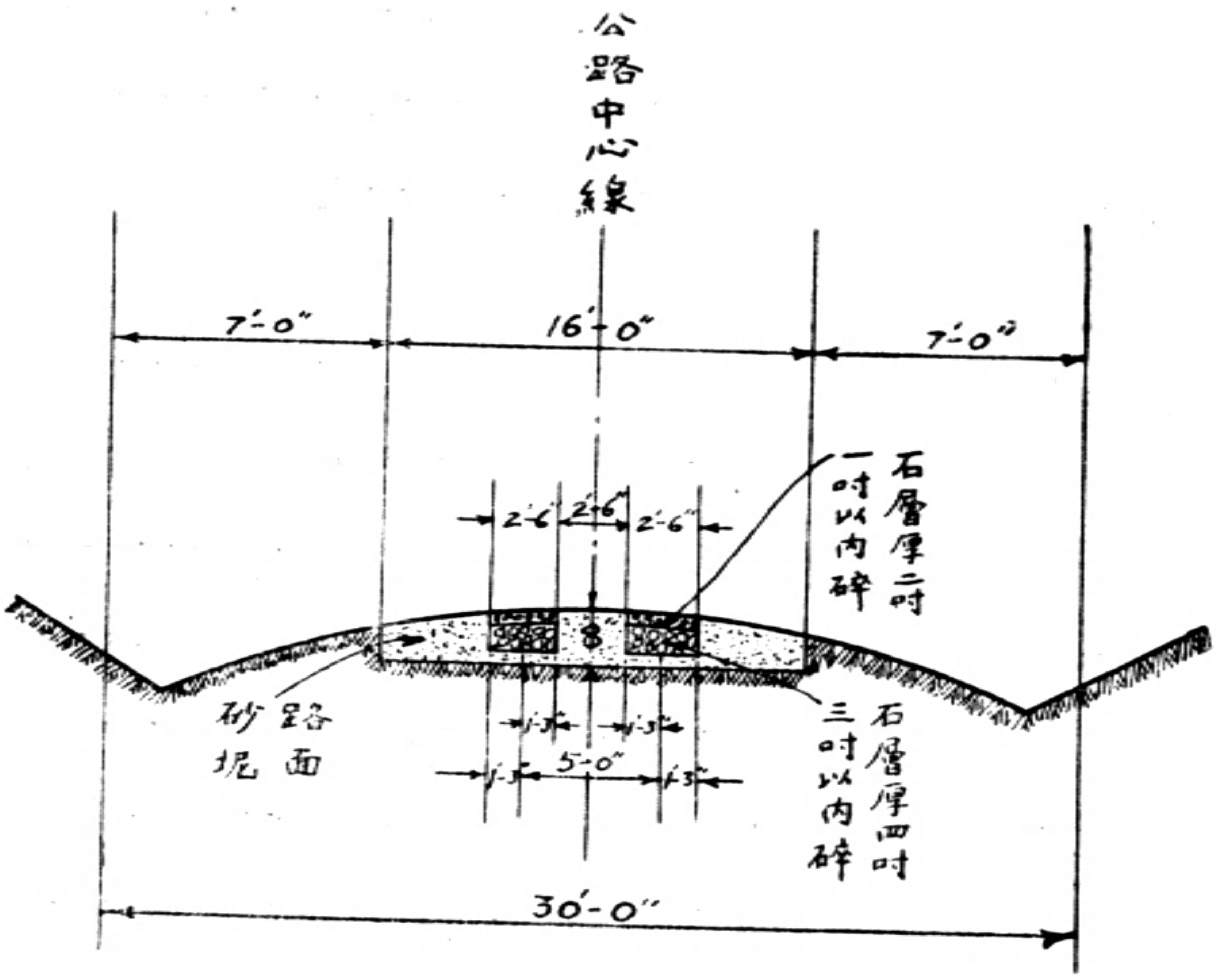
建築公路之方針 道路何以稱爲公路?蓋以別都市或私人之道路,表示此道路,衆人可行.亦 總理天下爲公之意也.我國地大物博,欲求交通便捷而普及,當以從速多築公路,爲惟一之目標,其建築之良善與否次之.全國一心,上下一致,奮勇進行,築妥一段,即通車一段,築妥一路,即通車一路.至各處公路,已具模形,公路系統完成,乃圖所以改良之方法,不爲過晚.何以言之?蓋公路建築費,一分一毫,均出自人民之財力.人民渴望交通已久,自應採用最廉省而可行之方法,將公路從速築成,即行通車,以償民望,而鼓勵其繼續進行.通車之路段愈多,則人民對於公路之興趣愈深.人民之興趣愈深,則公路之進行愈速.公路之進行愈速,則全國公路之完成,可指日而待.全國公路完成,交通靈便,治安鞏固,實業振興,文化普及,吾國之富强,自不待言矣.

公路路基路面之建築 發展交通之宗旨,既在建築多數之公路.公路之建築,首重路基路面之建築.查歐,美諸國道路史,其公路建築之進程,大都以

先建築多數之坭土路爲根本,然後次第改善,由坭土路改良至砂坭路,或卵石路,再進而至於瀝青碎石路,及三合土路,以及其他各種路面.美國素稱富強,財力甲於世界.建築事業,進行迅速.而其全國公路,二百五十萬英里中,坭土路及砂坭路,佔百分之九十.歐洲各先進國家,坭土路及砂坭路,亦佔全國公路之大部份.由此可知發展公路,在初期進程中,似應積極建築坭土路及砂坭路.較爲適宜.坭土路建築費廉,然一經雨雪,路面浮軟,坭𣿬不堪,故養路費用浩大,砂坭路面,建築費略昂.建築時如用相當成份之砂及粘坭,則路面經雨雪後,較坭土路易於乾燥,修理易而養路費省.惟路面完全砂坭,大雨雪後,猶不免浮鬆.車輛往返,頗感不便.我國財力不足,在公路建築初期中,採用完全碎石路面,係屬萬難實行之事.經余十年來築路之研究,與靜察車行之軌道,以建築砂坭路面,加鋪碎石軌道之公路,爲最適宜.此法建築費雖較坭土路及砂坭路爲昂,然其適於實用,決非坭土或砂坭路面,可與倫比也.茲詳論之如下:

碎石砂坭路面者,卽路面建築,以砂坭爲主體,而加鋪碎石軌道二條,以便行車者也,其建築方法,係先建築砂坭路面,在該路面上,加鋪碎石軌道二條,每條寬二英尺六寸,距離二英尺六寸.碎石軌道築法,爲先從公路之中心線,向左右量出二呎六吋,以定兩邊碎石軌道之中線.此中線插定後卽掘土成坑,闊二呎,深六吋,乃用三吋以內之碎石,鋪上一層,厚約五吋,用人工椿實,至厚度四吋.乃再鋪上一吋以內之碎石一層,厚約三吋,表面用砂坭鋪蓋,乃用石製或三合土製之路轆滾壓,至厚度二吋,與砂坭路面相平,隨滾隨洒水,滾壓至堅實爲止.(參看第一圖)

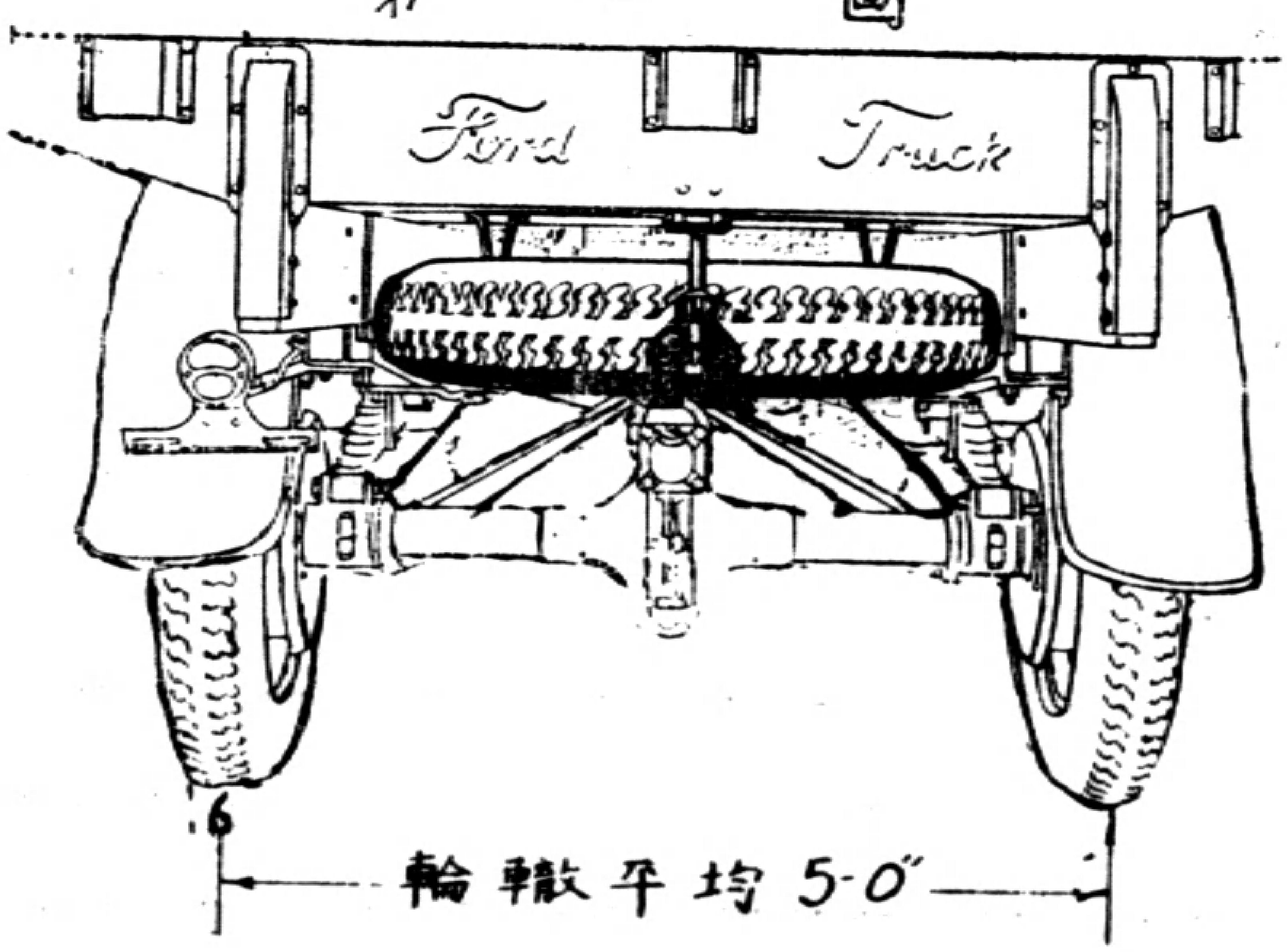
碎石軌之所以定寬爲二呎六吋,距離二呎六吋者,因如此,則碎石軌之中線距離爲五呎.正適合我國現在所用之普通長途汽車,及載重貨車之車輪轍量.(Track)蓋此項汽車轍量,經實地量度,係由四呎八吋,至五呎四吋也.(參看第二圖).碎石軌道,每條寬度二呎六吋,足供車輪之行駛而有餘.(參



碎石軌砂泥路圖

第一圖

第二圖

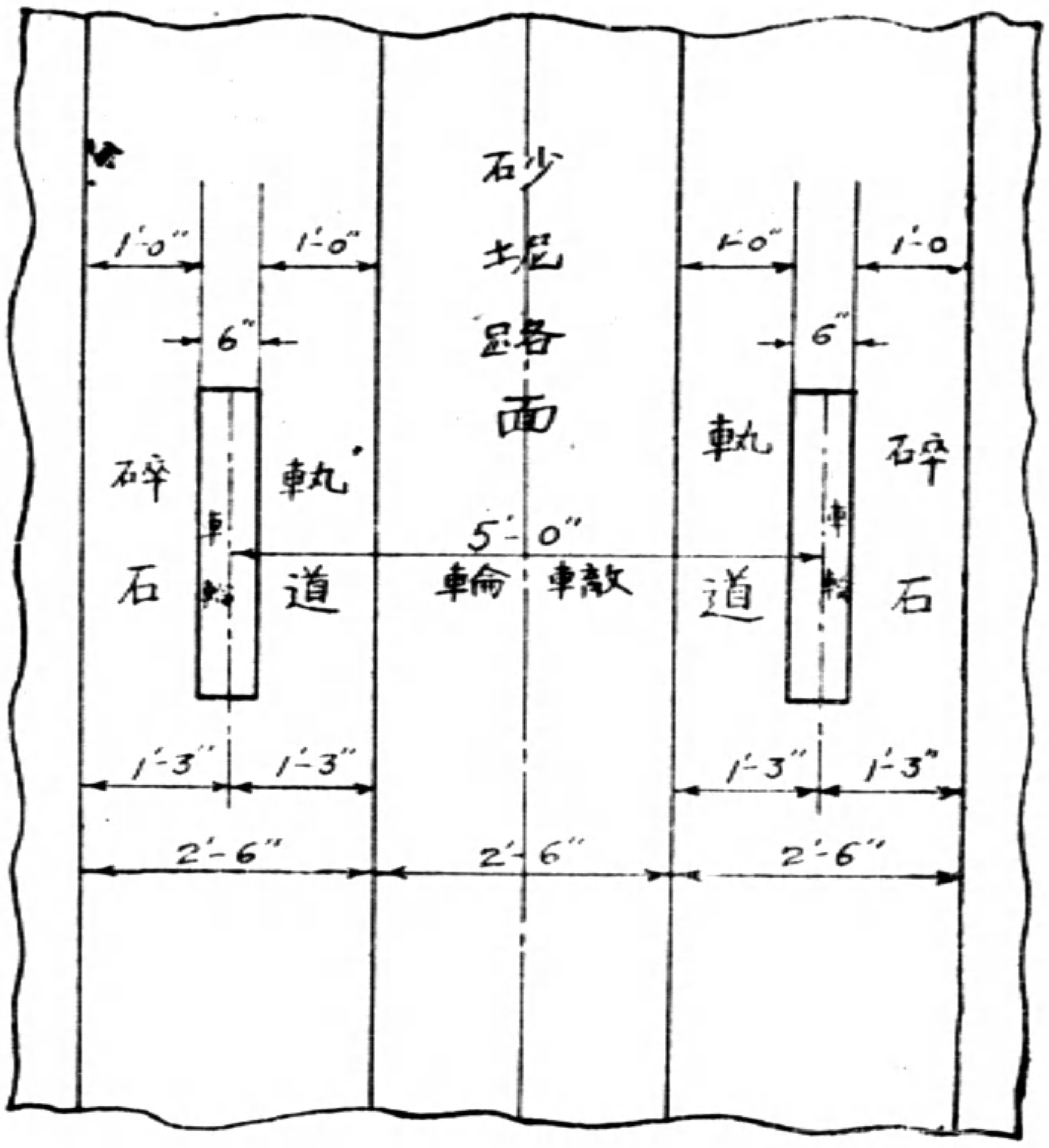


汽車輪轍圖

看第三圖).

以上碎石軌道之寬厚度係適宜之呎吋,經實地試驗,成績頗佳.但築路工程師,可照各地方之情形不同,經費之多寡,酌量增減之.

對於碎石軌道砂泥路面,頗有嫌其鋪石部份,不足以供兩車相遇之闊度.然吾輩須知公路長度,遠長於城市馬路,而公路上之車輛,遠少於城市馬路.故在公路上,兩車相遇之時候甚少,每車輛大多之時間,係在公路中央行駛.吾輩試留心視察公路上之車輛輪轍,便能明瞭.遇車之



碎石軌砂坭路平面畫之一部份

第三畫

時候旣少,則其損傷砂坭路面亦極微.故爲節省經費起見,實際上砂坭路面,不必完全鋪碎石也.

公路橋樑涵洞之建築　建築公路路基路面,旣以速成而適可之方法,爲我國現時之急需,故公路橋樑涵洞之建築,亦須取同樣之方針.惟橋樑涵洞建築費較路基路面爲多,其建築時間亦較長.每有路基路面,築成已久,祗以經費支絀,橋樑涵洞,未能完成,以致不能通車,任其毀棄,可惜孰甚!故橋樑涵洞之建築,當視經費之多寡,而定計劃.如經費短絀,應築臨時木橋,木架涵洞,以通車輛.如經費較裕,則築鐵筋三合土柱樑,木面之橋樑,至涵洞,則利用地方出產之材料.如石多,則用石涵洞,磚多,則用磚爲涵底及牆,而築鐵筋三合土涵蓋.石灰或蠔灰多,則用灰砂爲涵洞底牆,而築橋筋三合土涵蓋.如經費充足,則建築完全鐵筋三合土橋樑涵洞.惟在五百呎以上之河道,則鄙意主張用汽車渡船辦法,以節省經費,而資速成.其橋樑涵洞之計劃,當另篇討論.

結　　論

我國現在建設時期,公路建築,自屬急要之圖.惟頻年內戰,經濟困乏.故在公路建築初期中,工程旣應積極急進,交通復須安適,倡言建築三合土或瀝

青路面者,固屬高談,即建築完全碎石路面,亦非現時財力所能及.是故吾國建築公路方針,應採用碎石軌砂泥路面爲建築根本,先積極進行,完成公路統系.至交通便利,經濟寬裕時,再逐漸改良.至完全碎石路面,或更進而至瀝青碎石路或三合土路.現在我國建設同志,建築目標,最低限度,應築成 總理所擬一百萬英里之碎石路.務期共同努力,向前進取,以成完 總理築路之志願,而爲中國交通前途,放一光彩焉.

(續第339頁)

The plant comprises six Sulzer two-cycle engines, each developing 2900 B.H.P. and direct coupled to a 2500-K.V.A. flywheel generator, producing three-phase current of 40 periods and 6900 volts. Four Diesel-engine driven compressor sets, each of 1230 B.H.P., are provided for supplying compressed air. When the power station is completed, the normal output will amount to 22,300 B.H.P,. and, as the engines can temporarily be run at 20% overload, the maximum total output will be 27,800 B.H.P. The output of the Broken Hill power station is therefore greater than that of the Diesel engined power station which has hitherto been the largest in the world, the station at Shanghai, which is equipped exclusively with Sulzer two-cycle Diesel engines. Diesel engines are being always more and more adopted for large power stations, and this must to a large extent be attributed to their high efficiency, great reliability and constant readiness for immediate service.

最近中國建設狀況及其應注意之點

著者：石瑛

這幾年中央與各省政府日以建設新中國相號召.其過去成績如何,及以後應注意之點何在,似值得吾人切實的研究.

(一)鐵路與汽車路 吾國幅員遼闊,交通阻滯,商旅之往來,物產之運輸,在在均感覺困難.居今日而談建設,鐵路與汽車路,誠居第一重要位置.查美國鐵道線百倍於我.日本八千人有一英里鐵路.我國須五萬八千人,才有一英里鐵路.至於公路,美國已完成二百九十餘萬英里.以吾國面積與之比較,應有公路四百四十九萬餘英里.乃據中華全國道路協會最近統計,全中國已成之公路,約二萬餘英里.又據一九二三年統計,中國全國鐵路僅一萬二千七百餘里.最近中央雖設鐵道專部,以求鐵道之盡量發展.然因軍事及各種影響,區區一粵漢鐵路,至今尚未能完成,其他計劃雖多,亦尚未見諸事實.在這種狀況之下,無怪乎內地工商業無從產生.就是有一點土產,也無從轉運.類如最近報紙所載,中國每年豬鬃出口,約值銀一千萬兩,其中經過漢口者,每年值二百萬元.假令內地運輸便利,每年出口總額當遠過此數.雲南,陝西商人之經營此業者,每次由郵局寄十六斤豬鬃到漢口,須付運費三元.其運費之高,誠屬駭人聽聞.又如陝甘各地產麥,欲運至漢口,則每擔運費,必超過原價數倍無疑.而美國內地小麥,經過該國鐵道,再經過一萬七八千海里,運到上海,每擔運費不過二三角.這樣一來,何怪洋麵粉充斥中國.況連年兵燹,農業荒廢,我們的糧食不夠供給自己,那又更不必說了.我們當知道,鐵路與人力運費,約為十五與一之比.至於運輸速率,鐵路與步行約為百與一之比.汽車路與步行,約為三十與一之比.所以我們要促進農業工業商業之發達,不從整頓交通著手,是難望成功的.

(二)鋼鐵實業　鋼鐵爲半原料.生鐵除翻砂外,大部分爲鍊鋼之用.鋼又爲製鋼軌造船及製造各種機器的原料.所以有人說:『一國的盛衰,可從需要的鐵量上斷定』.又有人說:『世界各大工業國,莫不擁有廣大的煤鐵鑛』.鐵須焦炭化鍊,焦炭由煤製成.故煤量缺乏或煤價高昂的國家,縱有鐵鑛,亦難望製鐵工業的發達.若鐵鑛也同時缺乏,那就更無論了.吾國的煤,可以製焦炭者不多,這是第一個缺點.可以製焦炭的煤,又往往距鐵鑛甚遠,不若英美各國鐵鑛,與可以製焦炭的煤鑛壤地相鄰,這是第二個缺點.還有一個最大危機,就是全國的鐵鑛,據最近中央地質研究所切實查勘,已被日本人佔據十分之八有餘.環顧中國幾個鋼鐵廠,漢冶萍既經營不善,負債至五六千萬元而停止工作.龍烟公司用去六七百萬元,至今尙未開爐.揚子鍊鋼廠受軍事影響,焦煤運輸困難,以致成本過高,而不能維持.就是浦東一個小小的和興鍊鋼廠,因前數年佛郎低落,比國輸入大批廉價的鋼,遂致競爭失敗.近聞鐵道部籌有巨欵,擬恢復龍烟鐵廠,並添設鍊鋼廠,製造鋼軌,以發展中國的鐵路.我們當然希望這個計劃的實現.同時我們要知道中國在當今列强競爭之下,私人或公司辦一個工廠,慘淡經營,已經是不容易立足,今政府去辦工廠,假令用人稍一不當,開支稍一寬泛,那就是必然失敗無疑.況且現今世界鋼鐵實業的競爭,比任何實業的競爭,是更厲害些呢!我想政府當局,對於這點,早有充分的注意.

(三)造紙業　文化之進步,以印刷爲媒介.印刷所必需之品,紙居其一.吾國舊日造紙之地.以湖南江西浙江湖北福建安徽爲最著.自泊來紙輸入日多,吾國原有之紙業,遂一落千丈.一方面釀成造紙工人失業問題,一方面釀成全國經濟上一大漏巵.國人有鑒於此,在滿淸末年,即設立機器造紙廠數處,以冀挽回利權,並解除工人失業之痛苦.不幸原料缺乏,舊有之楮皮,桑皮,竹木等項,或因分量少而不敷分配,或因運輸滯而成本過昂,結果仍仰給外來之紙漿,以資挹注.加以經營不善,資本薄弱,優勝劣敗,遂大多數爲外貨壓

倒.如湖北之諶家磯造紙廠,白沙洲造紙廠,即其明證也.去年浙江建設廳籌劃改良全省手工造紙業,結果如何,尚未得有具體的報告.尚幸上海江南造紙廠試驗以蘆葦爲紙漿,現在已完全成功,這可算爲中國造紙原料闢一新富源.該廠對於連史紙之改良,賽宋紙之做造,成績均稱優美.但是我國每年洋紙的輸入,尚值四千餘萬元.以後文化事業,日見發達,其輸入之數,尚不止此,可以預料.我們希望政府與人民合力研究.像江南這樣造紙廠,總要還有十餘家才好.茲將以蘆葦造製紙漿優於竹木之點,約略述之於下:(一)蘆葦價值較竹木低廉.(二)竹木生長須較長時間,蘆葦春生秋收.(三)木竹須用相當人力培植,蘆葦天然生長.綜合以上數點,所以蘆葦漿較木竹漿的成本,減少百分之四十.我國各處湖沼,生產蘆葦較廣.這當然給我們造紙業一種天然的便利.現在我國需要紙價的總額,爲六千八百一十萬元.其中來自歐美者,達到百分之六十二,吾國新舊各紙廠所能供給者,僅百分之三十八耳.其詳見下表.

供給地	值	百分比
國內舊式工廠	一九,〇〇〇,〇〇〇	二七.八〇
江南造紙公司	一,五〇〇,〇〇〇	二.二〇
國內其他機器造紙廠	五,一〇〇,〇〇〇	七.四八
由歐美輸入	二九,二〇〇,〇〇〇	四二.九〇
由日本輸入	一三,三〇〇,〇〇〇	一九,二五

(四)農業　吾國數千年來以農立國,至今全國人民,業農者居百分之八十以上.國內因資本缺乏,工程人材不敷應用,機器製造品一時無法推廣銷場,欲捨農業國,一躍而爲工業國,其勢有所不能.況且許多農作品,又爲工業的原料.吾國此後建設政策,當然應極力推廣農業.第一步藉以供給人民衣食的需要,如近年陝甘諸省,餓莩載途,賣妻鬻子的慘狀,不至發現.第二步以其剩餘供給工業上的原料,使由手工工業,漸進而爲機器工業.由家庭工業,

漸進而爲爲工廠工業.據農商部調查,全國已耕種的面積,不過十五萬七千餘萬畝,尚不及可以耕種的總面積之百分之二十五.其故由於民國以來,戰禍頻仍,人民轉從流離,不暇耕種.彙之土匪充斥,搶刼燒殺,人民亦不敢耕種.又加以農田水利,日益荒廢.如陝西之鄭渠,今已湮塞.就是白渠,昔日灌溉涇陽,醴泉,三原,高陵四縣田七千餘頃.今則泥沙冲積,儲水量大減.又如湖北人民灌溉田畝,大概仰給於塘堰.近年來堰之冲壞者不修,塘之壅塞者不濬,以致一遇雨水過量,則無處容納.一遇天晴稍久,則窮於灌溉.此種情形,各省亦多相似.以後中央及各省政府的責任,在於勦匪息爭,給人民以修養生息的機會.使耕者不獨有其田,使有田者得以治其田.人民旣不致爲兵爲匪所逼,而拋棄已耕之田.庶可用其餘力,開闢未墾之田.益之以農民銀行之補助,合作社之組織,除蟲選種等新知識之灌輸,吾國農業之收入,不患不充裕矣.開墾之地畝,不患不增加矣.現在吾國產米量,每人平均計算,僅及日本印度之半.小麥每人平均計算,不及美國三分之一.棉花每人平均計算,僅及美國十分之一.以著名農業國,而所產之不豐如此,無怪乎經濟日蹙.據最近調查,美國每人平均有日金六元餘,英國每人五元餘,而吾國每人平均僅日金十分之一.這樣貧苦的現象,眞令人聞之酸鼻.補救的方法,要上有廉而且能的政府,下有勤而且慧的人民,通力合作,積極整頓農業,輔之以工業商業,庶幾有漸進於小康的希望.

小新聞

美國福特汽車公司在一九二九年製出車輛,共有一九五一零九二輛,較之一九二八年產額,增加一一三二三五八輛,或一三八百分比.

平漢鐵路長辛店機廠概況補遺

著者：張蔭煊

拙著長辛店機廠概況,已分別附載于「工程」四卷一號,四卷二號,四卷三號.其間設備一項,于工程上關要較重,而四卷一號所載者,類皆中文名稱,在今日中文工程名詞未能完全通行之時,此點不無誤解之虞.作者有見于斯,特備具該廠設備佈置圖一張,並依圖註號目,編列英文名稱一份附載如下.一以補前此之遺漏,一以供同志之參考焉.

(一) 平漢鐵路長辛店機廠設備佈置詳圖.

(二) 平漢鐵路長辛店機廠設備英文名稱詳單.

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MACHINE TOOL EQUIPMENT
C. S. T. LOCO. WORKS
P. H. R. Jan. 1, 1928

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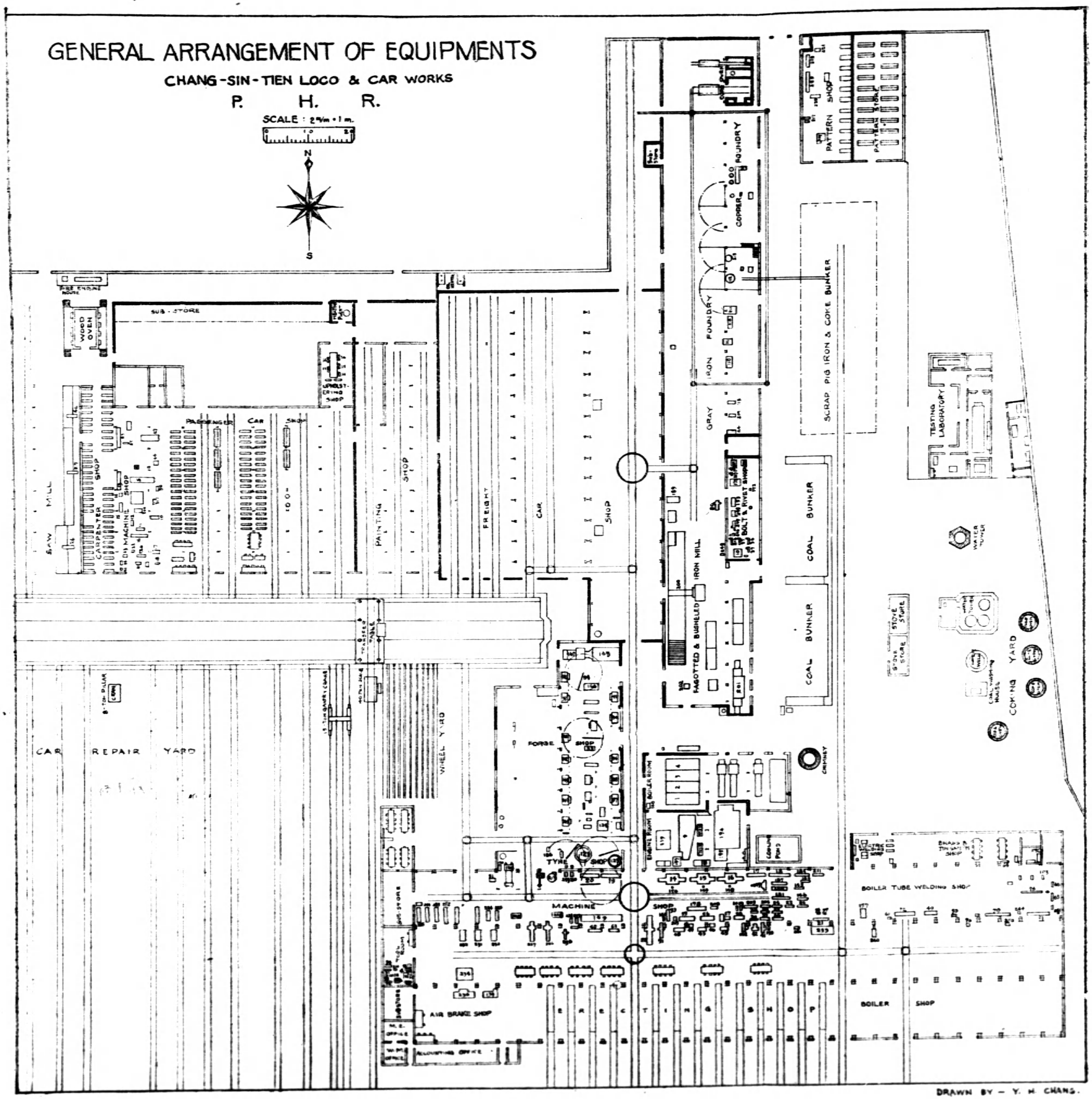
19. Carpenter Shop.
20. Saw Mill.
21. Power House.
22. Material Testing Laboratory.
23. Yard Equipments.

1. Machine Shop

a. *Machine Tools*

No. of Machines	*Nos. of Machines*	*Descriptions*
1	14	78″ × 78″ (2,000 × 2,000) locomotive driving wheel lathe.
1	15	72″ × 72″ (1,800 × 1,800) locomotive driving wheel lathe.
1	16	58″ × 78″ (1,500 × 2,000) car wheel lathe.
1	17	20″ × 13′-0″ (500 × 4,000) standard engine lathe.
1	18	20″ × 13′-0″ (500 × 4,000) standard engine lathe.
1	19	78″ × 78″ (2,000 × 2,000) axle lathe.
1	20	40″ × 78″ (1,000 × 2,000) axle lathe.
1	21	12″ × 97″ (300 × 2,500) boiler stay lathe.
1	22	12″ × 40″ (300 × 1,000) engine lathe.
1	23	12″ × 40″ (300 × 1,000) engine lathe.
1	24	12″ × 40″ (300 × 1,000) engine lathe.
1	25	12″ × 40″ (300 × 1,000) engine lathe.
1	26	12″ × 40″ (300 × 1,000) engine lathe.
1	27	12″ × 40″ (300 × 1,000) engine lathe.
1	28	12″ × 40″ (300 × 1,000) engine lathe.
1	29	12″ × 40″ (300 × 1,000) monitor lathe.
1	30	10″ × 40″ (250 × 1,000) engine lathe.
1	31	12″ × 40″ (300 × 1,000) engine lathe.
1	32	12″ × 40″ (300 × 1,000) engine lathe.
1	33	12″ × 40″ (300 × 1,000) engine lathe.
1	34	12″ × 40″ (300 × 1,000) engine lathe.
1	98	2″ × 16″ (50 × 400) bench lathe.
1	132	2″ × 16″ (50 × 400) bench lathe.
1	139	Quartering machine with a 2 h.p. d.c. motor.
1	144	16″ × 40″ (400 × 1,000) engine lathe.
1	145	16″ × 40″ (400 × 1,000) engine lathe.
1	146	3″ (80) threading machine.
1	178	32″ × 78″ (800 × 2,000) double spindle lathe.
1	181	32″ × 79″ (800 × 2,500) gap lathe.
1	185	16″ × 58″ (400 × 1,500) standard engine lahthe.
1	187	18″ × 97″ (450 × 2,500) engine lathe.
1	188	18″ × 97″ (450 × 2,500) engine lathe.
1	199	40″ × 19′-6″ (1,000 × 6,000) gap lathe for axle.


GENERAL ARRANGEMENT OF EQUIPMENTS
CHANG-SIN-TIEN LOCO & CAR WORKS
P. H. R.
SCALE
N
S
FIRE ENGINE HOUSE
WOOD OVEN
SUB-STORE
UPHOLSTERING SHOP
SAW MILL
CARPENTER SHOP
MACHINE SHOP
PASSENGER CAR SHOP
PAINTING SHOP
FREIGHT CAR SHOP
IRON FOUNDRY
COPPER FOUNDRY
PATTERN SHOP
PATTERN STORE
SCRAP PIG IRON & COKE BUNKER
GRAY
BOLT & RIVET SHOP
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FAGOTTED & BUSHELED
COAL BUNKER
COAL BUNKER
TESTING LABORATORY
WATER TOWER
STOVE STORE
COKING YARD
CAR REPAIR YARD
WHEEL YARD
FORGE SHOP
CHIMNEY
BOILER ROOM
ENGINE ROOM
TYRE SHOP
MACHINE SHOP
BOILER TUBE WELDING SHOP
SUB-STORE
AIR BRAKE SHOP
ACCOUNTING OFFICE
ERECTING SHOP
BOILER SHOP
DRAWN BY - Y. H. CHANG.

No. of Machines	*Nos. of Machines*	*Descriptions*
1	203	16″ × 58″ (400 × 1,500) standard engine lathe.
1	204	18″ × 58″ (450 × 1,500) tool makers' lathe.
1	211	18″ × 40″ (450 × 1,000) geared head engine lathe.
1	224	Flat turret screw machine, with a 3 h.p. d.c. motor.
1	225	Flat turret screw machine, with a 3 h.p. d.c. motor.
1	252	20″ × 97″ (500 × 2,500) reared head tool maktrs' lathe, with a 9.5 h.p. d.c. motor.
1	253	20″ × 58″ (500 × 1,500) geared head tool makers' lathe, with a 9.5 h.p. d.c. motor.
1	254	20″ × 58″ (500 × 1,500) geared head tool makers' lathe, with a 9.5 h.p. d.c. motor.
1	255	20″ × 58″ (500 × 1,500) geared head tool makers' lathe, with a 9.5 h.p. d.c. motor.
1	40	15½″ × 15½″ × 35″ (400 × 400 × 900) horizontal boring machine.
1	53	35″ × 35″ × 70″ (900 × 900 × 1,800) horizontal locomotive cylinder borer.
1	147	48″ (1,200) vertical boring mill.
1	235	40″ (1,000) vertical turret boring mill, with a 7.5 h.p. d.c. motor.
1	236	3 11/32″ (85 mm) horizontal boring, drilling, milling and tapping machine, with a 9.5 h.p. d.c. motor.
1	41	No. 4. vertical milling machine.
1	42	Profiling machine.
1	142	No. 4. universal milling machine.
1	208	No. 2, plain milling machine.
1	230	No. 3, universal milling machine, with a 7.5 h.p. d.c. motor.
1	231	No. 3, universal milling machine, with a 7.5 h.p. d.c. motor.
1	232	No. 3, universal milling machine, with a 7.5 h.p. d.c. motor.
1	233	No. 4, double head, side rod boring machine.
1	43	25″ (600 mm) high duty slow speed drill. max. diam. 1½″ (40 mm).
1	45	27½″ (700 mm) high duty slow speed drill, max. diam. 2¾″ (70 mm)
1	46	48″ (1,200) column radial drill, max. diam. 2″ (50 mm).
1	47	48″ (1,200) column radial drill, max. diam. 2″ (50 mm).
1	48	78″ (2,000) right line radial drill, max. diam 2⅜″ (60 mm).

No. of Machines	*Nos. of Machines*	*Descriptions*
1	96	Double spindle sensitive drill, max. diam. 13/32" (10 mm).
1	97	Double spindle sensitive drill, max. diam. 13/32" (10 mm).
1	143	20" (500 mm) drill press, max. diam. 1 3/16" (30 mm).
1	198	15" (400 mm) drill press, max. diam. 1" (25 mm).
1	210	12" (300 mm) drill press, max. diam. 3/4" (20 mm).
1	259	25" (600 mm) drill press, max. diam. 2½" (65 mm)
1	260	25" (600 mm) drill press, max. diam. 2½" (65 mm)
1	51	24" × 24" × 10'-0" (600 × 600 × 3,000) planer.
1	52	40" × 40" × 16'-6" (1,000 × 1,000 × 5,000) planer.
1	226	32" × 32" × 10'-0" (800 × 800 × 3,000) planer with a 9.5 h.p. d.c. motor.
1	227	32" × 32" × 10'-0" (800 × 800 × 3,000) planer, with a 9.5 h.p. d.c. motor.
1	256	20" × 20" × 5'-0" planer.
1	57	18" (440 mm) slotter.
1	58	11" (280 mm) slotter.
1	228	12" (300 mm) slotter.
1	229	12" (300 mm) slotter.
1	55	12" (300 mm) double head, traveling head shaper.
1	56	20" (500 mm) double head, traveling head shaper.
1	205	16½" (420 mm) crank shaper.
1	129	250-ton hydraulic wheel press.
1	130	Triple cylinder hydraulic pump, with a 6½ h.p. d.c. motor.
1	186	35-ton hydraulic press.
1	251	200-ton hydraulic wheel press, with a 4 h.p. d.c. motor.
1	54	8" (200 mm) power hack sak.
1	59	Wet tool grinder.
1	60	Wet tool grinder.
1	77	Wet tool grinder.
1	100	Drill grinder.
1	101	Saw grinder.
1	81	Hand operated light rail bending machine.
1	191	Wet tool grinder.
1	234	Teavy face grinder, with a 6½ h.p. d.c. motor.
1	237	Wet tool grinder.

No. of Machines	Nos. of Machines	Descriptions
1	238	Wet tool grinder.
1	242	Milling tool grinder.
1	243	Drill grinder.
1	261	Double disc grinding machine, with an exhaust fan.
1		Portable electric driven cylinder borer.
1		25″ (600 mm) drill press, max. diam. 2½″ (65 mm).
1		25″ (600 mm) drill press, max. diam. 2½″ (65 mm).
1		25″ (600 mm) drill press, max. diam. 2½″ (65 mm).
1		25″ (600 mm) drill press, max. diam. 2½″.
1		25″ (600 mm) drill press, max. diam. 2½″.
1		Portable electric driven grinder, with a 2 h.p. d.c. motor.
1		Double disc grinder, with an eshaust fan.
1		Hydraulic press accumulator.
1		Wet tool grinder.

b. *Other Equipments*

No. of Machines	Nos. of Machines	Descriptions
1	63	Cast iron surface plate.
1	104	Flexible boiler making drill, with a d.c. motor (125-volt, 10-amp.).
1	105	.... do ....
1	192	Electric driven portable grinder.
1	148	Pneumatic hoist.
1	149	Pneumatic hoist.
1	150	Pneumatic hoist.
1	256	5 h.p. d.c. motor (tool room).
1		Pneumatic hoist.
1		5-ton hand operated over head traveling crane.
4		Benches and vices for machine shop workers.
1		Laying out table.
1		Hand operated centering machine.
4		Benches and vices for apprentices.
1		Bench and vices for tool room.
1		2000-kilo weighing scale.
		Pneumatic tool bins.
		Drill storage bins.

2. Electric Welding Shop

a. *Machine Tools*

No. of Machines	*Nos. of Machines*	*Descriptions*
1		Welson plastic arc welding, type KB electric panel, (1 welding plug, 40-volt, 150-amp.).
1		Welson plastic arc welding, type KA electric panel. (1 welding plug, and 1-cutting plug; 40-volt, 150).
1		Welson plastic arc welding, type KA, 15 h.p. d.c. motor generator set.
1		Welson plastic arc welding type KB, 7½ h.p. d.c. motor generator sets
1		Welson plastic arc welding type K.A, portable 15 h.p. d.c. motor generator set, with 2 plugs (1-welding, 1-cutting).
1		Welson plastic arc welding type KA, portable 15 h.p. d.c. motor generator set, with I welding plug.

b. *Other Equipments*

No. of Machines	*Nos. of Machines*	*Descriptions*
1		Surface plate.
1		Bench and vices.

3. Brass and tin Smith Shop

a. *Machine Tools*

No. of Machines	*Nos. of Machines*	*Descriptions*
1	64	Sheet metal shear, max. thickness, 5/64″ (2 mm).
1	65	Sheet metal bending and straightening machine.
1	66	Sheet metal bending and straightening machine.
1	103	Iron plate shear, max. thickness, 5/32″ (4 mm).
1	170	Double disc grinding machine.
1	173	½ h.p. d.c. motor generator set.

b. *Other Equipments*

No. of Machines	*Nos. of Machines*	*Descriptions*
1	68	Forge furnace.
1	70	Forge furnace.
1	71	Tinning table.

No. of Machines	Nos. of Machines	Descriptions
1	155	Bench and vices.
1	156	Bench and vices.
1		2000-kilo weighing scale.
1		Pipe brazing forge.
1		Nickle plating electrolytic tank.
1		Work bench.

4. Boiler Tube Welding Shop

a. *Machine Tools*

No. of Machines	Nos. of Machines	Descriptions
1	74	Hydraulic pipe testing set.
1	76	Double grinding machine.
1	79	Pipe scraping machine.
1	241	Centrifugal blower (2000 cu. ft./min., of free air, 8″ diam. of exhaust pipe).
1	244	Double grinding machine.
1	250	Double disc grinding machine, with an exhaust fan.
1		Hand operated pipe bending machine.

5. Boiler Shop

a. *Machine Tools*

No. of Machines	Nos. of Machines	Descriptions
1	49	78″ (2,000) right line radial drill, max. diam. 2⅜″ (60 mm)
1	50	48″ (1,200) column radial drill, max. diam. 2″ (50 mm).
1	61	20″ (500 mm) circular cold cut saw.
1	72	8′-0″ × 1⅛″ (2,500 × 30) bending rolls.
1	73	Shear and punch machine. max. punch diam. 2″ (50 mm), thickness, ½″ (12). max. plate shear 4″ × ½″ (100 × 12).
1	157	Shear and punch machine. max. punch diam. 1¼″ (32 mm), thickness, ½″ (12 mm). max. plate shear, 4″ × ½″ (100 × 12). round shear, 2⅛″ (55 mm).

No. of Machines	Nos. of Machines	Descriptions
		T shear, 2″ ×½″ (50× 12).
		L shear 4¾″ × 4¾″ × ½″ (120 × 120 × 12).
1	155	Portable boiler making universal radial drill, with a 2 h.p. d.c. motor.
1	159	Portable boiler making universal radial drill, with a 2 h.p. d.c. motor.
1	240	Ienox rotary shear, max. thickness, ⅛″ (3 mm).
1	257	Portable boiler making universal radial drill, with a 3 h.p. d.c. motor.
1		Portable boiler making universal radial drill, with a 3 h.p. d.c. motor.
6		Goliath type NG5 rivet hammer max. diam. 1⅜″ (33 mm).
		Goliath type NG4 rivet hammer max. diam. 1⅛″ (20 mm).
6		Goliath type PC2 heavy chisel.
6		Goliath type PC150 light chisel.
2		Boyer stay riveter.
2		Goliath type NC50 rivet cutter, max. diam ⅝″ (16).
1		Boyer No. 1 rivet cutter.
2		Heavy riveting machine, max, thickness 29½″ (750).
2		Pneumatic hammer, ¼″ (32 mm).
2		Pneumatic hammer, max. diam. 1″ (26 mm).
2		Pneumatic hammer.
2		Goliath type OR reversible drill, max. diam. 3″ (80).
4		Goliath type 1 NR reversible drill, max. diam 2″ (50).
6		Goliath type 1 NR reversible drill, max. diam. 2″ (5 mm).
6		Goliath type 2 NR reversible drill, max. diam. 1⅜″ (35 mm).
6		Goliath type 3 NR reversible drill, max. diam ⅞″ (22 mm).
2		Little Giant reversible drill, max. diam ½″ (12 mm).
1		Goliath angle drill.
4		Goliath No. 3 BR drill for wood.

6. Erecting Shop

General Equipments

No. of Machines	Nos. of Machines	Descriptions
1		25-ton electric overhead traveling crane, span, 46′-0″ (14-m).
3		Benches and vices for general fitting work.
1		Compressed air reservoir.

7. Air Brake Shop

a. Machine Tools

No of Machines	Nos. of Machines	Descriptions
1		Test bench with complete installation for testing purposes.

b. Other Equipments

2		Benches and vices.

8. Tyre Shop

General Equipments

No. of Machines	Nos. of Machines	Descriptions
1	123	Tyre heater, coke fired.
1	125	Tyre heater, coke fired.
1		4500 cu. ft./min. centrifugal blower, diam. of exhaust pipe, 12″ (300 mm).
1		4500 cu. ft./min. centrifugal blower, diam. of exhaust pipe, 12″ (300 mm).
1		4000-kilo jib crance.
1		4000-kilo jib crance.
1		tool box.

9. Forge Shop

a. Machine Tools

No. of Machines	Nos. of Machines	Descriptions
1	83	350-kilo single frame steam hammer.
1	166	1-ton double frame steam hammer.

No. of Machines	Nos. of Machines	Descriptions
1		Hand operated laminated spring second plate end bending machine.
1		Hand operated laminated spring second plate eye bending machine.
1		Hand operated laminated spring cambering machine.
1		Hand operated laminated spring cambering machine.
1		Hand operated laminated spring first plate eye bending machine.

b. *Other Equipments*

No. of Machines	Nos. of Machines	Descriptions
1	84	2000-kilo jib crane.
1	87	Forge furnace, double type, with water tank.
1	88	.... do ....
1	94	.... do ....
1	90	.... do ....
1	91	.... do ....
1	92	.... do ....
1	93	.... do ....
1	161	.... do ....
1	162	.... do ....
1	163	.... do ....
1	164	.... do ....
1	165	.... do ....
1	124	Double decked reverberatory furnace.
1	167	250-kilo iron heating (busheled) furnace.
1	168	Internal fire boiler (20 sq. m. heating surface) attached to the end of the iron heating furnace.
1		500-kilo jib crane.
1		2000-kilo weighing scale.
2		Surface plate.
1		Saw brazing clamp.

No. of Machines	Nos. of Machines	Descriptions
1		Water tempering tank.
24		Tool box.
24		Anvils and upsetting blocks.
2		Vices.
2		Drinking water boiler.

10. FAGOTTED AND BUSHELED IRON MILL

a. *Machine Tools*

No. of Machines	Nos. of Machines	Descriptions
1	189	Ryerson friction saw with a 35 h.p. d.c. motor.
1	200	Ajax 14" × 44½" rolling mill, with a 100 h.p. d.c. motor.
1	202	1.16-ton double frame steam hammer.

b. *Other Equipments*

No. of Machines	Nos. of Machines	Descriptions
1	201	Waste heat fire tube boiler, 63 sq. m. heating surface.
1		Waste heat fire tube boiler, 63 sq. m. heating surface.
1		Waste heat fire tube boiler, 63 sq. m. heating surface.
1		Steel stack, diam. 500 mm.
1		250-kilo iron heating furnace.
1		250-kilo iron heating furnace.
1		3-ton reheating furnace.
1		3-ton reheating furnace.
1		2000-kilo pillar crane.
1		Rack for holding mill rolls.
1		2000-kilo weighing scale.
1		Anvil.

11. BOLT AND RIVET SHOP

a. *Machine Tools*

No. of Machines	Nos. of Machines	Descriptions
1	35	1³⁄₁₆" (30 mm) bolt cutter.
1	36	1⅛" (30 mm) bolt cutter.
1	37	1³⁄₁₆" (30 mm) bolt cutter.
1	80	Vertical shear machine max. diam. 1" (25 mm).

No. of Machines	Nos. of Machines	Descriptions
1	153	1¼″ (32 mm) hot press heading machine.
1	171	1″ (25 mm) hot press nut machine.
1	179	1″ (25 mm) nut facing machine.
1	180	1⅛″ (28 mm) nut tapper.
1	212	1⅛″ (28 mm) bolt cutter.
1	213	1″ (25 mm) nut facing machine.
1	245	1¼″ (32 mm) nut tapper.
1	246	2″ (50 mm) bolt pointer.
1	247	1″ (25 mm) bolt pointer.
1	248	Punch press.

b. *Other Equipments*

No. of Machines	Nos. of Machines	Descriptions
1	172	Forge furnace.
1	249	Centrifugal fan blower, cap. 2000 cu. ft. min.. diam of exhaust pipe, 8″ (200 mm).
1	10	36 Kw d.c. shunt motor.
1		Bench and vices.
1		Forge furnace.

12. FOUNDRY

a. *Machine Tools*

No. of Machines	Nos. of Machines	Descriptions
1	44	27½″ (700 mm) low speed heavy drill, max. diam 2¾″ (70 mm).
1	110	Edge runner stone mill.
1	111	Ball Stone mill.
1	112	5-ton cupola.
1	118	Double grinding machine.
1	209	15″ (400 mm) drill press, max. drill 1″ (25 mm).
1	214	25 h.p. d.c. motor.
1	215	3-ton cupola.
1	216	No. 5. Roots blower.

b. *Other Equipments*

No. of Machines	*Nos. of Machines*	*Descriptions*
1		Morgan tilting furnace, cap. 200 lbs. steel.
3		Coke furnaces, diam. 20½" (520 mm), depth, 29" (740 mm).
1		5-ton elevator.
1		3 h.p. d.c. motor with a centrifugal fan blower, cap. 460 cu. ft./min. of free air, 5" of exhaust pipe.
1		500-kilo weighing scale.
1		200-kilo weighing scale.
1		Core oven, 16'-6" × 24'-0" × 10'-6" (5,000 × 7,300 × 3,000).

No. of Machines	*Nos. of Machines*	*Descriptions*
1		Core oven, 12'-4" × 24'-0" × 10'-0" (3,750 × 7,300 × 3,000).
2		Core carriage.
1		20" (500 mm) steal stack.
2		2000-kilo jib crane.
1		1500-kilo jib crane.

13. PATTERN SHOP

a. *Machine Tools*

No. of Machines	*Nos. of Machines*	*Descriptions*
1	217	Wet tool grinder.
1	218	8" × 60" (200 × 1,500) lathe.
1	219	23½" (600 mm) circular saw, with 4" × 28" (100 × 700) buzz planer.
1	220	Endless band saw.
1	221	25 h.p. d.c. motor.
1	222	32" (800 mm) Pattern makers' Lathe.

a. *Other Equipments*

No. of Machines	*Nos. of Machines*	*Descriptions*
11		Benches and vices.

14. Freight Car Shop

No. of Machines	Nos. of Machines	Descriptions
2		Forge furnace.
1		Compressed air reservoir.

15. Painting Shop

No. of Machines	Nos. of Machines	Descriptions
4		Oil heater.

16. Pholstering Shop

No. of Machines	Nos. of Machines	Descriptions
1	32	Sewing machine.
1	33	Sewing machine.
1	34	Sewing machine.
1	35	Sewing machine.
1	36	Sewing machine.
1		Sewing machine.
1		Sewing machine.
1		Work bench.

17. Passenger Car Shop

No. of Machines	Nos. of Machines	Descriptions
4		Benches and vices.
20		Wood benches.
2		Drinking water boiler.

18. Machine Shop (Cars)

a. *Machine Tools*

No. of Machines	Nos. of Machines	Descriptions
1	302	Shaper, with a 2 h.p. d.c. motor (wood working).
1	5	15¾" × 6" (400 × 150) planer (wood working).
1	8	Sensitive drill, max. diam. ⅝" (15 mm), (metal cutting).
1	10	2" (50 mm) band saw, (wood working).
1	11	32" (800 mm) circular saw (wood working).
1	12	Mortising machine (wood working).

No. of Machines	Nos. of Machines	Descriptions
1	13	Band saw grinder.
1	14	Circular saw grinder.
1	15	16″ × 40″ (400 × 1,000) wood turning lathe.
1	16	13¾″ × 4¾″ (350 × 120) buzz planer (wood working).
1	17	1¾″ (45 mm) band saw, (wood working).
1	18	20″ (500 mm) circular cold cut saw, (metal working).
1	20	32″ (800 mm) circular saw, (wood working).
1	22	Tenoning machine, (wood working).
1	23	Tool grinder.
1	24	Wet tool grinder.
1	25	Wet tool grinder.
1	29	32″ (800 mm) circular saw, (wood working).
1	42	Paint squeezer.
1	43	Band saw grinder.
1	44	Shaper (wood working).
1	47	1¾″ × 4¾″ (350 × 150) planer, (wood working).
1	50	16″ (400 mm) drill press, max. diam. ⅞″ (22 mm).
1	21	12″ (300 mm) crank shaper, (metal working).
1		24″ (600 mm) high speed heavy drill press, max. diam. 2½″ (65 mm)
1		3 h.p. d.c. motor.
1		5 h.p. d.c. motor.
1		100 h.p. d.c. motor.

b. *Other Equipments*

No. of Machines	Nos. of Machines	Descriptions
1		Band saw clamp.
3		Benches and vices.

19. Carpenter Shop

No. of Machines	Nos. of Machines	Descriptions
60		Wood working bench.

20. Saw Mill

a. *Machine Tools*

No. of Machines	Nos. of Machines	Descriptions
1	26	Band saw mill, with log carriage running on rails.
1	27	Band saw mill, with log carriage running on rails.
1	46	Band saw mill, with log carriage running on rails.

b. *Other Equipments*

No. of Machines	Nos. of Machines	Descriptions
1		8 h.p. d.c. motor.

21. Power House

a. *Boiler Room Equipments*

No. of Machines	Nos. of Machines	Descriptions
1	1	Interal fire boiler, having, heating surface..............415 sq. ft. (38.50 sq. m.). grate area........... 17 sq. ft. (1.58 sq. m.). rated gauge pressure............10 atm.
1	2	.... do ....
1	3	.... do ....
1	4	.... do ....
1	6	Electric wiring diagram.
1	140	File sharpener.
1		Brick chimney, height............131′-4″ (40 m). inside top diam ....59″ (1,500 m). inside bottom diam............85″ (2,160 m).
1		Double furnace internal fire boiler. heating surface ......950 sq. ft. (88.00 sq. m.) grate area .... 33 sq. ft. (3.06 sq. m.). rated gauge pressure ....8.5 atm.
1		Society locomotive boiler, heating surface ....1572 sq. ft. (146.00 sq. m.). Grate area............27.7 sq. ft. (2.57 sq. m.). rated gauge pressure ....10 atm
1		Roger locomotive boiler, heating surface ....1500 sq. ft. (139.44 sq. m.). grate area .... 23.7 sq. ft. (2.200 sq. m.) rated gauge pressure ....10 atm
1		.... do ....
1		Steam heater for bending wood planks.
1		Condensate reservoir.

b. *Engine Room Equipment*

No. of Machines	*Nos. of Machines*	*Descriptions*
1	195	Jones Burton 220 Kw compound generator, volt ....110 R. P. M. ....500 rope driven by:
	194	Jones Burton fixed compound steam engine, with one condenser, I. H. P. ....300 cyl. size 19 $11/16''$ × 31½" 35 $13/32''$ (500 × 800 × 900).
1	134	Boult Labbodiere 36 Kw, 3-wire, shunt generator, volt ....250 amp .... 72 R. P. M. ....440 direct coupled to a high speed vertical single steam engine.
1	135	Boult Labbodiere 36 Kw, 3-wire, shunt generator, volt ....250 amp .... 72 R. P. M. ....440 direct coupled to a high speed vertical single steam engine.
1	182	Boult Labbodiere 120 Kw, 3-wire, shunt generator volt ....250 amp ....240 R. P. M. ....420 direct coupled to a high speed vertical compound engine.
1	9	Hoyois coliss valve single steam engine, with one condenser, I. H. P. ....150 cyl. size. 17 $13/16''$ × 35 $13/32''$ (450 × 900). R. P. M. 75
1	197	Ingersoll Rand class J air compressor, air cyl. 16½" × 10½" × 10"
1	239	Ingersoll Rand class XPVR compressor with a compound engine drivers, steam cyl. ....21" × 16" air cyl. ....20" × 16" steam cyl. ....13" × 16" air cyl. ....12½" × 16"

No. of Machines	Nos. of Machines	Descriptions
1		Dierman 36 Kw d.c. shunt generator, volt ....120 amp ....340 direct coupled to a high speed vertical single steam engine.
1		3-wire, 250-volt, 120-Kw, d.c. generator panel.
1		3-wire, 250-volt, feeder panel.
1		3-wire, 250-volt, 36-Kw, d.c. genestor panel.
1		3-wire, 250-volt, 36-Kw, d.c. generator panel.
3		110-volt feeder panel.
1		2-wire, 110-volt, 220-Kw, generator panel.
1		2-wire, 110-volt, 36-Kw, generator panel.
1		Bench and vices.

22. Material Testing Laroratory

General Equipments

No of Machines	Nos. of Machines	Descriptions
1		50000 lbs. Olsen universal testing machine.
1		Olsen oil testing machine.
		Apparatus for determining viscosity. flash-point, freezing point, of lubricants.
		Emerson calorimeter bomb for b.t.u. of fuels.
		Complete apparatus for chemical analysis.
1		Bench and vices.

23. Yard Equipments

No. of Machines	Nos. of Machines	Descriptions
4		Coke oven.
4		2,200 gal. (10 m^3) water tower.
2		High duty Worthington water pump.
1		Water meter.
1		5-ton coal weighing scale.
1		Electric driven transfer table, with a 35 h.p. d.c. motor. (for car shop).
1		Hand operated transfer table for locomotive repair shops.
1		Steam heating boiler.
1		40-ton weighing scale.
1		15-ton gantry crane.
1		8-ton pillar crane.
1		Fire engine.

中央廣播無綫電台重行佈置播音經過及改善概況

著者：劉振淸

(一) 引言

中央台開始播音已及一載，所有播音及收音兩方面，尙少充分進展，攷其主要原因：一爲電力微弱，機械簡單，組合未能盡善（所有機械欠善各點見第二節），二爲利用無線電廣播事業，作宣傳利器，在吾國尙屬初創，國人對於遠距離收音，尙乏深刻之研究與適當之經驗。當去歲初派各省市收音員時，既乏相當專才，可備遴選，復因時間匆促，未及充分訓練，以致困難叢生，成效未盡滿意。嗣經屢次指導，漸臻佳境。今春特辦收音員訓練班，訓練較久，諸生於應用學識，大致均能通曉，技能亦尙嫻熟，畢業後續陸選派至各地服務。并經製發天線調整器，以增聲響，分選各種收音機，以適遠近需要，並令加長天線至二百呎以外，以增加遠距離收音效率，裝用地下天線，以免天電滋擾。近來迭據陳述，收音情形，較前實已有顯著進步。前此所擬擴充電力至五十啓羅瓦特之計劃，業經中央核准，一切正在籌備。已徵得各行廠機械圖樣，經詳細審核，分別接洽，不日可訂立合同，購運裝用。惟機件多須由外國定製運華，約計定購運送以至裝置完竣，尙須一年左右。在此時期中，自應先就原有機械，酌量改良，以應目前之需要。現經詳行研究，就能力環境所及，擬定改善方針，以重行佈置發射線路爲原則，所需材料，先就原存者分別擇用改造，以節經費。歷時半月，佈置告竣，開始使用，各地報告，多稱收音宏大淸晰，爲前此所未有。茲將辦理經過及現在概況，略述於後，尙希海內同志，惠予指教，以匡不逮爲幸。

(二) 原有機件之說明及其欠善各點

中央台機械概況,前嘗爲文叙述,刊登建設委員會無線電報月刊.茲特簡單說明,並附線路圖,以便攷查比較.台內機件,原向開洛公司訂購,可分發音播音兩部,前者係指發音室應用各機,後者係指播音台所用而言.

發音部機件首爲炭屑雙鈕式傳話器 Double Button Carbon Microplone, 次爲傳話放大器 Microphone Amplifier 該器有二級.第一級爲變壓放大級 Transformer Amplifier, 其柵極輸入,即接該級中傳話變壓器 Microphone Transformer 之次線圈.第二級爲推挽放大級 Push Pull Amplifier, 所有眞空管俱用 UX—210, 其燈絲電壓,用8伏爾次140安培小時蓄電池供給之,附有整流器.屏極電壓第一級爲 200 伏爾次,第二級各爲 360 伏爾次,由一600牟安培小時蓄電池供給之,亦附有整流器.柵極電壓第一級爲 10½ 伏爾次,第二級爲 28 伏爾次,亦由普通乙種乾電池供給之.所有線路,(見第一圖左下角)由輸出變壓器再經專線而至播音台管機員桌上之插座 Jack.

播音部機件,首爲管機員桌上之插頭 Plug, 而至話音放大器 Speech Amplifier, 該器包含推挽式一級,連同音度控制設備,其眞空管亦用 UX—210, 燈絲屏極柵極電壓來源,俱與前述相同,惟屏電壓加至 400 伏爾次,柵電壓用32伏爾次.至高壓充電設備,爲一 150 瓦特 500 伏爾次之小號電動發電機 Dynamotor. 該機來電,則另由一110伏爾次200 安培小時之總電池供給.(總電池主要用處另述於後) 其專線在發音室一端,及話音放大器輸入一端,俱裝總電抗線圈 Impedance Coil. 中間接出之頭, Center Tap, 俱經一繼力控制器 Relay, 與相當電壓至地線.(該器之作用,在管機員將塞子插入插座,兩處燈絲電壓及傳話器電壓同時接通.) 其線路因限於篇幅,未曾繪明.所有放大器線路(第一圖中下部) 輸出線,即經一調幅變壓器 Modulation Transformer, 而至調幅器 Modulator, 調幅線路爲屏極調幅式 Plate Modulation, (見第

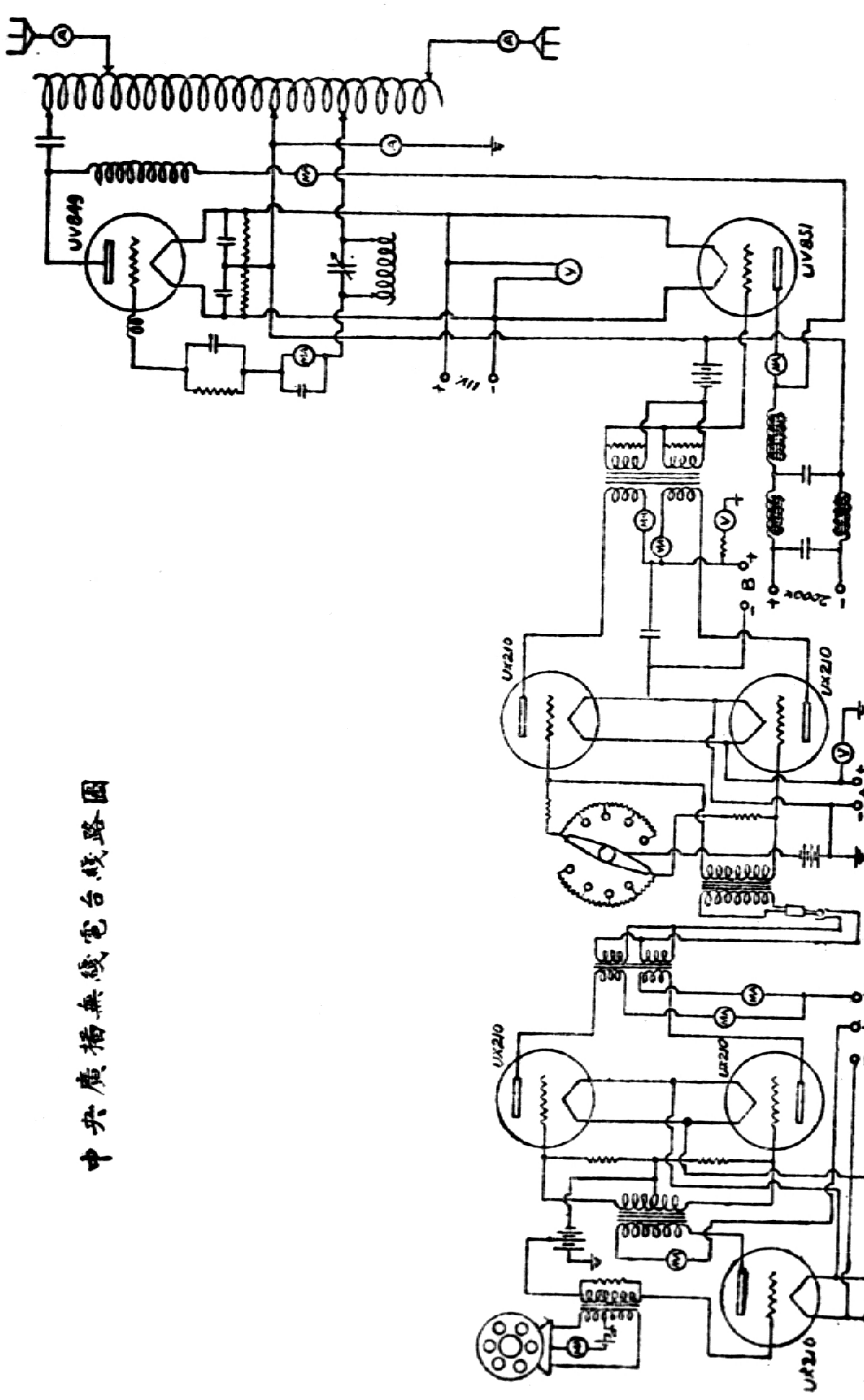
一圖右下角）該器真空管爲UX—851,1000瓦特式,燈絲電壓爲11伏爾次,屏電壓2000伏爾次,其來源俱由三聯馬達發電機一具所供給.（馬達來電又從110伏爾次200 AH之總電池來,總電池主要工作即在此）其高壓來線先經一濾波器Filter,其正號一端復經調幅用成音阻流圈, Audio Frequency Choke Coil,而後至調幅真空管之屏極,柵電壓約50伏爾次,用乙種乾電池供給之.

振盪器Oscillator線路,爲哈脫萊兼矮姆司屈倫式Hartley-Armstrong Circuit,真空管爲UX-204,250瓦特兩只並用者.燈絲屏極電壓與調幅器同.高壓來線即接調幅器成音阻流圈之後,再經一射電阻流圈 Rodio Frequency Chake Coil 而達屏極.其調幅之作用,即在此兩級屏極合用之成音阻流圈.發音聲調高下應響調幅器之屏電流,而該成音阻流圈之電位降,亦隨同升降,致振盪級屏電壓數值,遂亦依之大小,振盪電流波幅,乃有隨同語音變化之現象(該級線路見第一圖左上角).

天線Antenna地網Counterpaise俱爲T形,直接絞連於振盪器之配諧線路.天線高125尺,長110尺,係各以二十一號光銅線四十九根組合成纜,共用三纜.並行橫懸於兩鐵塔之中,每纜兩端距離均有三呎五吋,中間緊束併合(如角尖相對之兩三角形)通入電台,自然波長 Natural Wavelength 約爲310公尺,現用波長爲420公尺.

總觀上述說明,計其欠善各點,可得下列數項:

（一）<u>電力供給</u>　調幅振盪兩級真空管之屏極燈絲電壓,俱由一具三聯馬達發電機供給.2000伏爾次高壓發電機居中,14伏爾次之燈絲發電機,及110伏爾次直流電馬達,各居一端,排列方式既欠平衡,而直流電馬達速度變化往往因炭精刷 Carbon brushes 變流板 Commutator之接觸與分離,及磁感線圈 Field Coil 之多寡與地位,情形益形複雜.當其發出之各電壓,無論在未有負荷或滿載負荷時,各表指示不絕搖動.雖經濾波器,効用仍微.（非如交



中央廣播無線電台線路圖

流電馬達對於高壓發電機電壓搖動,可以相當之濾波器以矯正之,其燈絲電壓發電機本無採用濾波器者）以此接入振盪器,遂使週率波幅搖盪不穩,遠地收音,時有高低,馬達雜聲隨波四射.

(二) 調幅器地位　調幅器直接振盪器,非發音聲調偶有高下應響波長,卽有時發音稍響,振盪器驟失平衡,逐告停止.同時屏極熱度驟高,每一不慎,真空管損壞堪虞.欲求工作平穩,勢非將振盪線路減低効率,調幅成分限制極小,而播射効力,因以大減矣.

(三) 振盪器地位　振盪器直接天地線,一法每因風雨搖動,寒暖伸縮,應響週率之平匀.同時天線不易調整,電力輸出,尤難得最高之點.次波嘈雜,復不能免焉.

上列各點,僅指其最重要者而言.此外真空管橫列,使屏柵兩極,日久互碰,濾波器Filter中容電器指定電壓與使用電壓相等頻頻爆發,振盪器兩真空管幷接,而無各個燈絲較準設備,以致兩管負荷不能平分等等,均爲原有計劃,未能審愼精詳之處,業經陸續修改,以事屬細微,不復詳述.

(三) 改善計劃

中央台改裝計劃,係採用振盪放大制 Mastes Oscillator, 故其更動,祇限於振盪器一部份.餘如成音週波各級,除精密的較準各電壓使減少變調外,餘皆一仍其舊.玆將振盪放大各級線路詳述於下:

(一) 振盪級 Oscillator　美國新制,振盪器大都用晶體控制,其週率平衡莫與倫比.然在我國不易採購.故中央台採用自感式 Self Excitation 線路,擇哈得萊 Hartley 式,取其製用簡捷.真空管爲 UX−210.配諧線圈 (L_1) 係用十六號光銅線所自製,計繞三十圈,其直徑爲四吋,圈之距離空間爲⅛吋,配諧容電器,(C10) 爲二只收音機式,.0005 毫法拉特之變量容電器並接而成,藉以減少 (L_1) 圈數與直徑,維持美觀,蓋自感振盪器,宜用高容電量線路,以減低別

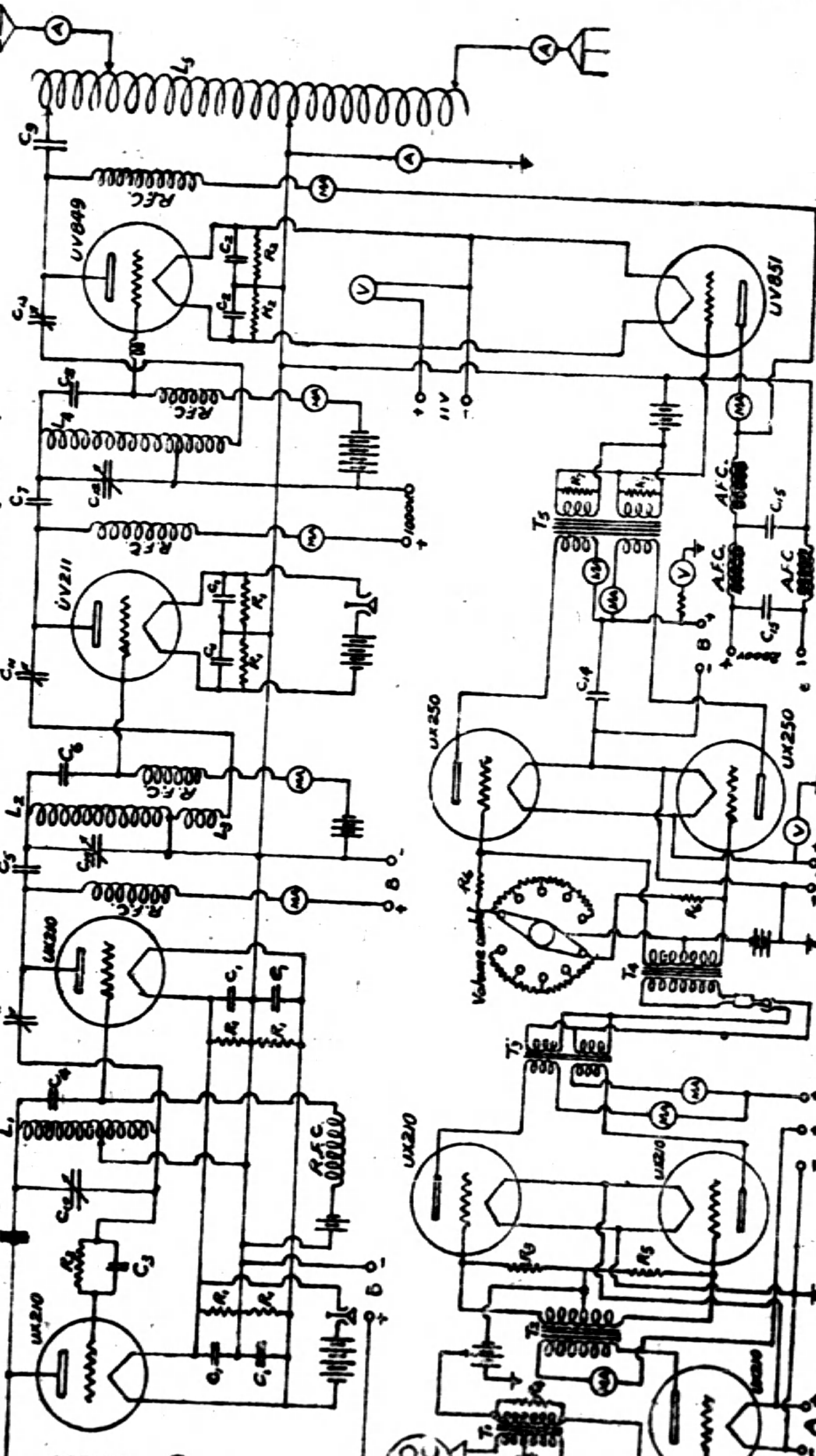
級應響.其餘柵極容電器,(C_3)爲.001 兎法拉特,柵漏阻(R_3)爲 1200 歐姆,電位器 Potentiometer 合爲200歐姆,燈絲支路容電器(C_1)各爲.002 兎法拉特,俱保收音機式.燈絲電壓爲8伏爾次120安培小時之收音式甲種蓄電池供給.屏極電壓爲 250 伏爾次,6000 犛安培小時之乙種蓄電池供給.所用射電阻流圈R. F. C. 爲三十號絲包銅絲,圍繞三層,每層約一百七十圈,其直徑爲一吋半長者.該級全部用鉛質方箱包裹,以免別級影響.

(二) 隔離級 Buffer Stage. 該器用一3300伏爾次.00025 兎法拉特之固量容電絞連振盪級.其與(L_1)接通之點,可以移動,以求適當之感應 Excitation. 所用眞空管及配諧線路,俱與上級相同.惟添一48伏爾次6000 犛安培小時之柵極蓄電池.屏電壓與上級公用,惟加高至350伏爾次.其相銷容電器 C_{11}. Neutrolizing Condenser 爲Pilot 23片之小容電器而取去片數之半者,(每間一片取去一片計取去十一片其容電量約爲.000025兎法拉特)接振盪級(L_1)之柵極一端.此外另添一2吋直徑⅛吋距離二十圈十六號光銅絲之線圈(L_3), 接通 (L_2), 則爲下級抵銷管內電容量之用.

(三) 第一放大級 First Stage Amplification. 該級亦用 3300伏爾次.00025固量容電器,直接上級(L_2),一如上述.直空管爲UX—211.75 瓦特(L_4)係十二號光銅絲.圍繞六十圈,其直徑爲四寸,圈之距離空間爲¼ 寸,其中四十圈爲配諧線圈,餘二十圈接下級相銷容電器(C_{13}).容電器(C_{12})爲.00035兎法拉特之高壓式(由上海大華購來)因較大容電器無處可得,遂致線圈形式,微嫌過大.該級相銷容電器(C_{11})與前級相同.燈絲電壓爲10伏爾次之收音機用甲種蓄電池.柵電壓用96伏爾次6000犛安培小時之蓄電池.屏電池與上兩級公用,惟加至800伏爾次,不日尙擬添辦1000伏爾次之小號電動發電機以供給之.至所用阻流圈,電位器,亦與前級相同.但各種固量容電器,(俱向大華定製)指定電壓均爲5000伏爾次.

(四) 末級放大級 Modulated Amplifier. 該級眞空管爲 UX—849, 500 瓦特

中央廣播無線電台改善後線路圖



十八年九月製印

亦用一.00025,5000伏爾次之固量容電器絞連前級.配諧線圈(L_5)隔離容電器(C_9) Blocking Condenser及燈絲屏極各電壓來源仍延用原物.惟柵電壓爲192伏爾次6000密安培小時之蓄電池.同時添28號絲包線圍繞四百圈直徑十三寸之射電阻流圈于柵路中.相銷容電器爲0001毫法拉特變量式.(稍嫌太大但別無小者)

(五) 天線配諧線路Antenna Tuning Circuit. 天線絞連線路,暫仍延用舊法.惟直接絞連既感配諧不便,而次波紛雜,擾亂空中秩序,亦所不取.一俟購得相當高壓容電器,接入末級放大器,配諧線路,及天地線線路後,即可改爲感應絞連,以期完善.

(四)使用方法

中央台波長仍爲420公尺配諧手續,先從振盪級依次調準,至各級線路完全諧振而應加注意之點,在各級相銷容電器之較準與天地線之絞連線圈之配諧,往往稍欠正確,非各級柵屏電流嘗呈不穩之象,即天線電流減至甚小,不可不愼也.

(一) 振盪級 先將屏柵兩極出線接(L_1)上下兩端,燈絲電位器(R_1)中心點接(L_1)中間,次以燈絲屏極電壓接上,乃以波長表置于420處,移近(L_1)徐動容電器(C_{10})以求諧振地位,幷即注意屏電流是否適當(按UX—210真空管在振盪時最大屏電流應爲60密安培)如有不及可將(L_1)接電位器(R_1)接點略移向上,如嫌過大,則略移向下,同時高週波電流亦發生大小,應感應下級可隨時較準.

(二) 隔離級 在振盪級未開前,將屏極與電位器中心點接通(L_2)上下二端,同時將燈絲屏柵各電壓接上,注意屏電流務將柵極電壓略事增減,求得屏電流適爲零度,此即第二種放大制 Class B Amplificotion 應需原則,其次將屏電壓開去,徐轉相銷容電器 C_{11}, 同時轉動配諧容電器 C_{10}, 此時振盪

級屏電流必有變動.逐漸較準C_{11},待至一點雖動C_{10}振盪級屏電流毫無變化時卽,爲本級眞空管內容電器完全抵銷之點.乃將屏電壓推上,重行配諧.卽轉動C_{10}至屏電流最小處是也.但在全機開用時,因各有負荷各級定數,微有變動須再依法略行較準,現在所用屏電流,約爲30孚安培.

(三) 第一放大級　該級因便於製用故配諧線圈與相銷線圈合而爲一(L_4)取其易于伸縮,配諧原則,亦如上述,該級接有柵電流表,以便查量,其在諧振最高點屏電流最低,柵電流最高,現在開用時,屏柵電流均在四十孚安培左右,相銷容電器用法亦如上述.

(四) 末級放大級　該級使用手續與前相仿,但柵電壓應爲能使屏電流得零數之兩倍,以增加眞空管效力,而適合調幅原則,卽所謂第三種放大制也Class C Amplificotion該級配諧線路內容電器.卽爲天線地網間之容電量,不能變換數值,致配諧手續較爲麻煩,普通入手方法,以天線地線間之圈數與地線地網間之圈數,使之相等,而以屏極出線與天線接連甚近,然後將各電壓開上,同時將天線地網兩接點等量增減,迨至屏電流最小天線電流最大而止,於是更增減屏極接點以求屏電流適合該眞空管之指定特性 Rating.現在配諧既甚周折,其相銷容電量方法亦感不便,最近辦法,係將L_5上天線地網兩端暫行卸下另配一收音式變量容電器接于L_5上屏極燈絲兩接點.然後先將燈絲電壓推上,另以波長表置420公尺處與之絞連,將相銷容電器置與零度,配諧該線路,迨至諧振,再動相銷容電器,迨波長表電流表指度最小.此時屏電壓未推並無危險.最後將各線接點恢復原狀依法配諧.現在所用屏電壓約爲1700伏爾次燈絲電壓10½伏爾次,柵電壓192伏爾次,屏電流約爲300孚安培柵電流約爲40孚安培,天線地網電流約爲7½安培,柵極輸入電流不求過大,但求足用,變更之法,在增減該級……之入(L_4)之圈數蓋甚便也.

(五) 試用情形

試用時,舊有調幅級仍與末級放大級銜接,即兩級眞空管之屏電壓來線,先經一成音阻流圈,而後接通兩管之屏極,一如前述.此時發音方面可以加高聲響,對於末級眞空管絕無前述之險象,因射電放大級固無由停止振盪也.三聯馬達發電機電壓,雖略有高下,但其應響祇及屏電流.對於放射電力,關係尙微.若以原有設備而論,該級爲自感振盪式屏絲電壓之應響,並及于柵電流,結果,放射電力受其危害,何啻數倍,(隨放大因數Amplication Constant而定) 自在意中,改用以來,馬達雜聲因以大減,播發聲響,可以大增,調幅成分亦以加大,此外週率不穩,時高時低之現象,亦消除迨盡.

管機方面有較前更宜注意者,即各級相銷容電器,與線圈,宜配置適當,各級配諧,宜極審愼,各級電池,宜時查量,否則有一不愼,各級屏電表即時呈搖動現象,同時波長不穩,雜聲稍作,但其程度固遠不及未改前之鉅大焉.是以改變線路以來,結果固已大著,而管理手續,亦屬較繁.此後播音成績良好與否,大半係於人力是否周至,非如前時之盡依機件爲轉移矣.

(六) 結論

自改裝完竣,試行播用後,迭據各地收音報告,均稱聲響倍增,雜音大減.茲特將改善前後各一星期中之收音成績,另製一表,以資比較.兩週銜接,時令尙無若何變化,并將去年同月收音情形,一併列入用備參攷.此外新新公司來書,據稱彼處收受中央播音,有時與該處本地開洛公司所播,同其聲響云.

此次從事改善,幸有一得.惟最感困難者,爲選購材料,難得相當之件.實因我國各經理行廠,概趨於短波發報機所需用之一途,致中波機應行添配之材料零件,絕少存貨,尤以電力較大之固量變量容電器爲最不易得.羅掘幾逼,尙難滿意.中央台本擬改天線與末級絞連方式爲感應絞連,Inductive Conpling 亦坐是不能實現.因是所得結果,仍未能達十分完滿之境.尙望鴻碩專家,時頒榘矱,是所至幸.

各省市縣黨部收音情形調查表

黨部	收音機種類	距京里數約計	收音情形 白晝 機件未改善前	收音情形 白晝 機件已改善後	收音情形 夜間 機件未改善前	收音情形 夜間 機件已改善後	附錄 去歲九月收音情形 白晝	附錄 去歲九月收音情形 夜間
南京	三號機		清響	清響	清響	清響		
江蘇	三號機	120	清晰	清響	未收音	未收音		
浙江	十六號機	410	尙明晰	清響	天電電報夾雜難聽	無電報夾雜極清晰		
安徽	滬廠式機	465	清晰	清響	音響惟時高時低及電報夾雜不能完全聽清	清響間有電報	清晰	音響時有電報夾雜
銅山	十六號機	500	清晰	清響	有天電及雜聲不甚清晰	清響		
九江	滬廠式機	675	清晰		尙有天電不甚清晰			
青島	滬廠式機	850	無電報雜清晰	無電報夾雜清響	不甚清晰	清響		
湖北	十六號機	890	清晰略微	明晰	尙可聞悉	洪大明晰間有電報	音微	清晰間有電報
漢口	十六號機	900	音微且有電報	音明晰略微而電報夾雜甚烈	雜報夾雜略可聞悉	洪大清晰間有電報	不能聽	可聽電報夾雜甚烈
江西	十六號機 滬廠式機	920		清晰		洪大清晰	音稍微可聽	清晰而有雜音
河南	十六號機	970	音大	音甚大	有天電及雜聲尙難記錄	雖有天電夾雜可記十之七八	明晰	音響間有電報夾雜
山東	十六號機	980	音微不清	音低稍清時有強烈電報	音高清晰	音高極晰可以全錄		
鄭州	十六號機	1150	可聽	清晰可聽	有電報天電夾雜尙可聞	音洪大惟有大電電報夾雜		
福建	德九號機	1200		音微電報雜擾難聞		音較大但天電夾擾勁強可聽		
湖南	十六號機	1340	音微	音微尙難聽	清楚	極清晰	不能聞	清晰
天津	德九號機	1500	音微	音略微且電報夾雜甚烈	尙明晰可聽	洪大明晰		津播音台夾雜難以聆悉

說明：(一)凡去年九月收音情形空白各黨部,其收音員均係今年派去.

(二)收音情形項下有空白者,適收音員有更動,未能比較.

(三)收音機種類,三號機係 Pierce Aero, 十六號機係 R.C.A. 16, 滬廠式機係 Chigoia, 德九號機係 Telefunken 9.

廣州市自來水水量水力水質及最近整理計劃之研究

著者: 陳良士

自來水有三大要素,曰水量,水力,水質.水量要充,水力要猛,水質要潔,三者備矣,始不辜負市民之望.今者廣州市自來水,每爲市民所譏,謂爲不足不猛不清,間常考之各區用戶,亦屬實事.其果因何而致,及其不充不猛不潔之程度,頗足研究,茲詳爲剖析如下.

(一) 水量

光緒三十二年,水廠成立,廠內不過有雙筩抽水機三副,開用者祗兩副,一副留爲預備,所供用戶,不過六千餘.計是時出水以平均開用兩雙筩機,每機每分鐘來復四十五次算,一晝夜出水五百一十六萬加倫,其時固不聞有水荒之事也.入民國後,用戶稍增,循至常川開用雙筩機三副,共出水七百七十四萬加倫.民國八九年間,用戶大增,水量頓形不足.民國十一年乃添設螺旋機一副,該機速度三千轉時,能一晝夜出水七百六十四萬加倫,合計是時可出水一千五百三十四萬加倫,直至本年仍無變更,但水量已時露不敷之象.民十三年起,每日門閉西關水掣三句鐘.民十六年水荒更甚,乃有現時開門西關水掣之辦法.循至本年,再增加雙桶機一付,每日應可出水一千七百九十二萬加倫.惟因蒸汽不敷,螺旋機不能常走三千轉,故現時每日祇能出水一千六百至一千七百萬加倫.以上各出水量數目係由約略試驗得來,因無水量表,確否不得而知.但照水力學計算由水廠清水池水平,至水塔底水平,相距約一百三十尺,而現時水廠水力錶,則週旋於二百尺之間,則耗於該廿四寸水管阻力者爲七十尺,卽阻力每千尺約七尺,(廿四寸水管總長約一

萬尺）以此阻力及廿四寸舊管合算出水量,則得出水量約一千萬加倫.以之與試驗之數比較,少去六百餘萬加倫,兩數相差如此之鉅,孰爲可靠,因無量水表切實證明,未敢臆斷,但仍以照原理計算之數爲近度.蓋如確有一千六七百萬加倫,比之用水量有過之無不及,則何有歷年水荒,其爲一千萬加倫也,庶乎近之.今試就用水量申明之.

廣州全市食水用戶,最初不過六千餘.其後逐漸增加,迄今已達三萬餘戶.以每戶平均五至八人,每人每日用水平均四擔,合三十加倫左右,則每日共用水四百五十萬至七百二十萬加倫.連公共及工廠用水,最高量約爲八百萬加倫.水廠能出水一千萬加倫,而最高用水,不過八百萬加倫,仍餘二百萬加倫以上,似不爲不足也.但水塔仍常時告乏,不特涓滴無存,抑且不敷灌注,則其故何在?此無他,滲漏與虛耗甚多耳.蓋前此自來水旣告不敷,限時開水,市民因水來之不時,故每將龍頭大啓,以待其至,若或深夜水到,遂聽其流溢,其耗水一也.自來水用戶中,鏢戶不過五千,月戶有二萬餘,月戶出費有定,可以無限制用水,故一瓢已足,動用多盤,其耗水二也.用水月戶旣有一定水費,常以一戶而接濟多家,接濟外人,不啻一戶化爲數戶用水,其耗水三也.自來水大小水管,埋地日久,未嘗更換,滲漏頻聞,修理不及,其耗水四也.有此四者,故雖每日出水超過用水二百餘萬加倫,亦無怪其不能補所消耗矣.但考之外國城市,大凡市民用水,合公共用水,平均約佔全部出水十之七至十之八五,有十之一五至十之三係滲漏亡去者.今本市滲漏之數,如以二百萬加倫計,則不過十之二,與普通外國城市等,非滲漏特別加鉅也.然則今日出水量果不充歟?以現時每日出水一千萬加倫,而水塔不存水,則謂之爲不足也可矣.

（二）水　力

在水力方面,由水廠至西關水塔一段,水力爲二百尺.除去水管阻力外,實

存水力約一百三十尺,恰足升入水塔底下.以現時用水量之巨,水到塔時,即轉行流入供水管,水塔并無存貯計算,則水力若干,卽爲塔底水平高度.此高度依照廣州水平標準,爲一百三十八尺,以此與市內各區水平及距離水塔之管長比較,便知各區水力是否充份.查廣州市各區水平,高低不一.就水平線劃分可將全市畫爲四區.(一)西關區.(二)老城中心區.(三)南關長堤區.(四)東關及東山區.

(一)西關區　該區居太平長庚路之西,水平平均爲二十二尺,爲廣州市最低下之區,曾受潮浸.惟以水力計,則異常充足,其原因有三:(甲)平均水平既屬二十二尺左右,以水力一百三十尺減之,得水力一百〇八尺,除水管阻力所失外,水力仍甚猛烈,卽約算最遠距離如泮塘等處,凡直駁大管者,均可上至二樓.(乙)水塔位置恰在該區中心,所接駁各處之水管,不患過長,卽阻力不患過大.(丙)該區爲繁盛地點,各街所設之水管,直徑甚大,每在四寸以上,故阻力較少.具此原因,該區向無水力不充之患.

(二)老城中心區　由大德大南路以北,爲該區範圍.水平自三十尺起,至最高處爲五十一尺,平均全區約四十尺,爲全市隆高之部份,尤以永漢北路財政廳旁昌興街廣大路爲最高.以水力計,在水平四十尺以下者,尙可達到二樓,四十尺以上,則祗可到樓下而止.其水力不甚充分,原因有三.(甲)平均水平,既在四十尺左右,以水力一百三十尺減之,祇得九十尺.在昌興街等處,高逾五十尺,水力尤慢.(乙)距離水塔甚遙,(由財政廳至西關水塔有二英里)水管過長,阻力較大.(丙)該區地方,繁旺稍亞於西關,且水管係陸續添設,祇幹管二枝,其餘多屬甚小之管,阻力較大,如用水量高時,水力卽有不充之虞.具此原因,該區水力,視地勢之高下,水管之長短大小,用水量之多寡而定.平日各戶,地下者不患無水,較高者或斷續其來,或完全不到亦有之.近二三年,因水量不充,較高者益感來源之短少.

(三)南關長堤區　由大南大德路,南至長堤,爲該區範圍.水平平均爲二

十五尺,爲全市高度適中之區.以水力計,雖地不甚高,而水力比西關一帶,似已較遜,其原因有二.(甲)距離水塔較遠,水管阻力加大.(乙)長堤一帶,舖戶高昂,用水亦多,其有四五樓者,水即不能到頂,卽到亦屬短時間之供給而已.全區水力,雖比西關略遜,但各戶除高如四五樓外,平日水力,尚無不足.

(四)東關及東山區　該區居老城東門以外,平均水平,東關約爲二十五尺.出東山則漸高至三十二尺.最高有至五十餘尺.以水力計,不問其水平高低,該區水量,不及老城,更不及西關.其原因有三.(甲)距離水塔極遙,由東山至水塔,可四英里,水管阻力之大,可以臆度.(乙)水管通東山者,祇四寸一條,管徑既小,且沾老城西關餘瀝,何能有充足水力.(丙)東山高地,有至五十餘尺者,以一百三十尺減之,不過剩七十餘尺,焉足以對抗長水管之阻力.具此原因,所以自民國十二年,水荒開始,該區水源,已漸缺乏.近二三年,則完全斷絕.蓋出水有限,用水日增,沾人餘瀝,自不能久也.(附各區水力不充範圍圖)

各區水力,既如上述,求水力達到高地,水量水力,均須設法加增.對於水量方面,因出水管過小,祇能每日出水一千萬加倫,無增加之可能,卽添設抽水機,亦於事無補.唯一辦法,除另設水廠外,惟有將此一千萬加倫,分別接濟,卽定時開水辦法.故自民十六年起,定期每日上午十時至三時,下午十時至十二時,爲關閉西關全區食水時間.當此時間,水量祇供老城東山綽有餘裕.兩三句鐘後,水塔卽可升至塔頂.而老城之較高處,在此時間,卽泊泊其來,惟東山之高樓,則因水管太長,阻力極大,水仍不能到達耳.至有多數市民,位居低地,而目下仍缺乏用水,及有甲街水多,而乙街水少者,此種情形,係由於水管銜接錯誤,駁水者不直駁幹管,而折駁枝管而致,固非水力之不足也.

(三)水　質

查水源爲增涉河,乃珠江支流之一.水質平日頗清,約濁度三至四十度,下雨則濁度或高至六七十不等.天旱濁度雖減,惟有機物大增,經日光蒸晒,乃

化爲水藻,停積砂面.使濾水困難,須洗滌一番,始能復舊.復以該河隨潮漲落,上下游之汚水,俱可隨時湧入,使有機物增加.政府復無保護河流之設備.上下游之排洩穢水入該河者,有染布廠米廠黑藥廠玻璃廠灰窰多處.而本廠洗砂汚水,亦還注於河,其不宜於水質實甚.水質既似不佳,前此自來水公司,又向無濁水之化驗,故水之性質,幾無從攷據.於是乃不得不向蓄水池抽取

廣州市自來水管理委員會水質化驗表

水別	抽取日期	抽取地點	物理試驗						化學試驗									細菌試驗		附記	斷定	殺菌效率		化驗師名	細菌師名	報告日期
			溫度	濁度	色	味	嗅	渣滓	分離錏	錏脭礬	氰弱礬	氰強礬	氯	需要養	不定硬質	固定硬質	定質	每立糎細菌羣數	最少水量桿菌數之發現有糎			百分數				
潔水標準			30°	0	0	0	0	0	.002	.01	.000	.100	2.5	.50			80	100	50							
廣州市自來水	六月十二日	用戶水管	28°	0	0	0	0	0	.02	.02	.000	.140	2.4	1.95	1°2	13°3	70	200	10	上水藻甚少水略濁沙池其時天多雨	此水尚可用	60	20	余子明	彭華利	六月廿五日
同	十月廿三日	水廠清水池	30°	0	0	0	0	0	.034	.046	.000	.014	2.0	.40	5°8	18°0	160	300	1½	沙隙易塞池上水藻甚厚雨水雖清但沙其時天久旱不	此水不潔	40	3	同	同	十月卅日
同	十月廿六日	同	28°	0	0	0	0	0	.018	.047	.000	.02	5.0	.50	11°0	18°0	160	170	>50	句鐘四磅後加用綠氣每	此水清潔	65	>100	同	同	十月卅日
同	十月廿六日	同	28°	0	0	0	0	0	.018	.047	.000	.02	4.5	.40	5°8	18°0	160	180	>50	句鐘三磅後加用綠氣每	同	64	>100	同	同	十月卅日
同	十一月廿九日	用戶水管	28°	0	0	0	0	0	.023	.053	.072	.03	5.0	.35	11°	23°6	35	100	50	久後三星期之句鐘一磅半加用綠氣每	同	80	100	同	同	十一月廿二日
廣州市濁水	十一月廿二日	水廠蓄水池	20°	29	0	0	0	有	.037	.065	.001	.026	4.0	.8	17°4	23°2	75	450	1/10	鐘以上已停蓄有七句未用綠氣此水并未經沙濾及	濁水			同	同	十一月廿二日

濁水,作臨時一度之試驗.試驗所得結果,(參觀附自來水化驗表)表示該經數句鐘停貯之濁水,其性質尚非惡劣,(其時天氣甚好)濁度不過纔廿八度,色味嗅均無.化學試驗,結果雖超過潔淨標準,但非過壞.惟細菌羣數極高,及胴桿菌數,少少水量,即已發現,可以證明有機物之衆多,上下游之沾汚甚大,生飲殊爲危險.然河水大抵如是,固不能比山泉之潔淨,用爲水源實不得已也.濁水性質,既如上述,吾人所最患者,爲細菌與胴桿菌之衆數.則清水之殺菌效率,斯爲吾人所應注意.查六月及十月之清水化驗報告,關於物理及化學結果,可稱及格.惟殺菌效率,仍似甚低,如細菌尚存二三百,胴桿菌且發現於二至十立糎.依照歐美標準,細菌應減至一百以下,胴桿菌應不發現於五十立糎,香港亦然.故其自來水,多可生飲.今廣州市之自來水,既在此標準之下,其不及外國實甚.所幸市民多沸水而飲,不致於發生虎列拉腸熱諸症.然當夏秋或亢旱之交,濁水質劣,殺菌效率愈低時,輒不免一場危險,實不容不謀改善者也.至市民之訾自來水爲不清,可斷其非指胴桿菌數之鉅而言.蓋普通市民,何能有此學識.其所謂爲不清者,乃因多年水管中,時有鐵之變質,隨水而出,爲狀黃濁,及有時水中定質微高,略帶有沉澱性之渣滓而已.

廣州市自來水不足不猛不清之情形,既如上述.其現時急待改善者,當爲水量之增加.水力之增強,與水質之改良,似無可諱.至其所以改善之法,自市政府收回管理後,即擬有治標治本兩項,今已次第實行.玆分別錄供,研究如下.

(一)治標方法——整理舊水廠

(甲)關於水量方面

添設雙桶螺旋機　自來水水量,既感不敷,當局遂有增設雙桶機螺旋機

(離心機)之譯.雙桶機由本廠自製,爲三連盤式二百四馬力之雙唧筒抽水機,與最初裝設之三副相同,亦能每日出水二百五十八萬加倫.故連此機出水計算,現時號稱出水一千六至七百萬加倫.但根據上述水量一段,究竟水量增加與否,殊屬疑問,預備作爲替換修理之用則不爲無補耳.至螺旋機現仍在訂購中,形式亦與現有者一樣,其目的本亦爲增加水量計,但照上述原因,亦祇可備作替換用而已.

添設新汽爐一座 查現時汽爐共五座,俱水鍋式,三舊二新,每日五座幷用,可出蒸汽平均一百磅左右,以之供給雙桶機四副螺旋機一副,已感不敷,故三千轉之螺旋機,改走二千六至八百轉,爲增加水量起見,當局遂有添設新式水管式蒸汽爐一座之議.該機已向保庇洋行訂購妥當,現正建築爐廳,預備勘裝.據云該爐用煤一磅,可出蒸汽八十二磅,計每月可省煤價二萬餘元.查現時之三舊爐因命逾廿載,日就損壞,實不能不另闢新途,以爲補救.第水管式之爐,管理不易,修葺煩難,其能否省煤,未敢遽斷.至謂增此爐後,各機可以恢復額定速度,使水量增加,則不明原理之言也.

(乙) 關於水力方面

抽水不經水塔 查水量之不足,已不易籌謀,水力之不足,尤不易措手.蓋抽水機力,已將開盡,卽使加厚蒸汽開快各機,可得稍大之水力.然現時蒸汽有限,事實上旣屬未能.卽使以後新蒸汽機完成,可得較高蒸汽,但各機速度有定,若任意增加,徒使抽水機能率減低,易於損壞,及使所增之水力,耗於水管及各項阻力中而已.至水塔方面,該塔建築已久,無從更變,况爲上灌下注之雙管制,水愈少則水力愈慢.整理之法,惟有開放橫掣,使水直接用戶,不經水塔,如有餘水,始上塔儲存,以得回水的速度力,彌補些微,此法似尙可行,現正在試用中也.

更換水管 水力由於管過小,及銜接不當者,乃人事所造成,非水力之不足,故整理之法,尙易實施.現時乘工務局改築馬路之便,當局已次第更換小

管,整頓亂管加裝大管.水力因此而恢復者,比比皆是.市民裝水,今亦漸悟前時裝設之誤焉.

(丙) 關於水質方面

添設殺菌機 據上列試驗成績,水質之不及格地方,既在細菌之繁多,則設法減殺此菌,確爲切要之圖,於是本年乃有殺菌機之添設.該機於本年夏間運到,當即裝妥開用.惟所用氯氣份量,因出水數量,無從得知,殊難確定.且如所用過多,將恐氯氣太濃,發生氣味,貽市民以譏誚.故舉行試用,每句鐘用氯氣四磅三磅二磅半數種,結果四及三磅殺菌效率極佳,而用氯氣似略多,磅半已能殺胴桿菌至五十立糎外,故現時治用此數,水質方面,似可無慮矣.

(二) 治本方法——建設新水廠

上舊水廠所出之水力水量水質三項,除水質外,水力水量,均不及格,求根本之解決,惟有另闢途徑.况慢性沙濾,漸成過去,尤應追溯潮流,改求新法.故市府接管後,酌量財力,即有每日一千萬加倫之新水廠計劃,以爲補充.現時機件合同,皆已訂妥,并經開始建築,預料一年內,可以成功.其內容大概如下:

(甲) 小抽水機

在舊水廠之西南,有空地二十餘畝,地勢略高,半屬竹林,經由當局收用,爲新水廠地址.西南一角,設小抽水機三副,機房一座.水源爲現時蓄水池內之水,今擬由小抽水機,吸上濾水池內.該機爲電行直接螺旋(即離心)式,由英商怡和洋行承辦 Pulsome'er 公司製造,每副每日能抽水五百萬加倫,兩副常用,一副預備.電力由內燃機供給,該機價值一千四百五十鎊.

(乙) 急性濾水機

急性濾水機,包含石灰池,沉澱池,沙濾池,洗沙機等具.濁水由小抽水機分左右管送入沉澱池,同時與石灰池送出之石灰水混合.沉澱池左右各二十個,每個面積三百九十方尺.石灰混合濁水在沉澱池內上下流動,於是有機

無機物質,自隨石灰結團沉下.及至沙濾池,水漸澄清.沙濾池左右各八個,每個面積三百八十四尺.洗沙機設沙濾下,用機製壓氣,由砂下放氣,使水沙翻騰,自動洗滌.其省工省時,較舊法爲勝.水由砂濾下出.匯歸一清水坑,總流入其旁之清水池中.以上各項機件,亦統由怡和承辦, Paterson 公司製造,共值英金一萬八千五百鎊.

(丙) 清水池

清水池居濾水機旁,長二百尺,闊六十尺,高十五尺,容量爲二百萬加倫,由委員會自建.

(丁) 大抽水機及內燃機

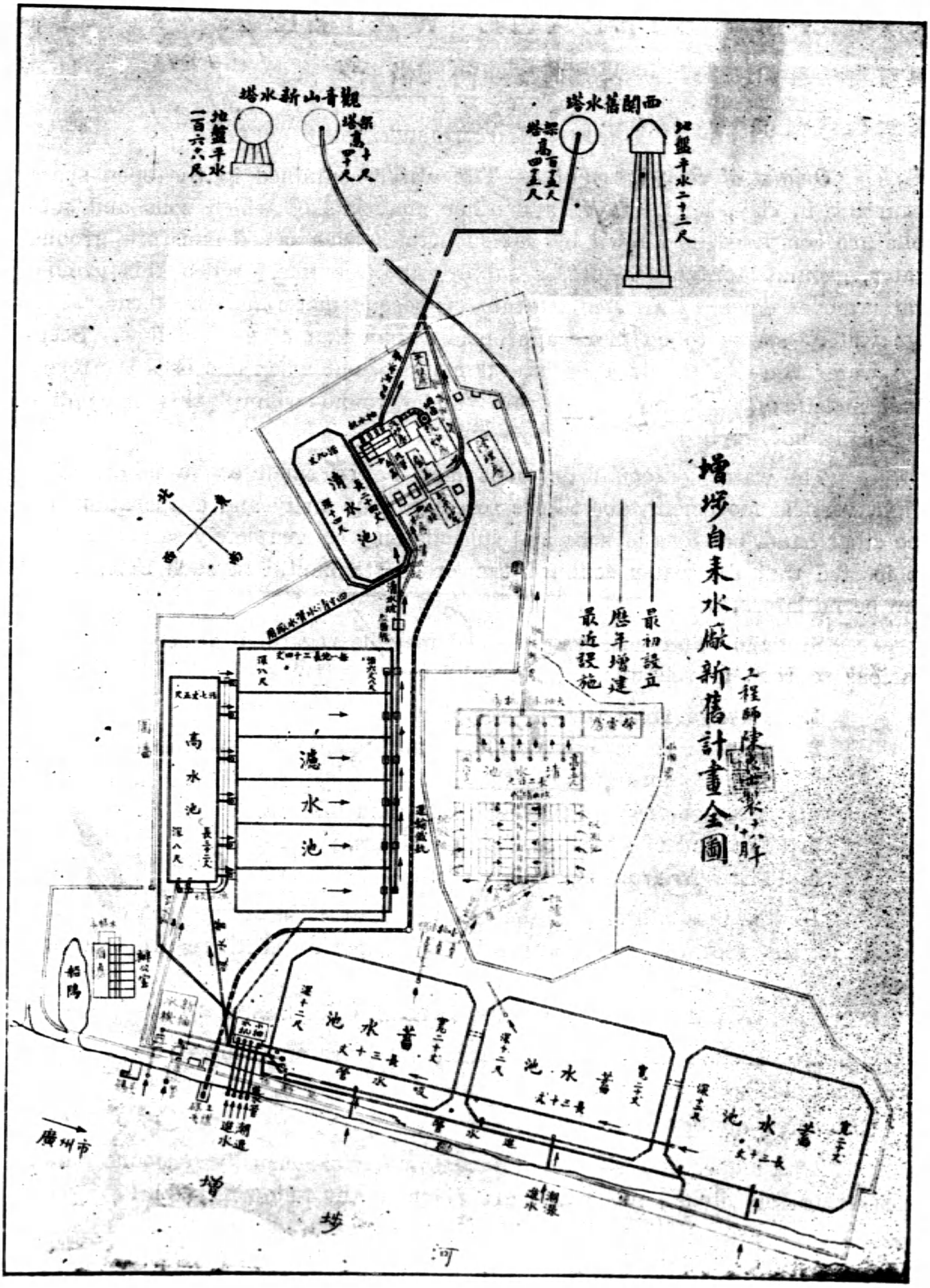
大抽水機共六副,爲電行高壓離心式,由德商禮和洋行承辦.每副每日能抽水二百五十萬加倫.電力由六副三相交流電動機供給.全座位置於清水池旁,機房由委員會自建,廣闊三十五與一百一十尺.內燃機共三副,爲狄佘氏柴油引擎式,亦由該商承辦.每副能常發六百匹馬力,以備供給電力於大小抽水機.以上各機,共值港幣二十三萬餘元.

(戊) 水管

水管定內直徑爲三十寸 鐵套管,由大抽水機起迄水塔止,共約一萬尺.受水力平時三百尺,最高六百尺,現在訂購中.

(己) 水塔

水塔定爲圓身直徑四十尺,容量二十餘萬加倫,鋼鐵板製造,架高十尺,上塔水管設一條,位於越秀公園舊炮台處.(水平爲一百六十八尺)并擬築亭台環繞之,以博美觀.


增埗自來水廠新舊計畫全圖
最初設立
歷年增建
最近設施
觀音山新水塔
西關舊水塔
清水池
高水池
濾水池
蓄水池
蓄水池
蓄水池
廣州市
增
埗
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SEEPAGE WATER

著者：曹瑞芝

CHAPTER I. INTRODUCTION

Origin of Seepage Water.—The water contained in the open space occurring in clay, sand, gravel, and other materials of which soils and subsoils are composed, is known by various names, such as soil moisture, ground water, ground storage, subsurface supply, and the like. When this ground water moves down an inclined stratum of porous materials, the term "seepage water" seems to be more appropriate than that of ground flow. Seepage water conveys the idea of lateral motions, but when one uses the terms "soil moisture," "ground water," or "underground water," this conception is usually not implied.

The water content in dry soils may be so small as to admit of a slight vertical movement, due to the forces of capillarity and evaporation. On the other hand, portions of soils and subsoils may be completely saturated, but so located that the water confined therein is stagnant. In such cases there can be no lateral flow.

Seepage water as herein defined may be regarded as coming from various sources, as follows:

1. Seepage from direct precipitation.
2. Seepage from irrigated lands and conveyance systems.
3. Seepage form reservoirs.
4. Seepage from mountain slopes and hillsides.
5. The underflow of creeks and rivers.
6. The flow from artesian wells.

In this thesis, however, the last two sources have not been discussed, owing to the fact that they are not very important with regard to irrigation. -

CHAPTER II. FACTORS INFLUENCING SEEPAGE

The factors which have a marked influence on seepage losses will be first discussed as follows:

1. Character of Materials. –

The names and sizes of different materials usually encountered in excavating for ditches and canals are given in the following table:

TABLE I. *Classification of Soil Particles*

Ordinary Designation	Size of Soil Grains (Mm.)	Size of Soil Grains (In.)
Fine Gravel	2 to 1	1/12 — 1/25
Coarse sand	1 „ 0.5	1/25 — 1/50
Medium sand	0.5 „ 0.25	1/50 — 1/100
Fine sand	0.25 „ 0.1	1/100 — 1/250
Very fine sand	0.1 „ 0.05	1/250 — 1/500
Silt	0.05 „ 0.005	1/500 — 1/5000
Clay	0.005 „ 0.0001	1/5000— 1/12500

As regards typical soils of the arid region in the United States about 16 per cent of their volume consists of clay, 36 per cent of silt, 19 per cent of very fine sand, and 18 per cent of fine sand. These four classes combined may thus be said to constitute about 89 per cent of such soils. Other conditions being closely equal, the larger the size of the earth grains, the greater the seepage loss. The most unfavorable condition as regards this loss occurs when the earth grains are not only large, but fairly uniform in size. It frequently happens, however, that open spaces in coarse material are so filled with smaller particles as to form a compact mass thru which little water passes. This is exemplified in a way by the results given in Table II.

TABLE II.

Effect of Various Treatments on the Volumes of soil
(In Terms of Cubic Yards)

Volumes of Original Materials							Volumes after Treatment			
Gravel	Coarse Sand	Medium Sand	Fine Sand	Black and Brown Earth	Clay	Total	Mixed but not tamped	Mixed and tamped	Mixed Moistened and Tamped	Poured into water & drained
1.00	0.25		0.25		0.50	2.00	1.63	1.38		1.40
0.75			0.50	0.38		1.63	1.31	1.09		1.16
1.00		0.50		0.25		1.75	1.44	1.22	1.14	1.25
0.63			0.37		0.38	1.38	1.17	0.94	0.91	
2.00		0.25			0.75	3.00	2.38	2.00	1.88	
0.75	0.25	0.13		0.50		1.63	1.25	1.11	1.03	
0.75		0.25		0.25		1.25	0.97	1.84	0.77	

2. Action of Capillarity and Gravity.—

Through the action of capillarity and gravity, water is withdrawn from earthen channels. The effects of capillarity can best be observed in the smaller watercourses of irrigated farms. The irrigator makes daily use of this force to moisten soil and to place the required amount of water within reach of the roots of the plants. He turns water into furrows for the express purpose of having it withdrawn by capillarity. Unlike the main canal, the furrow attains its highest efficiency when all the water is absorbed along its length. The distribubtion of water from furrows in the citrus orchards of southern California was investigated in 1905 by Doctor Loughridge of the University of California, and from the results obtained, Figure A and Figure B are introduced. Figure A shows in vertical section an outline of the four furrows between two rows of orange trees, the layer of dry soil mulch, and the moistened areas at stated periods of time after water had been turned into the furrows. Figure B shows the same features obtained in another orchard, where hardpan interfered with the downward movement of the water, but increased its lateral distribution. These somewhat typical cases show the effect of capillarity as well as gravity. By means of gravity, water flows in the furrow, but the gradual absorption of this water is largely due to capillarity. The combined action of these two forces is shown in the downward movement of water in Figure A. In porous soils, this downward movement is greatly increased without any corresponding increase in the lateral movement.

3. The Gradual Deposition of Silt.—

All streams used for irrigation carry more or less silt during periods of heavy runoff, while some streams are muddy throughout the year, either from surface erosion or as the result of mining operations. In transporting silt-laden water through a canal of low or medium velocity, the heavy particles are deposited on the bottom and sides. This forms a natural lining which is often quite effective in presenting seepage. Such gradual deposition of silt accounts for the fact that a new canal loses much more water than the same canal after it has been in operation for several years. A case in point is that of a canal in Imperial Valley, California, where, in 1904, the seepage losses per mile were 20% of the flow. The same portion of the canal was again tested in 1910, and the loss was found to be only 3% per mile.

4. Depth of Water in the Canal.—

The depth of water is not likely to have much influence on the loss in canal per hour. In running water through a dry earth channel, the loss by absorption under a depth of 6 inches is likely to be nearly as large as under a depth of 6 feet, provided the wetted area is not increased. Again, when the water which escapes from a canal in use takes the form of capillary moisture in the soil, it is doubtful if the pressure due to the head of water in the canal increases the loss to any considerable extent. The manner in which canals are built and coated with sediment likewise tends to nullify the effect of the depth of water. The bottom of any canal of fair size is fairly well compacted and puddled by the passage of ceams and wheeled scrapers of various kinds during the last stages of construction.

The effect of depth of water is evident where the canal traverses broken rocks, coarse gravel, or any other porous material. It is also evident when the material through which water escapes from a canal is saturated or contains gravitational moisture. The speed and ease by which pressure can be transmitted through water are well known, and when the pressure due to depth of water can be transmitted directly through this same medium, even though the columns may be extreemly small and irregular, the action serves to provide a supply for capillary distribution in comparatively dry soil and in this way increases the seepage loss.

However, the effect of depth on seepage loss in canals, where the seepage water percolates only through a small depth of soil, is indicated by the results of experiments made by the Irrigation Investigations of the United States Department of Agriculture. Tanks were filled with 3 feet depth of ordinary clay loam soil, held by a mesh screen at the bottom; a constant depth of water was maintained on the surface of the soil, and the seepage water was caught and measured. The following results were obtained:

Rate of Percolation Through a Soil Depth of 3 Feet

Depth of Water in Inches	Depth of Water Lost per 24 Hours, in Inches	Ratio of Loss to Sq. Root of Depeth
36	11.75	1.96
30	10.58	1.94
24	9.07	1.85
18	8.10	1.91
12	7.00	2.02
6	6.21	2.53

Excepting the values obtained for the smaller depth of 6 inches, the last column seems to indicate that for these special conditions, the seepage loss might be proportional to the square root of the depth.

Ingham's formula, which is

$$P = C\sqrt{d}\,\frac{W\ L}{1{,}000{,}000}$$

also shows that the seepage loss is proportional to the square root of the depth. But the general factors involved preclude the use of any such simple relation for general application.

5. *Relative Extent of the Wetted Area.—*

It is well understood that, other conditions being equal, the greater the wetted perimeter, the greater will be the seepage due to the larger area through which water may pass. This accounts in part, at least, for the fact that the seepage loss from the smaller channels is relatively greater than that from the larger channels. Comparing two extreme cases, the wet area of a channel carrying 1 sec.-ft. is approximately 2.2 sq. ft. per lin. ft., while that of a channel carrying 3,000 sec.-ft. is approximately 156 sq.ft. per ft.

6. *Velocity of Flow in the Canal.—*

The effect of velocity in lessening losses due to seepage may be observed in the canals which divert water from many of the creeks of the Rocky Mountain region. Those natural water courses, as well as the canals leading from them, flow down steep grades, and, considering the porous character of the beds, the seepage losses are not so great as one would expect to find them. The Venturi meter may be mentioned as an extreme case of the effect of velocity. Under high velocities, no water escapes through the opening in the throat of the meter.

Both the foregoing are, however, exceptional cases, and the influences exerted by velocity should be *confined*, not only to typical canals, but also to practical considerations of such canals. From this viewpoint, the influence of velocity is relatively small. This is chiefly due to the fact that sediment cannot be deposited when the mean velocity exceeds a rather low limit. Of the two factors, sedimentation and velocity, the former exerts the greater influence in lessening seepage losses, so that any increase in velocity which tends to prevent sedimentation is determinable rather than beneficial.

7. Inflow of Seepage Water.—

During the first stages of irrigation development in the United States the lands bordering the streams were, for obvious reasons, the first to be watered. In the course of time, lands farther removed from the source of supply and at higher elevations were provided with water. Thus it has come about that two or more canals are frequently located at the same bench at different elevations and at varying distances apart. The water derived from the surface runoff and seepage from irrigated fields often finds its way to the next lower canal, and this in turn may similarly affect still lower canals. Even under normal conditions, there is apt to be no fixed regimen as regards seepage, but in the cases just mentioned, very wide variations are the rule.

8. Temperature of the Soil and Water.—

Water flows more readily in an unobstructed channel when warm. The influence of temperature, is, however, marked when the water is forced to pass through the particles of fine soil. In experiments conducted in the Puhjab, India, it was found that the rate of absorption in the three hottest months was more than double the rate in the three coldest months.

A similar effect was observed in the flow of water from the horizontal galleries placed in the bed of Cherry Creek, Colorado. In 1886, the Denver Water Company undertook to tap the underflow of Cherry Creek 15 feet below the surface and convey the water for domestic purposes 8 miles to Denver. After the plant was completed and in operation, it was found that the flow as measured over a weir varied greatly with the seasons, and that the flow of the creek seemed to have little effect upon the quantity of water which entered the galleries 15 feet below. The conclusion was finally reached that temperature was the controlling cause of variation in the underflow. No records of the temperature of the fine sand in the bed of Cherry Creek were available, but the temperature of the air in the shade at Denver were taken instead. Figure 1 shows the temperature and discharge records from March, 1888 to August. 1891, inclusive.

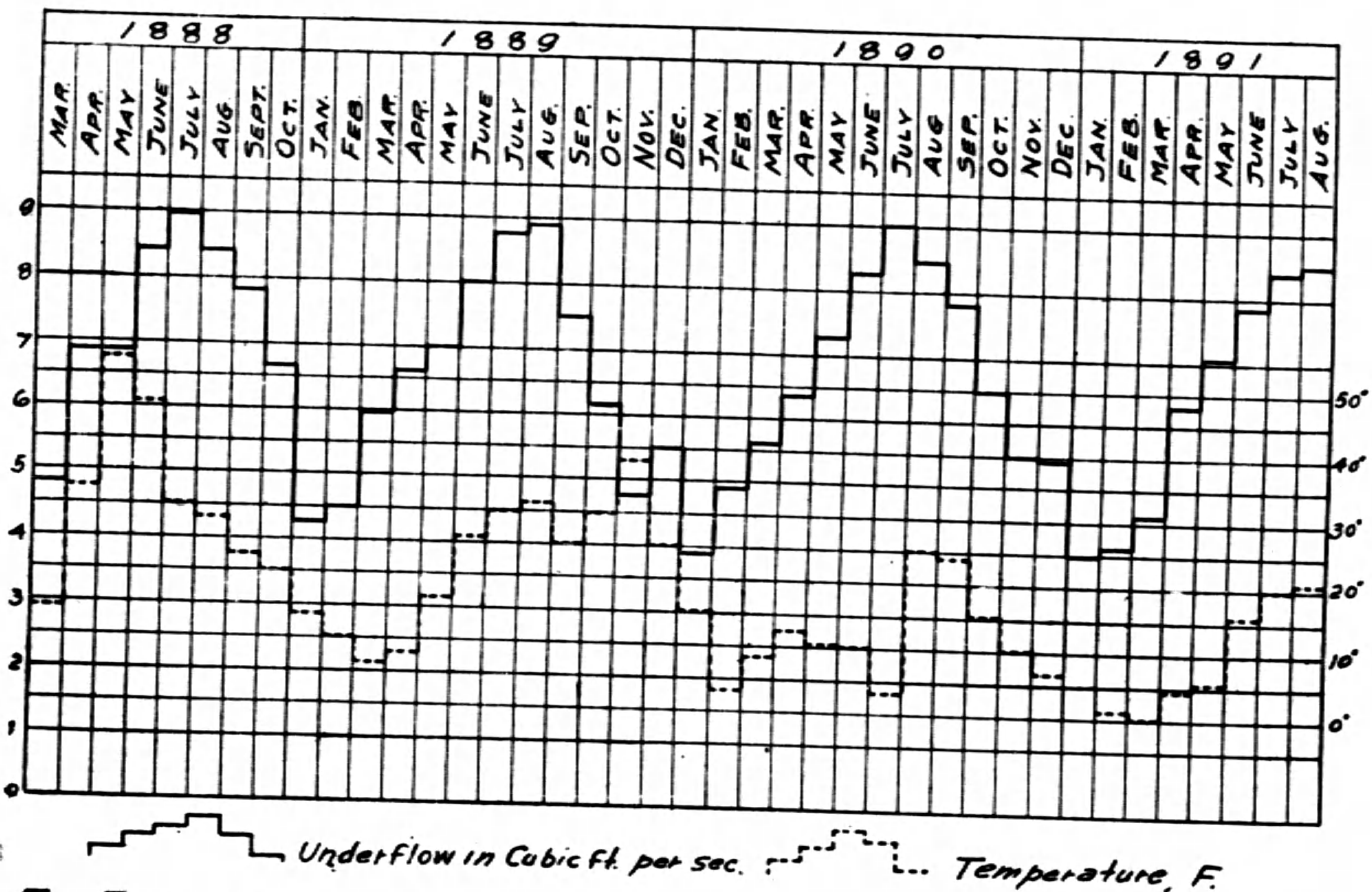


Fig. I RELATION BETWEEN AIR TEMPERATURE AND CHERRY CREEK UNDERFLOW

9. Location of the Water Table.—

The passage of water through saturated soils is quite different from that through soils containing only capillary and hygroscopic moisture. The same laws cannot be applied to both in the say way, since the two sets of conditions differ. For this reason the location and extent of saturated material, if any exists along the route of a canal, demand careful consideration.

10. Steepness of Slope.—

Closely related to the foregoing is that of the steepness of the slope at right angles to the general direction of the canal. Considering only the force of gravity, such a transverse slope is an important factor in the movement of water through earth.

Then there is the loss of water due to evaporation from wet banks and to transpiration from trees or rank vegetation which line the ditch bank. The presence of hardpan in the soil and of moss or other aquatic vegetation in the canal is another factor which might be considered if space permitted.

CHAPTER III. SEEPAGE FROM DIRECT PRECIPITATION

As stated in the first chapter, seepage water has various sources. The first one is from direct precipitation, which will be discussed in the following.

The amount of seepage from precipitation is governed by three factors:

1. Topography
2. Character of soil and crops
3. Amount and character of precipitation

In the arid regions, there is comparatively little loss from this source. During snowfall, percolation is deferred until snow melting occurs and the frost is out of the ground.

The following formula may be used to give approximate results for monthly values of precipitation more than 1 inch; for values less than 1 inch, it may safely be assumed that there will be no loss.

$P_v = \frac{1}{10}(R-1)\ N,$

P_v=seepage from precipitation in inches per month

R=monthly precipitation in inches

N is a factor having the following values:

For level or gently rolling of sand loam 1.0

for steeper slops of clay soil 0.7

For very sandy or gravelly lands 1.5

CHAPTER IV. SEEPAGE FROM IRRIGATED LANDS AND CONVEYANCE SYSTEMS IN ARID REGIONS

The second source of seepage water to be considered will be that from irrigated lands and conveyance systems.

The amount of natural seepage or seepage from direct precipitation in the arid regions, when compared with seepage from irrigated fields and canals, is so small that it may be neglected.

It cannot usually be determined whether seepage water may come from conveyance systems or irrigated lands above. The discussion that follows relates to these waters, irrespective of their source.

1. Gradual Accumulation of Seepage Water.—

For years after the arid portion of American began to be cultivated, little attention was paid to seepage water. The low lands, being more cheaply reached by water, were the first to be irrigated, and the chief effect of the surplus water supplied was to raise the ground water. As the cultivated lands are increased and men began to build large high-line canals to cover elevated bench lands, a change was soon apparent in the physical condition of soil and subsoil. Fields that formerly required to be irrigated were found to be sufficiently damp to produce abundant crops without any artificial watering, while other low lands were converted into swamps and morasses,—fruitful sources of malarial disease,—and rendered worthless for agricultural purposes.

There are in Ogden Valley more than twenty ditches or canals, and these were accurately measured twice during the period from July 6 to September 10, 1894. The results are shown in Figure II.

The dotted curve represents the daily volumes flowing into the valley; the solid curve shows the quantities of water daily flowing from the valley; while all below the heavy dark line, which is dotted in places, indicates approximately the amount of water which was diverted and applied to the land. Where the amount of irrigation water is not accurately known, a dotted line is used.

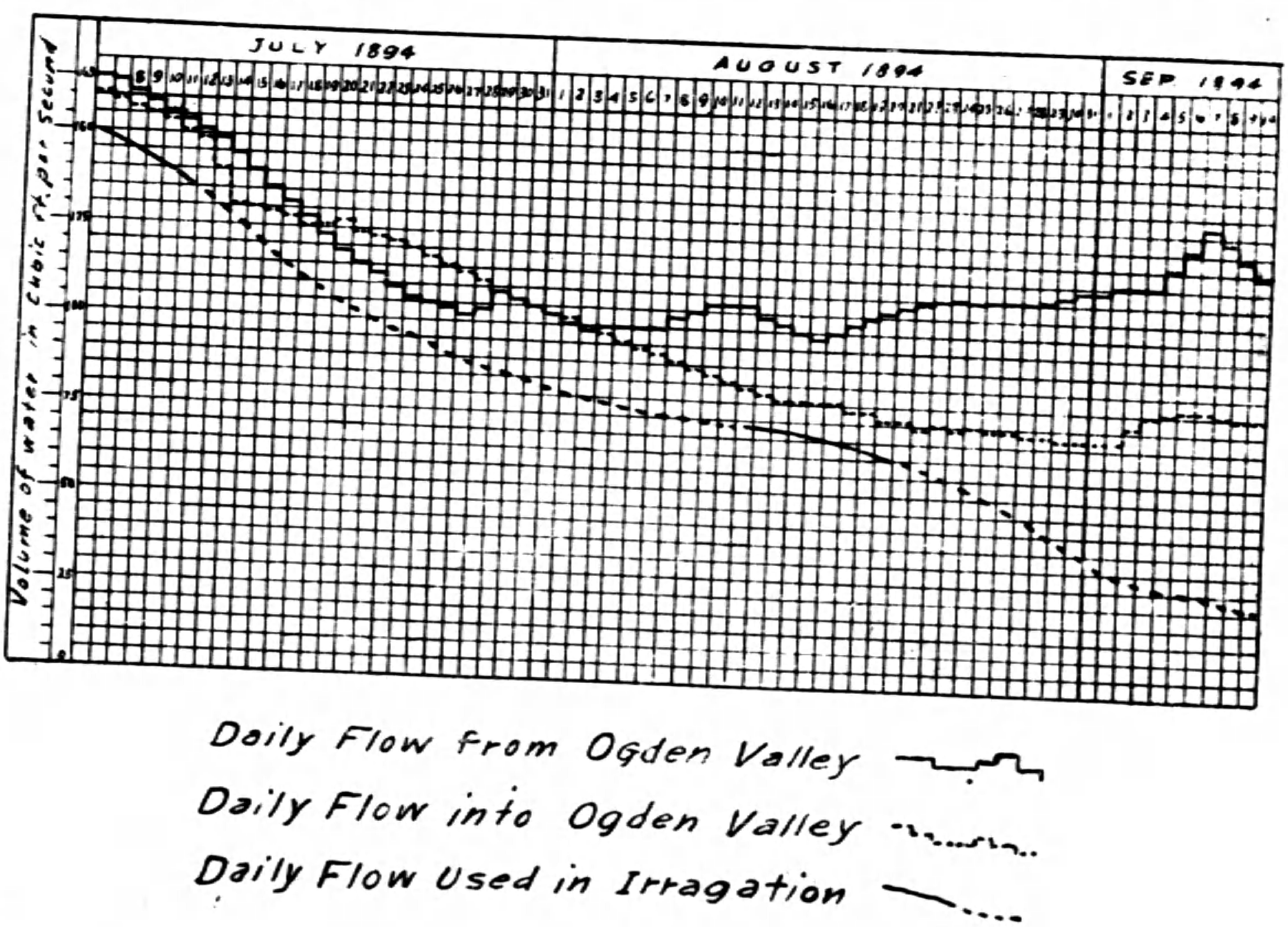


Fig. II. THE EFFECTS OF SEEPAGE WATER

2. Relation between Seepage and Areas Irrigated.—

There is a relation between the areas irrigated and the amount of seepage. However, we cannot expect to find the relation a very close one, even had we the means to know the total area or the total amount of water applied with accuracy, as there are many interfering conditions.

A portion of the water applied raises the water table. The land newly irrigated gives no material return for several years, as most of the excess of water applied fills the subsoil. If the land is some distance from the river, the element of time also enters. There are sometimes many seepage ditches constructed for the purpose of taking the seepage water before it reaches the river, and again applying it to the land. The relation between the seepage and the area irrigated will be obscured by the causes of this kind. The return for any one year is not from the water applied in that or in any other one year. It is rather the result of the applications of several different years at different distances. Hence, while the amount varies from year to year, variations from one year to another is less necessary to take into account as the strip irrigated becomes of greater width.

In 1894, there were 116,000 acres of land irrigated in Poudre valley, from which a return of 104½ cubic feet per sec. on the average, or one cubic foot per second from each 1,100 acres irrigated, occurred. In 1895, it amounted to one cubic foot per second to every 700 acres. In the case of the Platte, one cubic foot per second returns from still fewer acres.

3. Relation between Seepage and Amount of Water Applied.—

The seepage cannot be expected to be very closely proportional to the area irrigated, where the drainage of land enters each of the lateral channels and finally reaches the river, or not until after a series of years. The seepage is slow, and there is reason to think that from some of the outer ditches has not yet reached the river. The construction of seepage ditches, to drain the seepage water from waterlogged land, or to catch the seepage water, also interferes with the normal distribution. They collect and carry the water sometimes a number of miles from where it appears. The effect of the seepage ditches is to increase the apparent seepage near the lower end of the stream. The amount of water lost from canals is much more than from an equal area of irrigated land. An area of one acre forming part of a canal channel loses as much water as 200 to 400 acres of land under ordinary irrigation. The losses near the heads of the canals, especially those near the mountains, are greater than the average. An estimate of the number of acres of canals would be desirable before the study can be completely satisfactory.

The amount of water which is applied is affected by the stage of water in the river. When the river is high, the canals are full, water is unstinted. If low, the amount used is decreased. In this case, the ditches of later construction are the first to suffer. The development of storage reservoirs has increased the amount applied. (In 1894, there was an inflow reaching the Poudre of 104 cubic feet per second, from an application of 250,000 acre feet, or a constant flow of one cubic foot per second from each 2,400 acre-feet applied).

Table III shows the amount of increase in different parts of the Cache a la Poudreand the area of irrigated land which drains into the same section. In the third column is given the amount of water applied to that portion of the valley whose natural drainage is into the river between the points indicated in the first column. In the fourth column is given the per cent of the total amount applied to the whole valley. In the column headed "Computed Inflow," is given the amount of inflow there would be if the inflow were in exact proportion to the amount of water applied. How much land will furnish underflow to a given part of the river cannot be very closely told, even with detailed knowledge of the topography and the location of the farms where water is applied, but this table is close enough to show the relation between the areas and the amount of water applied.

TABLE III

Amount of increase in different parts of the Cache a La Pondre

	Distance in Miles	Water Applied		Average Inflow From Seepage			
		Acrefeet	% of Total	No. Yrs. Obser-vat'n	Ob-served	Com-puted	Ob-served gain per mile
Canon to L. & W. Canal	7.25	18,400	7	9	15	8	2
L. & W. to No. 2 canal	10.10	51,800	21	9	21	21.6	2
No. 2 to Eaton canal	3.0	37,000	15				
Eaton to No. 3	9.0	30,300	12				
No. 3 to Pump House Greeley	3.0	46,700	18				
No. 2 to Pump House Greeley	15.0	114,000	45	7	28 6	48	2
Pump House to Ogilvy Ditch	2.5	23,000	9	8	19.2	10	8
No. 2 to Ogilvy Ditch	17.5	137,100	55	9	45.2	57	2.5
Ogilvy to mouth of Poudre	4.0	42,700	17	8	23.8	18	6
Beyond mouth of Poudre		38,000					

4. Drainage Problem Influenced by Seepage.—

On nearly every irrigation project, there will be found large and frequently increasing areas subject to the rise of ground water. The principal contributing influence in most cases is the seepage losses from the lateral systems, although a portion, of course, is due to over-irrigation of the fields.

On the Sunnyside Project in Washington, some four or five thousand acres of the best land was seriously affected when the United States purchased the system a few years ago, large areas having been practically forced out of cultivation. In this case, the United States was compelled to build a deep channel, at a cost of some $340,000, mainly for the purpose of affording an outlet to the surplus water. On the Minidoka Project in Idaho, the drainage feature is one of the most serious problems.

At Umatilla, the seepage water accumulating below the project in the Umatilla River has increased the summer flow some 100 sec.-ft., and has rendered necessary the excavation of extensive drainage ditches through the lower lands.

There is no question that much relief from this increasing danger will be experienced by eliminating from the ground water accumulations the bulk of the canal seepage. It is my belief that as time goes on, it may even be found necessary for legislatures to require canal systems to be lined or otherwise protected from seepage loss, not only in the interests of the investor and water user, but as a reasonable measure of conservation when supplies are limited.

5. Utilization of Seepage.—

Seepage water can be utilized to irrigate lower lands by pumping. An example is given in the follwing. The Bonneville Irrigation District built works in Davis County, Utah to supply water to 4,860 acres. The water is derived from the Jordan River just north of Salt Lake City, and consists of the return water from seepage and waste from lands higher up on the river, which would otherwise flow unused into Great Salt Lake. A pumping plant is installed to lift the water to two levels, 150 and 300 ft., respectively, above the source of supply. When another 5,000 acres are included in the district, the development cost is approximately $70 per acre, it is claimed, which is said to be much lower than that of gravity system in the vicinity.

The pumping station, located near a 44,000-volt transmission line, contains four pumping units, each direct connected to a 2,300-volt motor. The motors used on the 300-ft. head are rated at 1,200 h.p. and 700 h.p., respectively, while those on the 150 ft. head are 600 h.p. and 350 h.p., respectively. The pumps are all single-stage, double suction, centrifugals, having 20 in. and 15 in. discharges, delivering 25 and 15 sec.ft. respectively. The pumps on the 300 ft. lift are connected in series.

The operation, maintenance, depreciation, and amortization charges for the first twenty years are estimated at about $10 per acre-foot of water required, or an average of $23 per acre of land in the district.

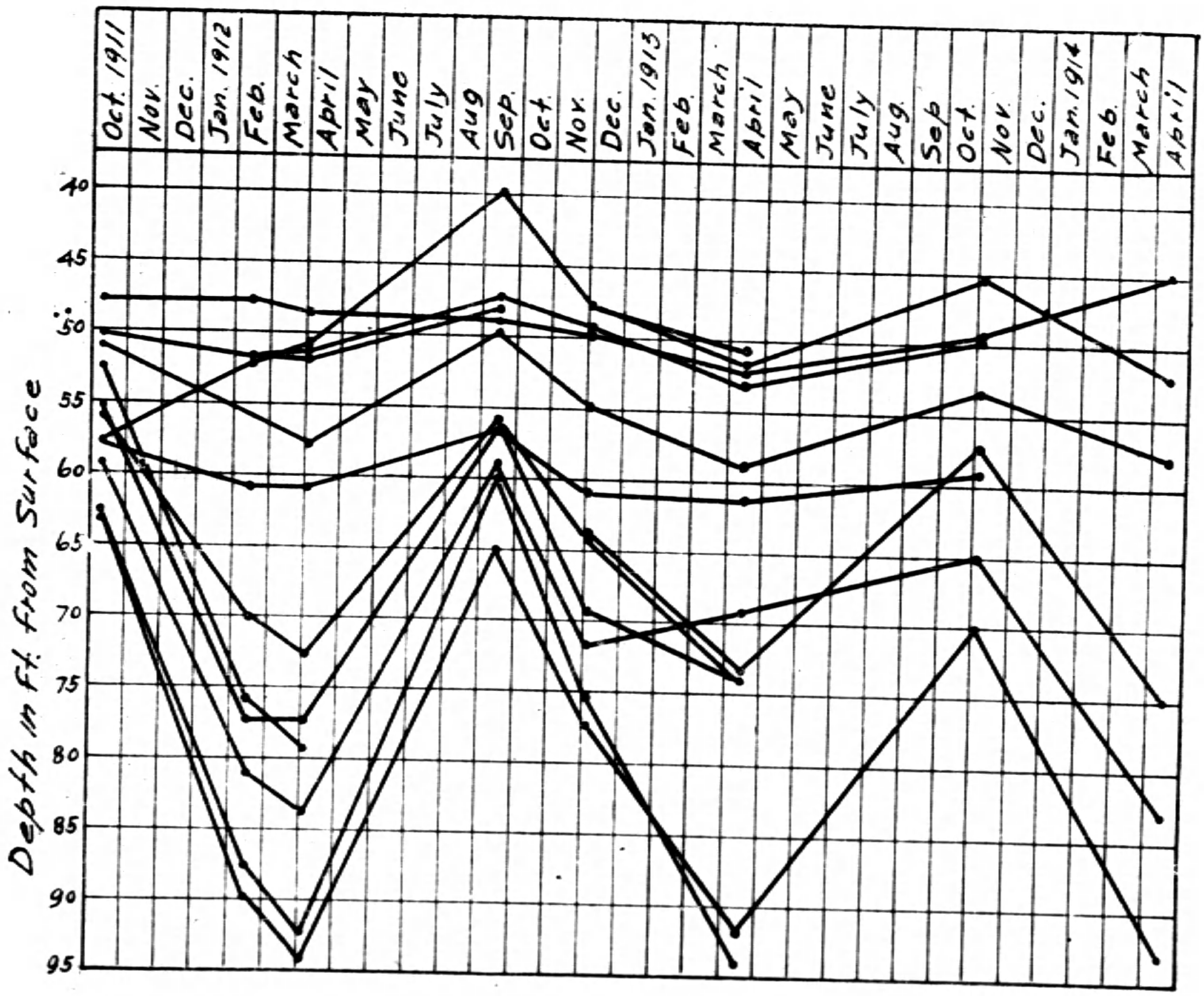


Fig. III VARIATION IN DEPTH TO WATER IN WELLS IN IDAHO

6. Deep Seepage Waste.—

Much of the water applied in excess of 1 or 2 ft. per acre in any region is lost through evaporation, surface waste, or deep seepage. With the more porous soils, the loss from deep seepage beyond the reach of the plant roots is the greatest source of waste from the fields, as well as the hardest one to overcome. That large losses are experienced from this source is proved by the fact that the ground water under almost all irrigation projects rises rapidly, the rise being either a seasonal or a permanent one. Where excellent underdrainage exists, the water level usually recedes during the winter or non-irrigation season, but drainage of some sort is ultimately found necessary in at least a portion of most projects. A typical case of annual rise of water caused by deep seepage from porous irrigated land, there being excellent underdrainage from the land in question, is shown by the accompanying curves, (Fig. III). These curves show the annual rise and fall of water in 13 wells in the vicinity of Rigby, Idaho, where there are 40,000 or 50,000 acres of porous irrigated land upon which large quantities of water are applied.

Chapter V. Seepage from Irrigation Canals

Since the quantity of water lost in canals is very large, and in some cases appears to equal and even exceed the quantity actually delivered to the lands, seepage waters from this source should be discussed separately in this chapter.

1. Conveyance Losses of Water.—

Of conveyance losses of water, Mr. E. A. Moritz has given useful information as follows:

The accompanying table (Table IV) shows that variation in percentage of losses from year to year must be expected. The U. S. Reclamation Service projects are nearly all in process of development, and conditions are continually changing, new canals and laterals are built, and large quantities of water carried perhaps through longer distances. Another factor that may have considerable effect is the cleaning of silt deposits from the canals. When an extensive job of this kind is done, the following season is very likely to show a considerable increase in the losses.

After a study of this table, Mr. Moritz concluded that it is fair to assume that 25 per cent is about the minimum loss that may safely be assumed under favorable conditions, and that 50 per cent is sufficiently high for a well-planned project under unfavorable conditions.

TABLE IV

Seepage Losses on Government Projects

In per cent of water used, average from 1912 to 1918.
See Reclamation Record," April 1921, p. 180-182.

Salt River		42.2	Sandy loam and clay
Yuma		27.1	Rich alluvium
Orland		25.8	Sandy loam, silt and gravelly loam
Uncompahgre		6.1	Red sandy gravel, adobe, and clay loam
Boise		36.7	Clay loam and lightysandy loam
Minidoka			
N. Side gravity		35.2	Sandy loam, clay loam, and volcanic ash
S. Side pumping		35.8	Ditto
Huntley	34.9	34.9	Clay and sandy loam
Milk River		41.8	Sandy loam, clay and gumbo
Sun River		37.1	Sandy loam, clay, adobe, and alluvium
Lower Yellowstone		46.9	Sandy loam and gumbo
North Platte		43.6	Sandy loam
Newlands		35.4	Sandy loam, clay and volcanic ash
Carlsbad		53.2	Pecos sandy loam; large lime content
Rio Grande		6.6	Rich alluvium
Umatilla		33.2	Sandy loam
Klamath		42.5	Disintegrated basalt, volcanic ash
Belle Fourche		32.3	Clay and sandy loam
Okanogan		29.6	Volcanic ash, sand, and gravel
Yakima, Sunnyside		26.9	Sandy loam and volcanic ash
Yakima, Tieton		24.8	Volcanic ash
Shoshone		37.1	Light sandy loam and clay loam

It is commonly accepted as a fact that the seepage losses from canals decrease as time goes on and the banks become more compact and the interstices become blinded with silt. The figures given in the table do not show such a tendency. However, this does not prove the absence of such tendency generally, because, as has been stated, the change in percentage of lost water from year to year is affected by new construction, variation in total quantity of water used, and maintenance work. But in some cases, the absence of a tendency for canals to become tighter with continued use is clearly indicated. The Sunnyside Project show that the average loss for the years 1912 to 1918, inclusive, is 0.2 per cent higher than the loss in 1912. The lcsses were little or not at all affected by the factors above mentioned.

From a large number of experiments conducted by the Department of Agriculture, the following results forcefully indicate the effect of the capacity of the canal upon the loss due to seepage. As these investigations covered a wide range of conditions, the figures may be assumed to be fairly representative:

TABLE V.

Effect of Capauty of Canal upon Loss Due to Seepage

Conditions	Percent loss per mile
Canals carrying 100 sec.-ft. or more	0.95
Canals carrying 50-100 sec.-ft.	2.58
Canals carrying 25-50 sec.-ft.	4.21
Canals carrying less than 25 sec.-ft.	11.28

Compiling the results of observations on several hundred miles of canals in eight different projects of the U. S. Reclamation Service, Mr. E. A. Moritz has prepared a list of average values for losses in unlined canals, constructed in variuos types of soil. The data agree closely with the results indicated in the foregoing table.

TABLE VI

List of Average Values for Losses in Unlined Canals

Kind of Material	Loss in Cubic Feet per Sq. Ft. of wetted area per day
Cement, gravel and harden with sandy loam	0.34
Clay and Clay Loam	0.41
Sandy loam	0.66
Volcanic ash	0.68
Volcanic ash with some sand	0.98
Sand and volcanic ash or clay	1.20
Sand soil with some rack	1.68
Sandy and gravelly soil	2.20

In designing a canal, it is probably unsafe to figure on a smaller loss than 0.5 ft. over the wetted area in 24 hours in even the most impervious material, and after a loss of over 2 to 2.5 ft. is reached, the question of lining the canals will generally require very serious consideration from the point of view of value of water and damage to adjoining lands from waterlogging. The limits within which seepage loss should be considered may, therefore, be generally defined as 0.5 feet and 2.5 feet per day over the wetted area of canal, for the minimum and maximum respectively.

2. *Seepage and Evaporation Losses in Canals of Various Soils.*—

Seepage and evaporation losses in concrete-lined sections and in earth sections of various general soil types are available, covering the series of irrigating seasons extending from 1911 to 1920. These losses are in terms of depth in feet per 24 hours over wetted perimeter, and are graphically represented by Figure 4. The maximum loss of 2.79 ft. occurs in the sand and gravelly earth section, which, by means of concrete lining, may be reduced to a loss as low as 0.28 feet.

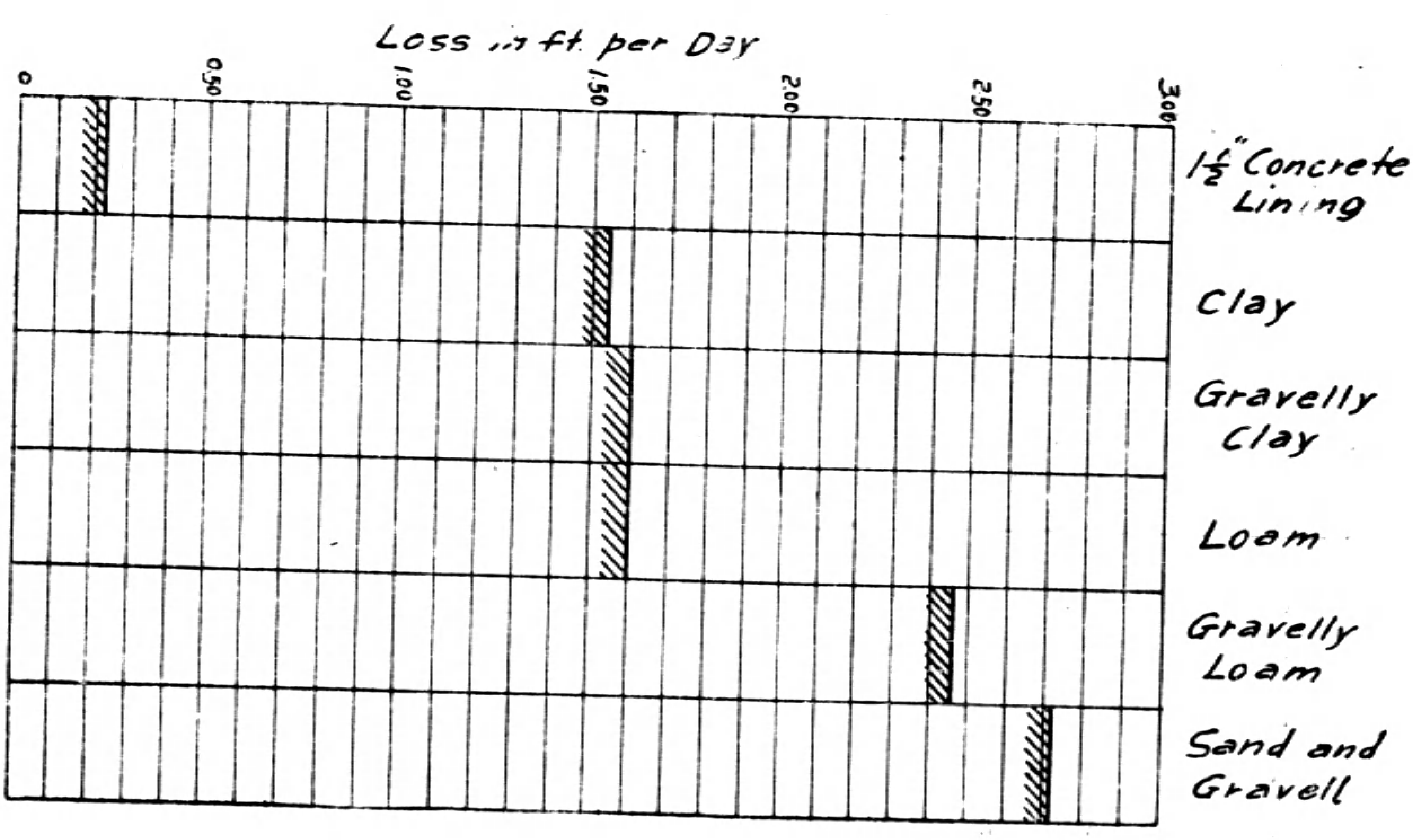


Fig. IV SEEPAGE AND EVAPERATION LOSSES FROM CANAL

3. Methods of Stopping Seepage.—

Conveyance losses, in addition to the value of the last water, frequently constitute a serious menace to adjacent lands and frequently to land some distance away. In the latter case, drainage ditches must be built which will be likely to remedy the situation, but in the former drainage is apt to prove ineffective. In that case, the only remedy is to stop the seepage from the canal. The two most common methods of doing this are: lining with concrete and puddling with silt. Concrete lining is very expensive, and on this account should be resorted to only after all other means have failed, especially if concrete materials are not readily available. Moreover, concrete lining does not have an indefinite life, and is subject to injury from various causes, principally frost and alkali action, whereas earth puddling is permanent so far as its physical stability is concerned.

Each individual case must, of course, be considered in the light of all the local controlling factors, but the point it is desired to emphasize is that concrete lining is not the best remedy for all seepage ills. It has not even been demonstrated that it reduces the losses to a minimum. Table II gives three classes of material, namely, clay, clay loam, and gumbo and sand loam, that show an average loss as low as or lower than concrete lining. The permanency of concrete lining depends much upon the foundation upon which it is laid. Where the foundation is suitable and the concrete of good quality, this form of lining has in many cases given excellent satisfaction. It is well, however, in all cases to consider fully the practicability of cheaper methods before doing much of this expensive work.

(a) Sluicing Silt to Reduce Canal Seepage.—The main canal of the Grand Valley irrigation project of the United States Reclamation Service in Colorado was excavated along the north side of the irrigation lands, largely in porous shale, and the losses from seepage were excessive. The possibility was discussed of diminishing seepage by sluicing into the canal clay or fine silt, which would be carried in suspension for considerable distances and finally be deposited in sufficient quantities material to reduce the losses of water. Previous work had been locally successful in puddling and priming certain sections with rather poor material available adjacent to the canal and brought up with scrapers, but this method was impracticable along many sections where the material was entirely shale and not disintegrated. Few data were available on the equipment necessary for sluicing in the priming material, or on the cost of installation and operation, so that it was decided to install a plant to determine experimentally what could be accomplished.

(b) Lining an irrigation Ditch with Hess Metallic Fluming.—The Burbank Company of Burbank, Walla Walla, Washington, constructed a ditch lined with Hess Metallic Fluming for about 3,000 ft. in the form of 6 ft. 4½ in. semi-circle. The portion of the canal to be lined was located on a steep, sandy, hill side, where an earth canal was not practicable because of the porous character of the sand and soil, and because it would have been difficult to maintain the canal bank, owing to the light character of the material of which they would be composed and the exposure to strong winds. Concrete lining was not looked upon with favor for this particular work, because of the great scarcity of suitable sand, gravel, and water, and the necessity for completing the work in a very short time.

It was considered that the smooth interior of the Hess flume would permit the soil drift to pass through the flume without deposit by force of the wind, and during the irrigation season the velocity of water would be sufficient to carry away any deposit.

Three thousand feet of No. 120 Hess improved metallic flume, constructed of No. 22 gage torsion metal and held in shape by steel ribs and bands heavily coated with asphalt. Total cost per foot is $1.62.

(c) Lining with Clay Puddle.—Much of the water now wasted in conveyance might be saved by the use of clay puddle. Clay and water, or clay and water mixed with sand and gravel, will make good puddle. These materials are both cheap and abundant and can usually be found along the route of the canal. New canals over gravelly bars should be excavated about nine inches below grade, and this space filled with clay. The bed may then be barrowed to reduce the clay to fine particles. It should then be dampened either by a street sprinkler or by allowing a small amount of water to flow through the channel. By driving stock, preferably sheep, back and forth over the canal, when the clay is sufficiently moist, a good puddle will be formed.

Should the current be liable to wash away the clay, a layer of gravel should be placed over it and well rammed down either by the feet of animals or by the use of tamping bars. The sides of the ditch or canal can best be lined by making an extra quantity of puddle in the bed and placing a part on each side. For this purpose, the clay should be mixed with gravel to make it more rigid.

(d) Some Simple, Effective Means for Stopping Seepage Loss.—

(1) First, to provide such a grade that the velocity will not be excessive. Many laterals are built on the slope of the country which may be fifty or one hundred feet per mile, and the erosion thus induced causes not only excessive seepage losses, but also unsightly dangerous gullies, which detract from the value of adjoining land. Where these laterals are already constructed, it might be well to place checks or drops at frequent intervals, thereby reducing the grade and consequently the velocity.

(2) Second, where the velocity is not excessive, it has frequently been found very satisfactory to dump fine clay into the ditch at the head gate, or just above a particular section. The current will carry the particles of clay along and deposit them in the channel, forming, eventually, an impervious lining. Where the channel passes over a gravel wash, land slip or gypsum bed, and fluming, because of its cost and maintenance expense, is not desired, burlapping spread along the channel and secured by pegs forms a valuable adpunct to the treatment with clay. The clay which would otherwise be washed into the interstices of the gravel and do no good, is caught in the meshes of the burlapping, the result being in the course of time that little or no seepage will occur where formerly excessive amounts of water were lost.

4. *How to Reduce Seepage in Canals Through Porous Shale.*—

The canals might be excavated through the shale hills. In this condition, it is very porous, and the losses by percolation must be a considerable amount, if neglected. How to prevent loss of this kind was considered by Mr. J. H. Miner, Project Manager of the Grand Valley Project. In this project, the main canal is for the greater part of its length along the lower edge of an area of shale hills. This shale, in general, is finely broken up by nearly horizontal seams and vertical fissures.

The prevention of excessive losses by seepage was given considerable prior to beginning the construction of the project main canal. Lining with concrete was not considered feasible, since these shales swell when wetted so that concrete lining might be expected to become cracked and inefficient. The protective measures adopted consisted in excavating the canal through shale to a depth of 1 ft. below the required grade, with a view of allowing silt to accumulate in this extra depth. When clearing may be necessary, the silt in this section will not be disturbed. At some points, where especially porous shale was encountered, the canal section was excavated with ½ to 1 side slopes below the normal water, but the top width of the wetted section was not changed. In this way, a triangular section was formed on either side of and outside of the required water section. These triangular areas were later filled with good surface soil crowded off of the top of the slope. Part of the earth lining was placed before water was turned into canal and part afterward. The work done with the water in the canal was the more effective, in that the material compacted better and more quickly and also spread farther out on the canal bottom.

Earth lining or artificial silting was necessary, due to the fact that the Grand River carries very little silt.

The local shales disintegrate very readily on exposure to air and moisture. Advantage was taken of this property by plowing and harrowing the shale portions of the canal bottom in the fall of 1915, after water had been run in the canal. The upturned shale was left exposed to the elements through the winter, and in the spring was again stirred with a heavy harrow to further assist nature in the breaking-up process. The shale has a tendency to break up in flakes that do not compact readily. A so-called "goat" was devised to hasten the compacting. It resembles a land roller, or pulverizer, except that the face of the rolls is provided with projections about 3 in. long, 2 in., in diameter at the tip, and spaced about 6 inches apart in each direction. The "goat" is hauled repeatedly over a given area and has the effect of trampling animals. It apparently made the canal bottom more compact, but no data have been secured to show directly what its effect might be in reducing losses by percolation.

The conveyance losses are shown in the following table, all losses being given in cubic feet per square foot of wetted area for 24 hours:

TABLE VII.

Sections	June	July	August
I	.557	.248	.201
II	1.007	1.076	.948
III	1.940	2.118	.588

From the above table, it is noted that the conveyance losses are much greater in canals of unharrowed bottom than in those of harrowed bottom.

5. Effect of Capacity and Depth of Water on Seepage.—

The effect of capacity and other factors upon the losses is shown by the curves in Figure 5. These curves indicate that losses per square foot of wetted area are largely independent of the volume of water in the canal, but that they are slightly influenced by the depth of water over the wetted area, and that the per cent loss per mile is greatly influenced by capacity where quantities less than 200 sec.-ft. are carried, but that with capacity in excess of 200 sec.-ft., the percentage of loss is remarkably constant. Great care must be used in the designing of small canals to allow for a sufficiently large per cent of loss. It is noted that small laterals carrying 1 second-foot and less almost invariably lose a large part of the water carried, and the percentage of loss decreases rapidly as the volume carried is increased, thus emphasizing the desirability of rotation system where the necessity of carrying small amounts is eliminated.

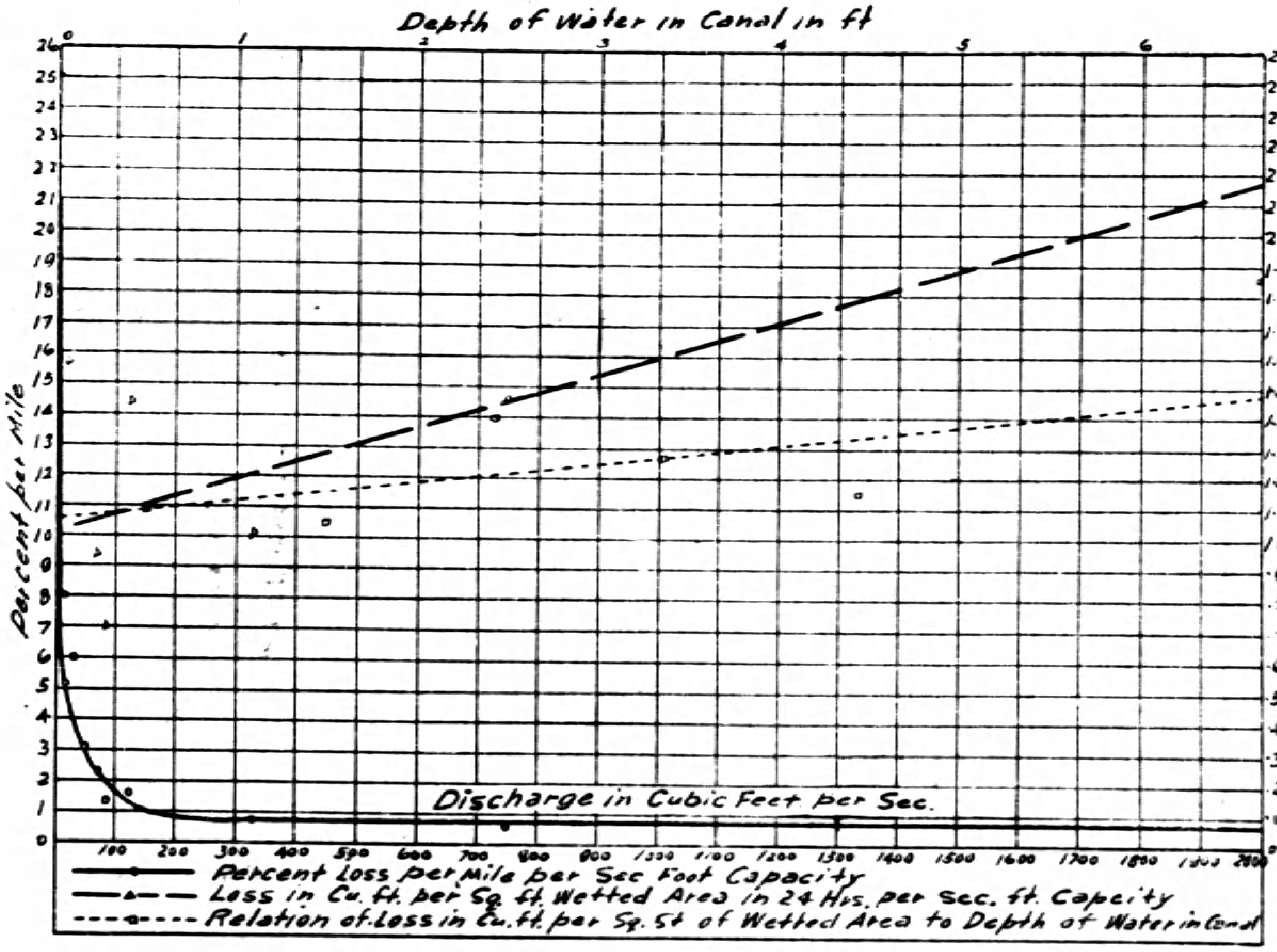


Fig. V EFFECT OF CAPACITY AND DEPTH OF WATER ON LOSS IN PER CENT PER MILE AND IN CUBIC FT. PER SQ. FT. OF WETTED AREA

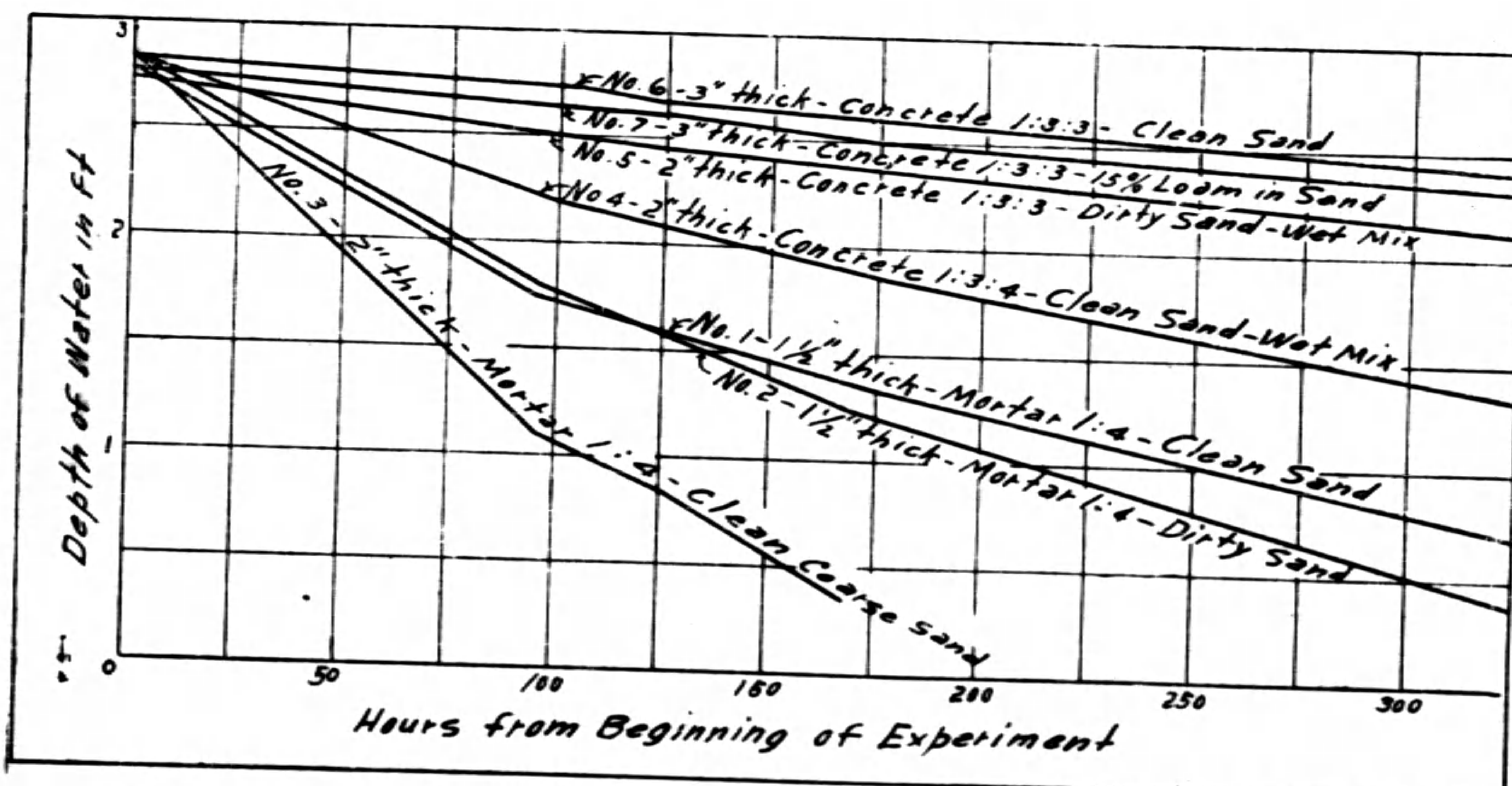
6. Seepage Loss in Concrete Lined Canals.

Seepage losses in concrete lined canals decrease with decrease in depth of water, and are far smaller than mortar lined canals. In 1913, a section of small lined canals was constructed in a sandy formation for experimental purposes. This canal had a bottom width of 2 ft., a depth of 3 ft. to top of lining, and side slopes of 1¼ to 1. It was divided into seven sections, each 8 ft. long in the clear, by a concrete wall 4 in. thick.

When these basins were just filled with water, the seepage losses were quite large. After one or two preliminary wettings, all the basins were filled on June 5, 1912, and observations continued till June 20. The results are shown graphically in the accompanying diagram, which gives the depth of the water from the beginning of the experiment to 350 hours thereafter.

A noteworthy point indicated by the diagram is the reduced rate of loss as the depth of water decreased as indicated by the slope of the lines. This tendency is less marked for sections No. 5, 6, and 7, which probably indicates that these losses are principally the results of evaporation, which is independent of the depth.

Another noteworthy result of the experiments is the evident superiority of the concrete lining as compared with the mortar lining for preventing seepage losses.



Typical Section

Fig VI DIAGRAM
SHOWING SEEPAGE LOSSES
IN CONCRETE LINED CANAL

7. *Seepage Formulas.*—

(a) The following formula is proposed as representing the results of existing data, to be used in estimating seepage to be expected from contemplated canals:

$$S=C\sqrt[3]{d}\,\frac{P\ L}{4{,}000+2{,}000\sqrt{v}},\ \text{where}$$

S=seepage in cubic feet per second

C=coefficient depending on material of canal

D=mean depth of water in feet

P=wetted perimeter in feet

L=length of canal in feet

V=mean velocity of water in canal

Values of C are listed as follows:

TABLE VIII.

Coefficient-C	Materials
1	Concrete, 3 to 4 inches thick
4	Clay puddle, 6 inches thick
5	Thick coat of crude oil, new
6	Cement plaster, 1 inch thick
8	Clay puddle, 3 inches thick
10	Thin oil liming, cement grout
12	Clay soil, unlined
15	Clay loam soil, unlined
20	Medium loam, unlined
25	Sandy loam, unlined
30	Coarse sandy loam, unlined
40	Fine sand, unlined
50	Medium sand, unlined
70	Coarse sand and gravel, unlined

Care should be taken not to give too much weight to the above arbitrary values of C, as the seepage depends not only upon the surface of the cannal perimeter, but also to some extent upon its backing. Any one of the linings above listed will make a tighter canal if placed on a clay or loam soil than if it has a backing of sand or gravel, which transmit the water freely.

(b) Mr. T. Ingham, Chief Engineer of Irrigation Works of Punjab, India, (1896), gives as the most approved formula for loss by seepage in Punjab canals:

$$P = C\sqrt{d}\ \frac{W\ L}{1{,}000{,}000};\ \text{where}$$

P=loss by seepage in cubic feet per second for a length of canal L
C=a constant usually taken at 35
D=depth of water in canal in feet
W=width of water surface in canal in feet
L=length of canal section considered in feet.

(c) The seepage loss may be expressed in the following manner:
For the general case:

Let A=area of cross-section in square feet
b=bottom width in feet
d=depth in feet
r_{bd}=ratio of bed width to depth
i=average intensity of seepage in cubic feet per square foot
$n_1 : 1$=side slope of n_1 feet horizontal to 1 vertical
Q=carrying capacity in cubic feet per sec.
V=velocity of flow in ft. per second
S=total seepage loss in su. ft. per sec. per mi.

Then,

$$S = \frac{(r_{bd} \times d + \frac{4}{3}\sqrt{n_1^2 + 1} \times d)\ i \times 5{,}280}{8{,}640}$$

Substitute for d its value in terms of A, r_{bd} and n_1, and for A its value in terms of Q and V, and obtain:

$$S = 0.061 \left(r_{bd}\sqrt{\frac{Q}{v\,(r_{bd}+n_1)}} + \frac{4}{3}\sqrt{n_1^2+1}\sqrt{\frac{Q}{v\,(r_{bd}+n_1)}} \right) i$$

In the above equation, a considerable variation in r_{bd} produces only a small change in the value of S. Assuming a proportion of bed width to depth of 4, and a side slope of 1½ to 1, which are commonly used for canals of a distribution system, the equation reduces to

$$S = .17\ i\sqrt{\frac{Q}{V}}$$

For proportions of bed width to depth similar simplified equations may be obtained.

The average intensity of seepage in cubic feet per second per sq.ft. in 24 hours may be obtained from the following table:

TABLE IX.

Average seepage loss in cubic feet per square foot of Wetted Perimeter for Canals not Affected by the Rise of Ground Water.

Character of Material	Cu. ft. per Sq. ft. in 24 House
Impervious clay loam	0.25-0.35
Medium clay loam underlaid with hardpan at depth of not over 2 to 3 feet below bed	0.35-0.50
Ordinary clay loam, silt soil or lava ash beam	0.50-0.75
Gravelly clay loam or sandy clay loam, cemented gravel, sand and clay	0.75-1.00
Sandy loam	1.00-1.50
Loose sandy soils	1.50-1.75
Gravelly sandy soils	2.00-2.50
Porous gravelly soils	2.50-3.00
Very gravelly soils	3.00-6.00

CHAPTER VI. SEEPAGE FROM RESERVOIRS

It is an economic impossibility for an engineer to prevent seepage losses from beds of irrigation reservoirs, but he must accept responsibility for the choice of reservoir sites which will be a factor in reservoir losses. On this account, Mr. Hopson presented data for four typical irrigation reservoirs built by the Federal Government in the northwest.

Owing to one of them being without seepage losses, three typical reservoirs are chosen, as follows:

(1) The Cold Springs Reservoir.—The Cold Springs Reservoir of the Umatilla Project in Oregon is a good, average reservoir from a western standpoint. In the East, it would probably not be regarded as a site of special promise. The dam is an earthen one, nearly 4,000 ft. long, of a mex. height of close to 100 feet. The general structure of the country is volcanic, with vast overlying beds of stratified sands, gravel, and hardpan. The valley constituting the reservoir site is the outlet of some 200 sq. miles of drainage area, with little or no ordinary run-off. The reservoir is supplied by a feed canal some 25 miles long, diverting from the Umatilla River at times when the

latter has available water. This reservoir was first placed in commission in the spring of 1908, and has been operated ever since. We have, therefore, four yearly records of results. In this case, measurements were obtained with unusual accuracy, as the inflow practically all passed over a sharp crested weir at the lower end of the feed canal and the effluent was also carefully measured over another weir below the outlet gates. This reservoir shows losses ranging from 34% to 24% of the influent during the four-year period. Judging by the record of the past two years, it would appear that a fair condition of stability has been attained in the regimen, in which about one-fourth of the water entering this reservoir is subject to unavoidable loss through seepage and evaporation. (See Fig. 7)

(2) The Clear Lake Reservoir in California is a feature of the Klamath Project, situated just south of the California-Oregon line. It occupies a great natural depression of sink some 25,000 acres in extent at the reservoir flow line. About one-half of the bed consists of a natural sink of alkaline water known as Clear Lake that his for ages received and evaporated the surplus waters of Willow Creek. This reservoir was built by the Government for the principal purpose of holding back the water of Willow Creek, to facilitate the unwatering of land marginal to Tule Lake, a body of water into which Willow Creek ultimately discharges. The reservoir was intended to combine the purpose of a great evaporating pan and regulator of the diversion channel that diverts the discharge of Lost River from Tule Lake into Klamath River. More recent plans have, however, considered its possibilities as a source of irrigation supply being 450,000 acre-ft., with an area of 25,000 acres. The dam on Willow Creek is a rock fill structure, some 30 ft. in height, completed in 1909. We have two years of records of the action of this reservoir. (See Figure 7).

The rate of evaporation in this vicinity has been estimated at a little more than four feet in an average year. It will be noted that the evaporation is the principal loss in this reservoir, as had been anticipated. Seepage losses during the first year were heavy, but apparently the marginal lands became filled up so that losses in 1911 were comparatively moderate. It is important to note that in a year of copious run-off, like 1910-11, as much as 50% of the supply was subject to unavoidable loss or waste, which in this case was intentional, the principal purpose f the reservoir being the disposition of surplus water, rather than its cor .vation for use.

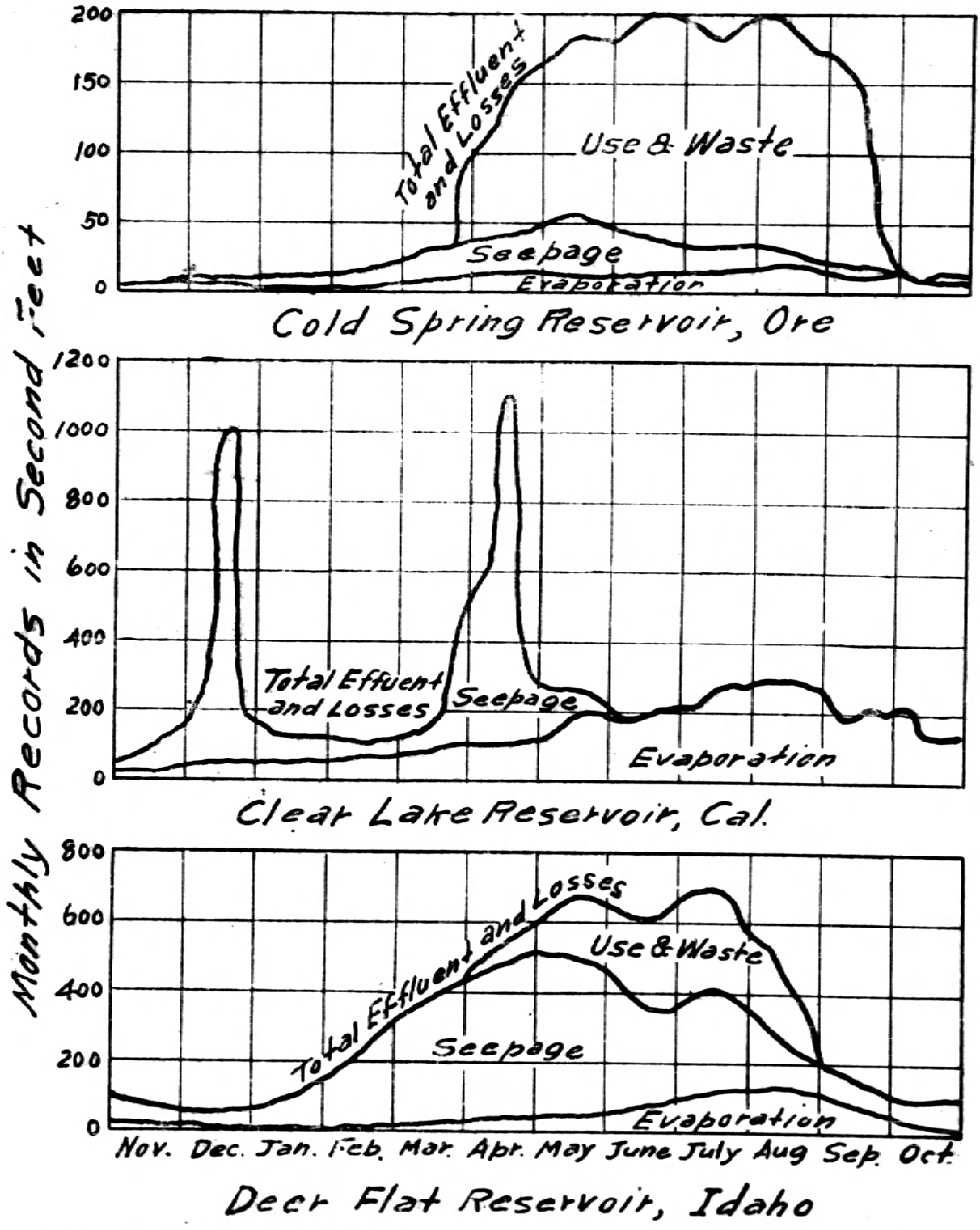


Fig. VIII EVAPORATION SEEPAGE, USE & WASTE OF WATER FOR THREE GOVERNMENT IRRIGATION RESERVOIRS IN THE NORTHWESTERN UNITED STATES

(3) The Deer Flat Reservoir is a feature of the Boise Project, in Idaho. It does not occupy a natural drainage valley or sink, being, on the contrary, situated on a flat saddle between the hills, the lower ends of which were closed by two earthen dams. The reservoir derives its supply through a feeder canal, known as the New York canal, diverting from the Boise River some ten miles southeast of Boise. The reservoir was first placed in commission in 1909, and has been in operation ever since. The bed of the reservoir consists in large part of silts, sands, and gravels, with a covering of from 3 to 5 feet of soil. Seepage losses in this case have been pronounced from the outset, and constitute the bulk of all losses. When the reservoir was first placed in commission, almost 90% of the water entering it was lost by absorption in the reservoir bed. In that year, however, the reservoir was only filled to one-tenth of its capacity. During the next two seasons, larger and larger quantities were introduced, and the proportion of losses has appreciably fallen, but still remains high. During the last season, about two-thirds of the water entering this reservoir was subject to loss through evaporation and seepage. It may be expected that conditions will improve at this point, as the adjacent and underlying strata of the reservoir gradually become filled by the constant application of water, but the extent and period of these ameliorating conditions are quite uncertain. (See Figure 7).

The above records, while incomplete and faulty in many respects, are among the best obtainable in a new country like this, and in any event are instructive. I think the general problem of reservoir losses is often given less attention by engineers than its importance warrants. The dam site is apt in many cases to monopolize attention, and an engineer acoustomed to deal with reservoir sites in eastern river valleys, where the adjacent water tables are high and losses are almost confined to evaporation, may be led to the commission of grave mistakes.

A great deal has been said and written about return flow. One of my earliest recollections in connection with reservoir studies is the discussions in the Proceedings of the Society between Messrs. Fitzgerald, Stearns, Fteley, and others on ground water storage of certain reservoirs in the east. Mr. Fitzgerald's conclusions as to the general inadvisability of giving credit to the invisible storage of a reservoir is, I believe, wise. Save under exceptional conditions, I doubt whether much, if any additional draft can be made from western reservoirs in excess of the visible storage.

The Cold Springs Reservoir has, during the past four years, absorbed some 30,000 acre-feet of water in its bed. It has apparently only yielded back about 1,500 acre-feet of this amount. The Deer Flat reservoir has apparently absorbed 270,000 acre-feet, with little or no return.

It should be observed that the amount of water discharged into Deer Flat Reservoir has largely increased each succeeding year, thus submerging large areas of new surface, and that in spite of this fact, the percentage of loss is steadily decreasing. This decrease of loss has extended into the year 1912, of which complete records were not yet available when this paper was written.

It is important to note that in a reasonably good representative irrigation reservoir, such as Cold Springs, one-quarter of the water turned into it is lost, and that apparently under the most favorable circumstances, as at East Park, 10% will be lost.

The main lesson to be derived from these few illustrations is that the geological structures of the site should be given the most careful consideration, it being vital to determine in advance, as nearly as may be, the amount of reservoir losses, and whether they are likely to be of a permanent character.

1. *Relation Between Reservoir Seepage and the Depth of Water in the Reservoir and the Acreage Submerged.—*

Seepage losses in the reservoir are greater as the depth of water in it increases. This may be described by the following example:

The Dallas and Waner reservoirs of the Modesto Irrigation District are formed by a series of low earth dams. When full, the reservoirs will have a combined capacity of 28,000 acre-feet, will submerge about 2,400 acres, and have an average water depth of a little less than 12 feet. When partly full, or when water was passing through the reservoir, the loss in seepage was quite noticeable. To determine just what portion of the reservoir water was lost in this manner, observations were made in 1914. The results were shown by Table X:

TABLE X.

Evaporation and Seepage from Reservoir in acre-ft per month

	Mean Area Submerged Acres	Evaporation Acre-ft.	Seepage Acre-ft.	Total Loss Acre-ft.	Max. Depth ft.	Acre-ft. Seepage per Acre Submgd.
Dallas Reservoir	730	311	3319	3630	9.1	4.54
Warner Reservoir	367	155	1668	1823	9.5	4.54
Total	1097	466	4987	5453	——	4.55

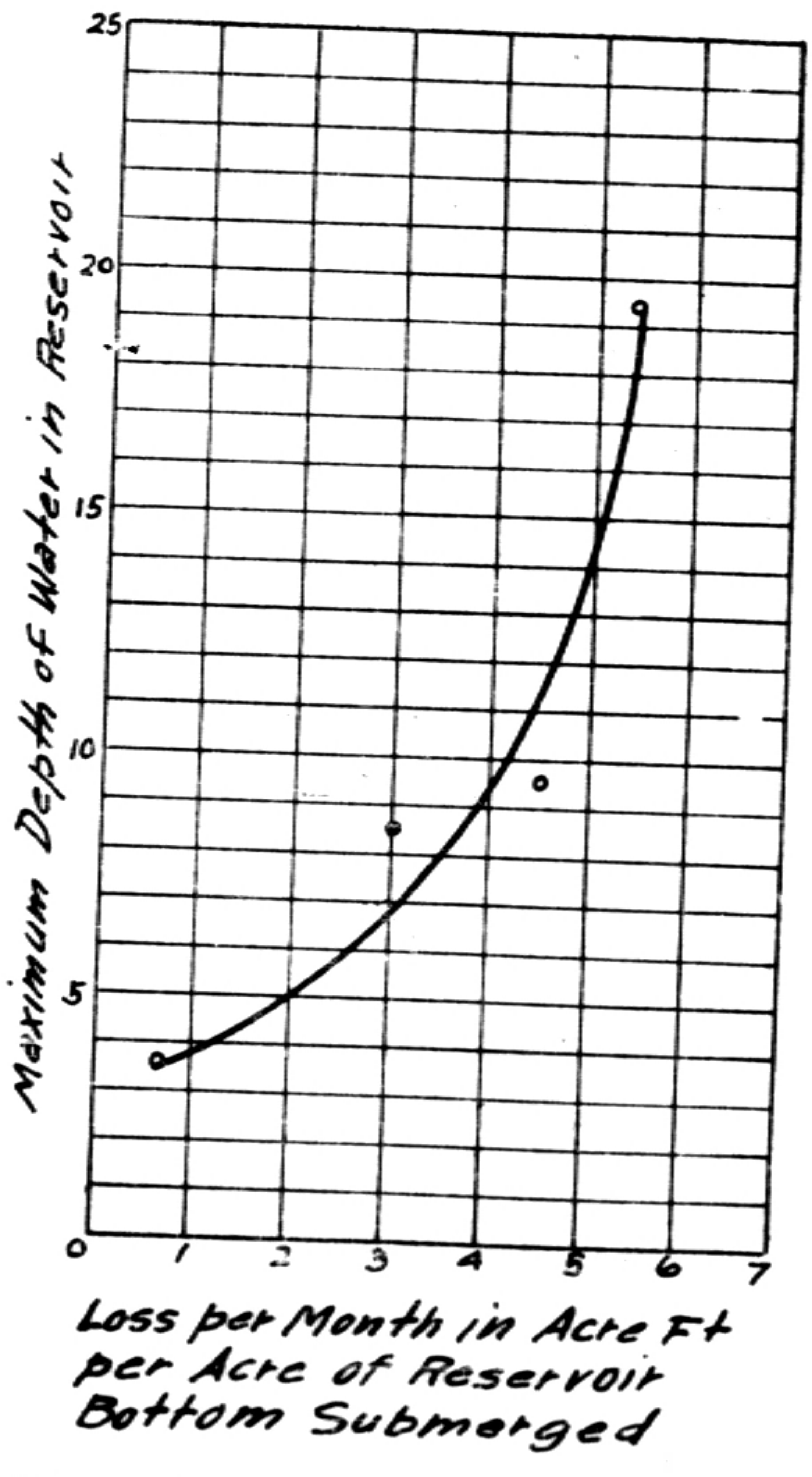


Fig. VIII RESERVOIR SEEPAGE LOSSES

From the data, a curve was drawn, (Fig. 8) of the estimated mean seepage in acres-feet per acre of reservoir bottom at different average maximum depths of water in the reservoir.

2. *Methods of Stopping Seepage.*—

(a) By Blanketing the Bottom: Bull Run Lake is a natural reservoir utilized for the water Supply of Portland, Oregon. There is no natural surface outlet or overflow, but the water passes out through an underground channel and emerges in the from of springs. A dam was built above this outlet to raise the water level. Seepage was discovered, however, through the boulders and shattered basaltic rock which appear to fork the greater part of the lake bottom and the interstices, of which have become filled with silt.

Clay containing some fine gravel was used for the blanketing, this material being obtained principally on the east side of the lake, about ½ mile from the work. It was transported on an improved raft made of cedar logs, and equipped with a gasoline engine and propeller and a wooden 5-yd. hopper. The material was dumped from the raft in amounts depending upon the nature of the leaks. Where these occurred among large boulders, the blanket was made several feet in thickness, but where the bottom was of shattered rock a thickness of about a foot was usually sufficient.

A dyke was built to cut off a bay where much of the leakage was concentrated. The dyke is an earth fill, backed with large boulders on the outer slope. Material was deposited by means of skips run on wire cables and by the raft material above, but after the fill neared the water surface, it was finished by means of the skips alone. Care was exercised to deposit selected clay on the face of the embankment.

When the fill had been brought to the proper grade, its inner face was ripraped to high-water level to prevent wash by wave action. Blanketing was carried out into the lake some distance beyond the toe of the dyke. No serious trouble had been encountered, the worst difficulty being found in obtaining suitable material for the dyke and for blanketing, as the formation is mostly loose rock and boulders, and a large quantity of waste material must be handled. All machinery and supplies for the work had to be hauled 20 miles in wagons from the nearest railway and then packed on horses for 11 miles over a mountain trail to the lake. The equipment, therefore, was necessarily light, and the work was more expensive than if it were accessible by wagon road.

To check results of the work, observations were made by means of gages placed in the lake at various points, by the receding of the water in the bay outside the dyke, and by means of weirs at the points where Bull Run River emerges from the ground. As soon as the dyke was carried across this bay, where most of the leaks occurred, there was a noticeable decrease in the subsidence of the water in the lake as shown by the gages. There was also a marked decrease in the flow of the water over the weirs at points one mile and onehalf miles from the lake.

(b) Lining a Reservoir with Concrete by Cement Gun to Prevent Seepage:

The Lindsay-Strathmore Irrigation District has a small reservoir covering about two acres, and holding 18 acre-ft. of water. The reservoir is known as a "balancing reservoir," and floats on one of the main pipe lines, being used to take up the daily fluctuation in flow, storing a surplus during part of the day, and supplying the shortage during the balance. Unfortunately, the location of this reservoir was necessarily confined to a certain area close to an old stream bed, and the reservoir was excavated in a gravel deposit and had a considerable loss due to seepage, amounting to two to three acre-ft. per day. Difficulty was also experienced in making the banks hold, due to water undermining the loose material.

It was decided to line this reservoir with a granite lining. The total area to be lined was 114,000 sq.ft., and specifications called for a gunite lining 1 in. in thickness, with a mix of one part of cement to 5.5 parts of sand; no lime was used in the mixture. The lining was reinforced with galvanized poultry netting, 1½ in, mesh, No. 19 gage wire, placed in the center of the concrete to confine cracks due to expansion to hair cracks, and no expansion joints were used.

The cement gun used was what is known as the No. 2 size. It was kept on the upper bank of the canal at a maximum distance of 600 ft. from the compressor, to which it was connected with a 2-in. iron pipe. The compressor was of the portable type, direct-connected to a semi-Diesel type of engine; it was 12 $\times$ 12 in., and ran at a speed of 300 r.p.m. A pressure of 42 lbs. per sq. in. was maintained. at the compressor, giving about 32 lbs. at the gun. A 2-in. rubber hose 200 ft. in length was used from the gun to the nozzle, and the rubber tips in these nozzles lasted nearly one week before requiring replacement.

3. Recommendations for Stopping Reservoir Seepage.—

Many remedies have been suggested for stopping seepage from reservoirs such as in the case of the Cedar River reservoir of Seattle's municipal water and power project, which was completed in 1914. The masonry dam built there was watertight, but great quantities of water flowed away through porous material in the north bank of the basin, and emerged as springs in the valley about a mile below the structure. Among the first repairs to be suggested was a cut-off wall, which would have involved a very large expenditure. The lining of the area with concrete was another alternature. Later developments indicated, however, that neither of these methods would be adopted. Mr. A. H. Dimack, City Engineer, favored a repair scheme involving the silting of the porous bottom with fine clay, and possibly the laying of an impervious asphaltic lining over a portion, or all, of the area to be submerged. In addition to his own recommendation, Mr. Dimack included in his report summaries of reports by Frederic P. Stearns, William Mulholland, and R. H. Thomson, consulting engineers. It is interesting to note that Mr. Thomson believes that sealing by silting will be sufficient and that an artificial lining will be necessary. Mr. Stearns, on the other hand, thinks it will be necessary to line the entire basin, while Mr. Mulholland occupies an intermediate position, holding that it will be necessary to line the slopes only and silt the bottom of the reservoir. Experiments by Mr. Dimock, the report states, have indicated the feasibility of the asphaltic lining.

CHAPTER VII. SEEPAGE FROM MOUNTAIN SLOPES

When rain falls on a mountain slope that has been denuded of its natural forest growth, there is little, if any, vegetable mold to absorb and retain, for a while, the moisture. The rain drops fall on the rocky surface, gather into rills, and these into streams, until a mountain torrent is formed. These intermittent streams that flow with great rapidity are in nearly every sense detrimental to the farmer. So, too, the snows of winter fall and are drifted hither and thither amid the bleak rocks and decaying stumps of a once well-timbered mountain. A little finds a lodgement in the deep ravines and recesses of the rocks, but the great mass succumbs to the warm sunshine of April and May and is speedily borne to the great inland sea.

On well-wooded mountain slopes, the case is different. Here the leaf mold of centuries absorbs and holds back the rainfall; and weeks, or even months afterward, some wheatfield far down in the valley may be invigorated by its presence. Here, too, the winter's snow finds a resting place, sheltered alike from wind and sunshine. The heat of spring melts the snow gradually and permits a large part to sink into the vegetable mold from which it is gradually conveyed beneath the surface to do good service to the irrigator of the plains.

Chapter VIII. Determination of Seepage

1. Seepage Measurements.—

The measurement of the discharge of the river or canal is made at a suitable point at the upper end of the section to be investigated. Then the course of the river or canal will be followed as closely as possible until a second point is found which would terminate the section. In following the river or canal, the distance is either measured, or such notes taken of landmarks that the length of the section can be determined from maps. The flow in all ditches diverting water from the stream, as well as all tributaries and visible inflow, are measured, and such notes taken of the character of the country through which the stream flows as will help to explain any unusual results. The measurements are made at such points as will include sections throughout which nearly uniform conditions prevail.

Where the water exceeds more than a few inches in depth in the smaller channels, or where there is sufficient to measure by the current meter, is usually used to determine the velocity and thus determine the amount entering the canals or ditches. In cases where the canal is small and the intake at the time of gaging is little, surface floats are often used, and the mean velocity determined in this manner.

In gaging the river at a regular gaging station, a tape is stretched across the river between points on sidewalls and the depth of water at each one-foot or two-foot interval measured throughout the entire width. Then observation are taken with the current meter, usually at two-foot intervals, sometimes at less, across the stream. Results cf such measurements are given in Fig 9:

The diagram, Figure 9, shows graphically the amount of return water as found in the different measurements made at the Poudre Valley, Colorado. The horizontal distance, or abscissae, give the distances in miles from the gaging station. The vertical distances or ordinates, indicate the amount of return water in cubic feet per second. The vertical lines are drawn at the principal points of measurement. The distances have been measured, not along the curves of the river, but on the map, taking generally a straight course across the bottom, because it is thought that the amount of inflow will not be increased by the curves of the river, but rather will depend upon the straight course of the river, other things being equal. The different lines indicate the different measurements. It is evident that there is a general agreement between them.

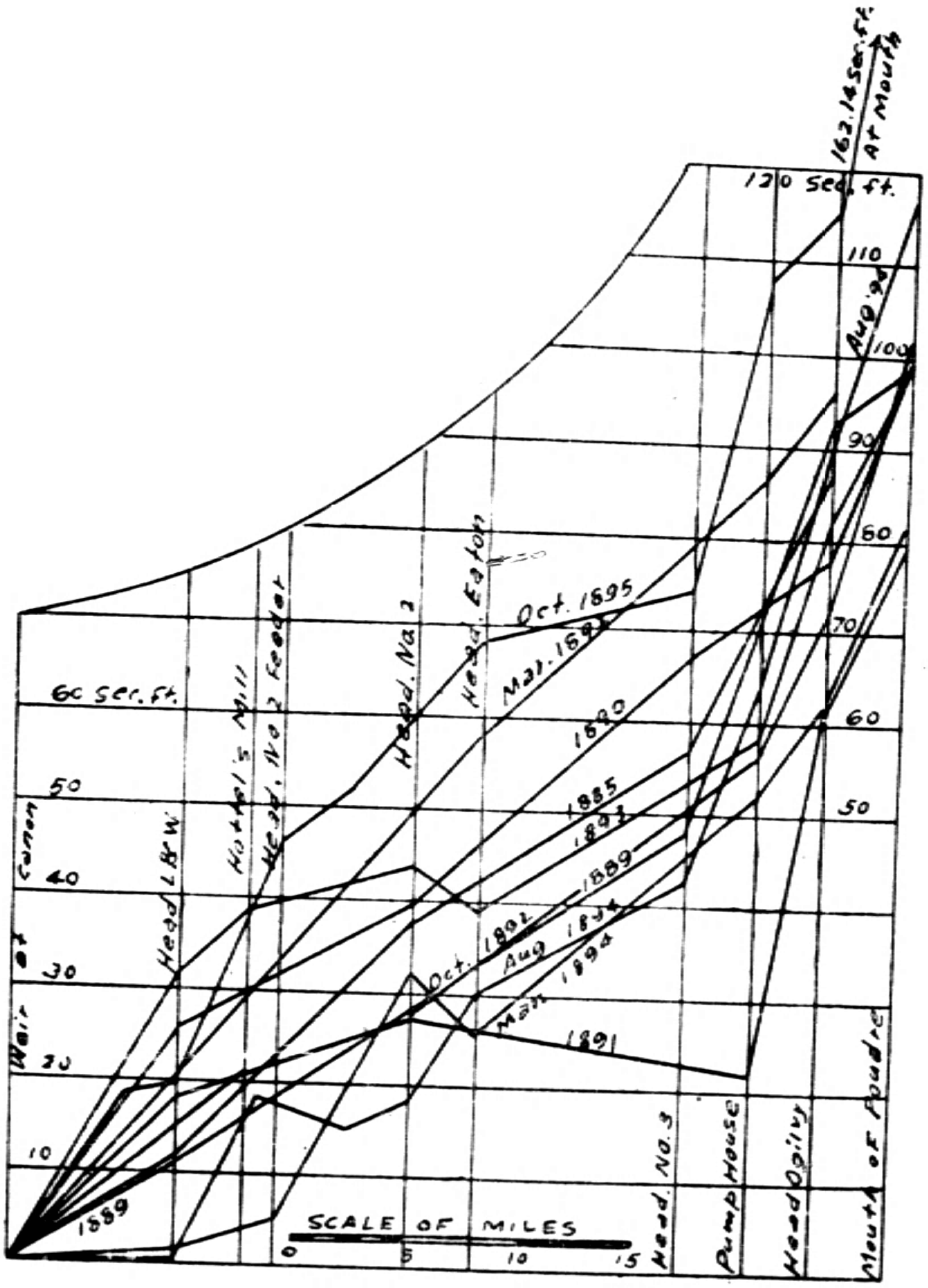


Fig. IX SEEPAGE INCREASE OF THE CACHE A LA POUDRE RIVER

2. *Tests of Seepage.*—

For the purpose of obtaining the rate of flow of water through various permeable soils on which were to be found dams and stopgates for irrigation works, Mr. W. C. Hamatt has made many tests with the type of apparatus shown by Figure 10. The horizontad pipe A-B is rammed full of the soil to be tested, and the water is admitted from the hose H and regulated by the valve C, so that the proper head is maintained by the overflow over the end of the pipe D. The percolating water flows out over the branch tee at B and is caught and measured in the vessel G. The quantity of water caught in a unit period of time, divided by the product of the cross-sectional area of the horizontal pipe by the percentage of voids in the soil tested, will give the velocity of seepage flow. Substituting this in Darcy's formula:

$$V = C \frac{h}{t}$$

V=velocity of the moving ground water

h=head (difference of pressure at the two ends of the soil column)

t=length or depth of the soil column

C=constant depending on the character and porosity of the soil.

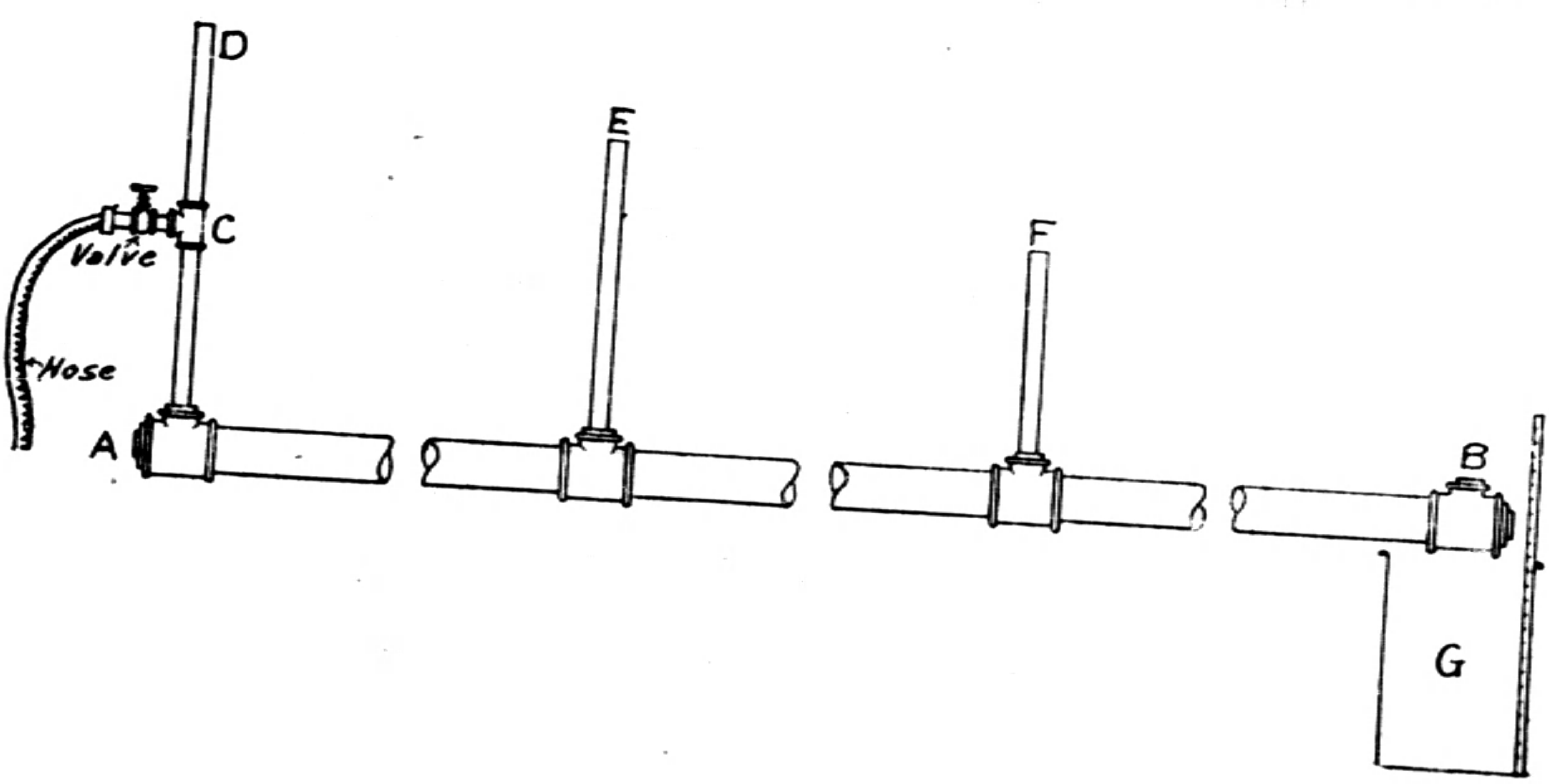


FIG. X APPARATUS FOR TESTING FLOW OF WATER THROUGH PERMEABLE SOILS

Together with the corresponding values of h and ι, we are able to solve C. This ι value of c he has found to range between 0.0001 and 0.0015 for the classes of soils which he has encountered in irrigation works in California.

Variations of head may be obtained without changing the feed pipe, by means of inclining the upright pipe A-D so as to give any pressure desired.

This apparatus has been used principally for the purpose of determining the safe length of seepage flow beneath irrigation structures. For this purpose, he varies the head A-D to determine at what velocity the soil will be eroded and carried by the seepage water over the outlet at B.

3. Diagram for Estimating Seepage Losses.—

As an aid in the calculation of seepage losses, Mr. E. A. Moritz, engineer of United States Reclanmotion Service, gave the diagram, fig.11 which has been used with satisfactory results.

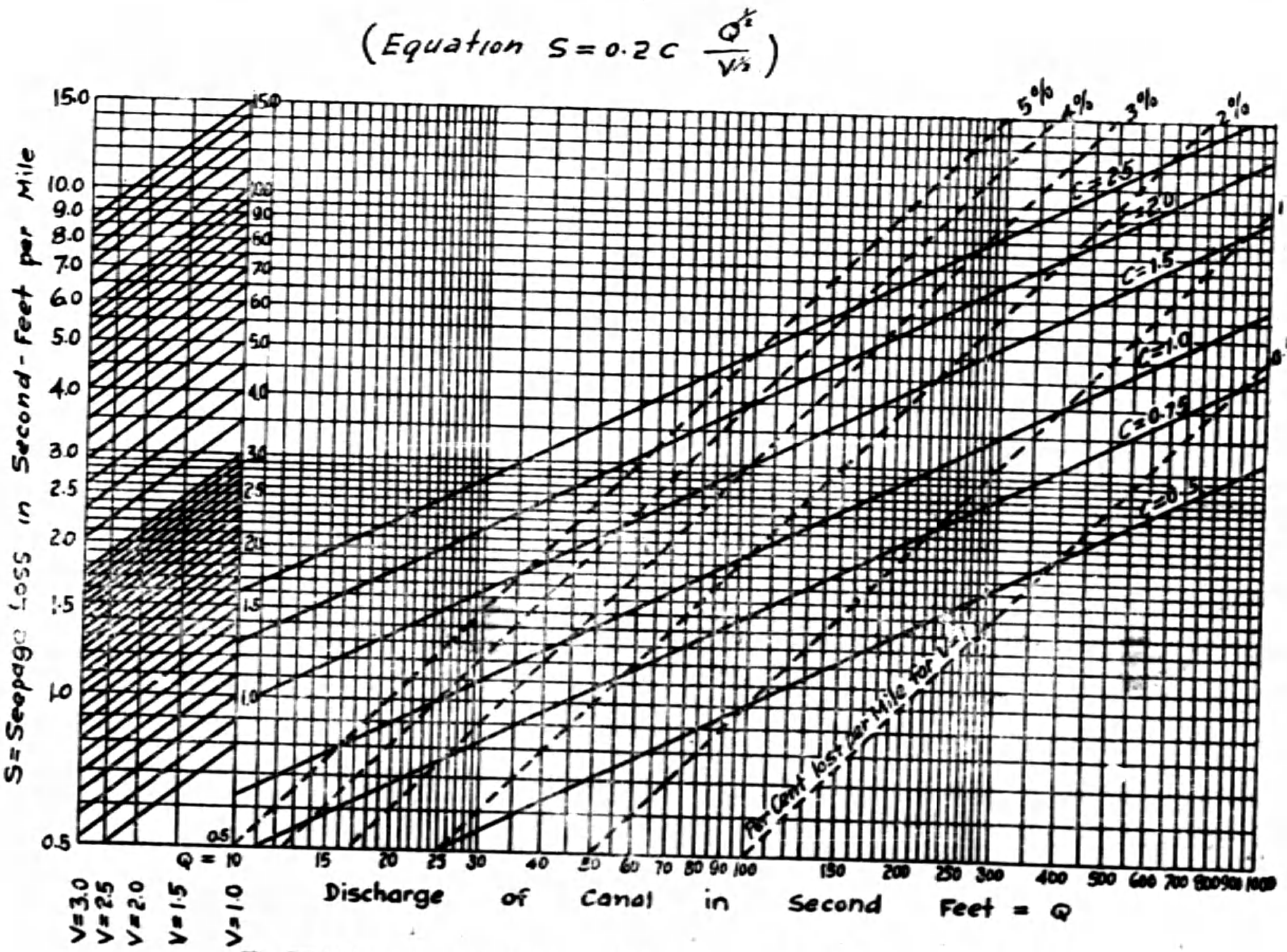


Fig. XI DIAGRAM FOR USE IN CALCULATING SEEPAGE LOSSES IN CANALS

$$S = 0.2\ C \left(\frac{V}{Q}\right)^{\frac{1}{2}}$$

S=loss in C.F.S. per mile of canal

C=depth of water in feet lost over wetted area in 24 hours.

Q=discharge of canal in C. F. S.

V=velocity of water in feet per second.

The above equation has been plotted on Fig XI with values of Q as abscissae and values of S as ordinates, the diagonal lines corresponding to different values of C. To care for variation in the velocity of flow, an auxiliary scale has been constructed at the left. The scales are all logarithmic. The auxiliary scale for different values of V requires a brief explanation. The base scale at the left is for a velocity of 1 ft. per sec., and its use may be demonstrated by the following example:

Assume Q=100; C=1.5; and V=1

Enter the diagram at the bottom and follow up the vertical line marked Q=100 to its intersection with the diagonal line marked C=1.5; thence horizontally to the base scale at the left, reading S=3 cubic feet per sec. per mile. Now, if the velocity is 2 ft. per sec., instead of 1, the other factors remaining the same, we do not stop at the base scale for V=1, but continue down the diagonal line to the left to its intersection with the vertical line marked V=2, reading S=212.

4. *Determination of Rapidity of Seepage Flow.*—

In the lack of direct field evidence with regard to the rapidity of seepage flow, we need to resort to laboratory experiments. An accomplished French engineer used cast iron tube 12 in. long and 12 in. in diameter, filled with sand, measuring the amount of water which passed through under different heads, and determined the relation between the pressure and the velocity.

From the experiments of Darcy, developed by Dupuit, it is found in minute channels the velocity varies directly as the head, and may be expressed by the equation,

$$V = K\ i$$

in which V represents the velocity, i the inclination (being the head or fall in a given distance, divided by the distance), and K a factor which varies with the kind of soil, size of interstices, etc.

Table XI.

Velocity of Flow Through Permeable Soils

Kind of Material	Size Grains in Inches	Proportion of Voids	Velocity			
			Per Sec.	Per Hr.	Per Day	Per Yr.
Minute Gravel	0.08	0.41	.024	86.47	2075	757,520
Coarse Sand		0.38	.0026	9.33	224	81,730
Fine Sand	0.008	0.35	.00047	1.69	40.5	14,777
Sandy Soil		0.30	.00022	.79	18.9	6,897
Sandy Clay		0.25	.00012	.42	10.2	3,725
Clay		0.20	.00003	.12	2.8	1,035
			.00008	.295	7.1	2,587

Example: What distance will water pass through coarse sand in a year, inclination about 1 in 100?

Here i=1/100. If the sand averages 1/10 inch diameter, without finer particles, it will approach what is here designated as minute gravel. In one year the distance would be the number 757,520, multiplied by the inclination 1/100, giving a distance of 7,575 feet, or about one mile and a half. If in coarse sand, as here termed, distance of about 800 feet.

If the movement is downward, then i=1. If there is a head in addition, then i may be greater than 1.

Chapter IX. Seepage Water Compared With the Flow of Water in Pipes

The seepage of water from a canal or reservoir is analogous to the flow of water in pipes. There must be some outlet, otherwise when the pipe is filled, the flow stops and the hydrostatic head becomes equal to that in the canal. In the case of seepage from a canal, the outlet may be an underground gravel bed from which water is being drawn by wells, a surface drainage channel, either natural or artificial, surface soil evaporation, or plant growth. It may be, and generally is, a combination of all these, and the dissipation of seepage water to its various distinctions is analogous to the drawing of water from a main pipe line into various service lines. In flowing through the soil to the various outlets, the water takes a certain gradient, and when this gradient is reduced, the flow is retarded, and should it become horizontal, the flow would cease. Moreover, the silting of a canal by deposition from the water carried, or the lining of a canal for the purpose of retarding the seepage losses, is analogous to the partial closing of a valve at the tank outlet.

Figure 12 shows the parallelism of the flow of seepage water in pipes. The various soils have different resistances, and the hydraulic gradient will vary through them in the same manner as through a pipe line of varying diameter.

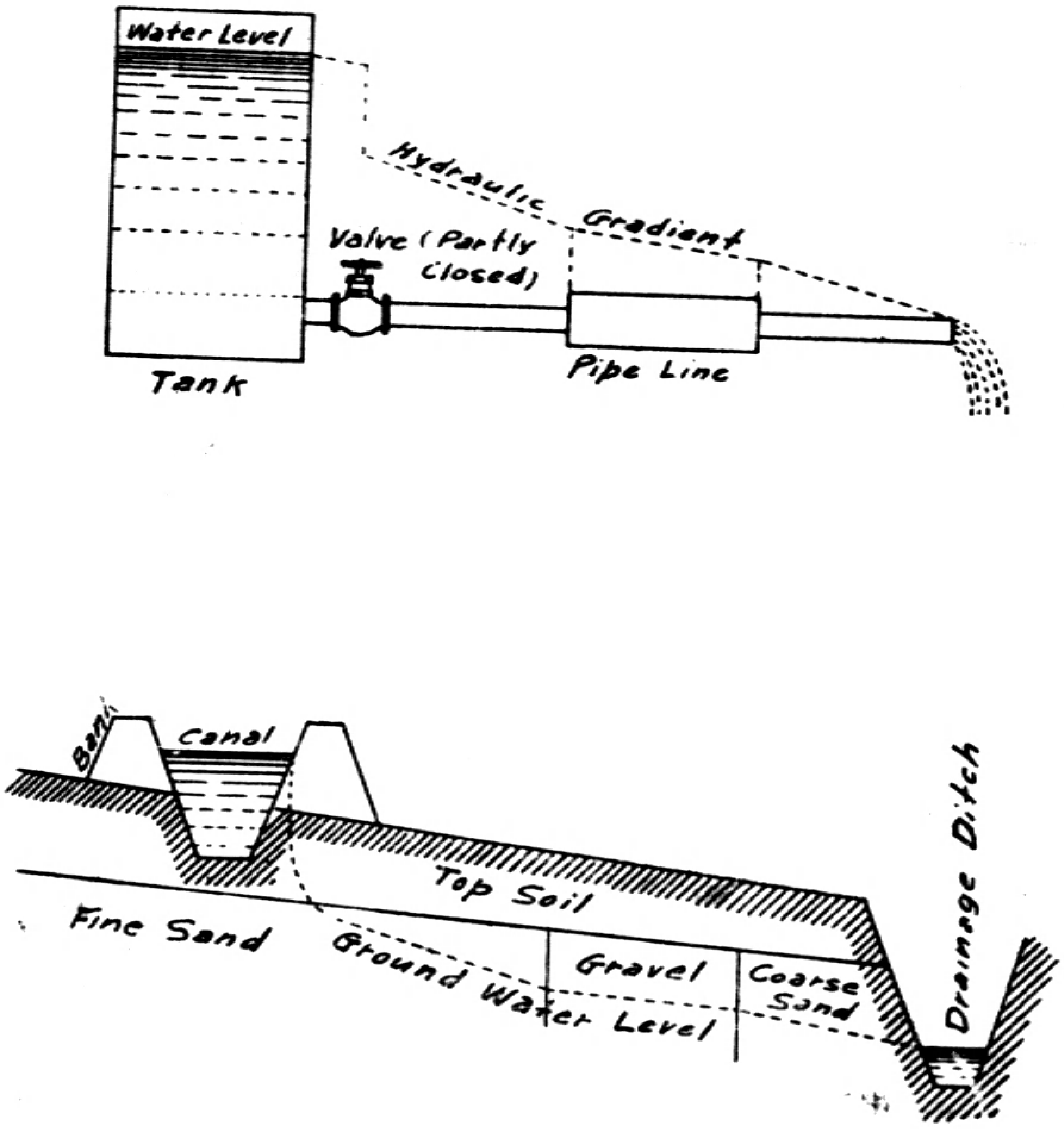


Fig. XII PARALLELISM BETWEEN FLOW OF WATER IN PIPES AND FLOW OF SEEPAGE WATER FROM CANALS

If there is no outlet by either underground or surface drainage, the water table will rise until the soil evaporation strikes a balance with the canal seepage under the reduced gradient.

CHAPTER X. DESTRUCTIVE EFFECTS OF SEEPAGE ON AGRICULTURAL LANDS AND ENGINEERING WORKS

In many of the oldest settlements of Utah, what were once the most productive fields have become nearly valueless on account of an excess of moisture. The waste occasioned by the careless methods in the use of applying water to land has raised in many places the ground water level, and owing to the proximity of the low lying lands to a "sink," or salt water lake, and to the prevalence of alkali in both soil and subsoil, this ground water usually holds in solution large quantities of mineral salts. If the impure ground water is eight or ten feet beneath the surface, its effects upon vegetation may not be noticed, but as the level of the water rises, it limits the available space from which plants get many of the chief elements of their food, and if not checked by a more economical use of water on the farms above, or by properly made drains, will finally crowd the roots and rootlets near to the surface, when farm crops are either destroyed or cease to be profitable.

The swamps and morasses caused by seepage waters and imperfect drainage is a live topic in Utah today.

Seepage water is also a destructive and dangerous element in earthen embankments and hillside cuts. Not a few of the bad railroad wrecks have been caused by landslides, while in earthen reservoirs and canal embankments, the destructive effect of seepage water is well known.

Some years ago, while making an inspection of the irrigation systems of Colorado, Mr. Samuel Fortier found on Beaver Creek the remains of a large fluke which had been built the year previous on a trestle 1,400 ft. long and 40 ft. high in the lowest place. The trestle was found on shale and boulders, and when water was first turned into the flume, it leaked. The escaping water, in time, saturated the hillside, which caused a landslide that completely wrecked both flume and trestle.

In July, 1891, a slide occurred about one and a half miles below the conyon, which carried away over 40,000 cubic yards from the lower embankment of the West Branch Canal, and deposited a portion in the middle of Bear River, 800 feet distant. The canal was new, water seeped through its bottom and sides into the lower embankment, and made paste of material sixty feet beneath the bottom of the canal. The semi-fluid mass could not uphold the enormous load, and a slide was the result.

The seepage from the Davis and Weber Counties Canal, with a capacity of 110 sec.-ft., has moved through a distance of a few feet many hundred thousand cubic yards of natural material.

Chapter XI. Conclusions

1. It is worthwhile for the irrigation engineer to make a thorough study of seepage water, as a gain of considerable money may be secured by using proper methods to control or to prevent it; but, on the contrary, it may cause a remarkable loss instead of gain, to let the seepage water free.
2. It has been realized that seepage water can be completely controlled by artificial methods.
3. The seepage water can be utilized to irrigate the lower lands by pumping.
4. Agricultural lands and engineering works may be destroyed by seepage water.
5. The amount of water lost from canals is much more than from an equal area of irrigated land. An area of one acre forming part of a canal channel loses as much water as 200 to 400 acres of land under ordinary irrigation.
6. A main canal, constructed through earth and unlined, may lose from 20 to as high as 50 per cent of the water diverted before it reaches the farms.
7. In the canal with a capacity in excess of 200 sec.-ft., the losses are considerably larger.
8. Seepage water from canals can be prevented to a great extent by lining with concrete, mortar, clay, and other materials.
9. In locating the reservoir site, the geological conditions should be carefully examined. If any leakage occurs after completion, it may be much more expensive to stop the seepage water in the reservoir.

10. The losses from the reservoir may be prevented by blanketing the bottom, lining reservoir with concrete by cement gun, silting the porous bottom with fine clay, and so forth.

11. It is my belief that the seepage water will become much more important a problem in irrigation than it is at present. The cost of water increases with the land values, which become higher from time to time.

BIBLIOGRAPHY

(1) Books

1. *Irrigation Engineering*, by A. P. Davis and H. M. Wilson.
2. *Irrigation Practice and Engineering*, Vol. 11, by B. A. Etcheverry.
3. *Principles of Irrigation Engineering*, by F. H. Newell and D. W. Murphy.
4. *Woking Data for Irrigation Engineering*, by E. A. Moritz.

(2) Bulletins

1. Reports 9-12, Bulletins 35-52, Colorado Experiment Station.
2. Reports 24-24, Bulletins 177-185, Colorado Experiment Station.
3. Fourth Annual Report of the Agricultural Experiment Station, 1891, Fort Collins, Colorado.
4. Reports 7-8, Bulletins 26-24, 1894-95, Colo. Exper, Station.
5. Bulletins 172-205, 1906-09, California Agric. Exper, Station.
6. Reports 13-16, Bull. 54-70, 1902-06, Wyoming Agricultural Experiment Station.
7. Reports 5-6, Bulletins 27-45, Utah Agricultural Experiment Station.
8. Reports 3-8, Bulletins 11-32, 1896-1901, Montana Agricultural Experiment Station.

(3) Engineering Magazines

1. Seepage Losses in Irrigation Channels, by Fortier, pp. 1060 and 1128, Engineering News, Jan.-June, 1915.
2. Canal Seepage, p. 402, Engineering News, Aug. 28, 1913.

3. Facts About Percolation from Canals, by W. C. Hammatt, pp. 881, Engineering News, July-Dec., 1913.

4. Lining An Irrigation Ditch with Hess Metallic Fluming, by Elbert M. Chandler, pp. 464, Engineering News, July-Dec., 1913.

5. Sluicing Silt to Reduce Canal Losses, by F. J. Barness, p. 337, Engineering News, Apr.-June, 1917.

6. Seepage Losses in Irrigation Canals, p. 71, Engineering and contracting, Jan. 27, 1915.

7. Seepage Losses in Concrete Lined Canals, pp. 22, Engineering and Contracting July 7, 1915.

8. Losses of Water by Seepage from Canals, pp. 544, June 14, 1916

9. Why Some Irrigation Canals and Reservoirs Leak, Engineering News. 80:663-5, April 4, 1918.

10. Canal Seepage Losses Are Affected by Temperature. Engineering News, 82:323-4. Feb. 13, 1919.

11. Sluicing Silt to Reduce Canal Leakage. Engineering News. 78:-337-9. May 17, 1917.

12. Small Irrigation Canal Lined with Concrete to Prevent Seepage Water Loss, Engineering Record, 73:508-10, April 15, 1922. '16

13. Methods of Reducing Seepage Losses in an Irrigation Canal Through Porous Shale, Engineering & Contracting, 46:522-2, Dec. 13, 1916.

14. Earth Lining Prevents Seepage in Porous Shale. Eng. Rec., 75:-108-9. J. 20. 1917.

15. Evaporation and Seepage from Irrigation Canals, Engineering News, 74: 294, Aug. 12, 1915.

16. Concreting a Creek Channel, Eng. & Min. J. 103: 979-80, June 2, 1917.

17. Losses of Water in Irrigation Systems. Eng. & Contr. 41: 720-4, Je. 24, 1914.

18. Seepage in Relation to Irrigation Project Drainage: Canal Lining. Eng. Rec. 69: 584. May 23, 1914.

19. Seepage Loss from Earth Canal. Eng. News. 70: 402-5, Aug. 28. 1913.

20. How to Express Seepage from Irrigation Canals. Eng. News, 74: 294-5, Aug. 12, 1915.

21. Losses in Concrete and Mortar Lined Canals. Eng. & Contr. 72: 1128-9, June 10, 1915.

22. Transmission Losses in Unlined Irrigation Channels. Eng. News, 73: 1060, June 3, 1925.

23. Transmission Losses in Modesto, Cal. Irrigation Canals. Eng News, 73: 1060-3, June 3, 1915.

24. Seepage Losses in Irrigation System: Their Economic Significance. Sci. Am S. 75: 569, Jan. 25, 1913.

25. Conveyance Losses of Water on U. S. Reclamation Service Irrigation Projects, p. 470, Engineering and Contracting, May 11, 1921.

26. Losses of Water in Irrigation Systems, by P.M. Fogg, p. 720, Engineering and Contracting, June 24, 1914, Vol. 41.

27. Reservoir and Canal Losses in Irrigation, Engineering News, 69: 618-23, Mar. 27, 1913.

28. Seepage Develops at Cedar River Reservoir, Eng. Rec. 71: 62, Jan. 9. 1915.

29. Puddling and Rolling to Assure Impervious Foundation for Kushelns Reservoir. Eng. Rec. 74: 534-6, Oct. 28, 1916.

30. Lining Reservoir with Concrete by Cement Gun. P. 167, Engineering News, July-Dec., 1919.

31. Blanket Lake Bottom to Stop Leaks from Water Reservoir, p. 711, Engineering News, Apr. 10, 1919.

32. Waterproofing a Concrete Reservoir, p. 1316, Engineering News, June 11, 1914.

33. Seepage from Irrigation Reservoir and Canals, by Herson, p. 294, 583, and 1001, Engineering News, July-Dec., 1915.

34. Drainage from Irrigation Lands Pumped for Irrigation, Idaho, by J. Hornbein, p. 192, Engineering News, Apr-June, 1917.

35. Return Water Pumped 300 Feet, p. 887, Engineering News, Jan.-June, 1921.

36. Recovery of Return Flow or Irrigation Waste Water. Engineering and Contracting, 54: 477-8, Nov. 10, 1920. Seepage and Waste Water Losses on Wapato Irrigation Project, Engineering News, 85: 365-6, Apr. 3, 1920.

37. Water Company Wins Imperial Valley Seepage Case. Engineering News, 81: 237-8, Aug. 1, 1918.

38. Duty of Water, by J. K. Kingdorn, p. 546, Engineering News, Jan. 1—June 30, 1921.

39. Net Duty of Irrigation Water, by W. L. Powers, p. 466, Engineering and Contracting, May 11, 1921.

40 The Duty of Water in the Pacific Northwest,—Proceedings of the American Society of Civil Engineers, No. 3, Mar., 1921, pp. 461-480.

APPENDIX

(A) *Seepage Through Dams and Its Prevention.*—

The points where the artificial structure joins or is placed upon the original earth or rock are those to which most care should be given, as along this line of contact water under pressure usually finds most ready access and passage. Great precautions must therefore be taken in preparing the foundations and in arranging junction such as will prevent or reduce the amount of seepage along this plane. Such seepage is checked or prevented usually by providing a cutoff trench or wall, extending deep into the foundations, this being extended or sometimes replaced by one or more rows of sheet piling, driven as deep as practicable.

The ground to be occupied by the dam should be carefully cleaned of all stumps, roots, or other organic matter liable to decay, and all of the loose soil removed down to a depth of a foot or more beneath the surface, this depth being dependent upon the character of the ground. If the subsoil is firm and free from roots or holes of burrowing animals, the depth of the stripping may be reduced, but in generel, it is better to be on the safe side, and uncover the entire proposed base of the dam to a depth below where the soil shows the effects of penetration by roots and of weathering.

Since we cannot make an earthen bank entirely tight, it is important to make it so nearly so that the slope of percolation of water from the reservoir will be steep, and will reach the ground before it reaches the lower toe of the dam, so that the downstream slope of the dam will not become saturated and induced to slough. For this reason, it is desirable that the entire upstream half of the dam be made as tight as practicable, and for the same reason some relief in the downstream half is desirable. This may be obtained by making this portion of the dam as coarse material, as coarse sand or gravel, which will allow small quantities of percolating waters to escape freely without danger of erosion. The same result may be obtained by installing under-drains about the center of the lower third of the foundation. These methotds of relief, however, should not be permitted unless reasonable tightness is sure to be obtained in the upper half; for if spaces of any size occur in the fine material, the free escape provided may permit erosive velocities, which, by enlarging the channels, may cause disaster.

(B) *The Net Duty of Water.*—

By the net duty of water is meant the amount of water artificially delivered to the margin of the farms for irrigation. It is usually expressed in depth on the land in feet or inches, which is identical with acre-feet or acre-inches per acre.

The net duty of water is very simply conceived in two parts:

1. The quantity of water actually consumed by plants; and,
2. The losses incident to supplying that quantity to the plant roots.

The losses are of three kinds:

1. Evaporation
2. Percolation
3. Surface Waste

CROP PRODUCING POWER OF WATER

Based on an average water cost of most porfitable plot records under field conditions, showing least probable amount of water (acre-in.) likely to be needed for different yields:

ALFALFA		CLOVER		GRASS	
Yield per acre tons	*Acre-in. requried*	*Yield per acre tons*	*Acre-in. required*	*Yield per acre tons*	*Acre-in. required*
1	5.23	1	3.84	1	4.27
2	10.46	2	7.68	2	8.54
3	15.69	3	8.54	3	12.81
4	20.92	4	12.81	4	17.08
5	26.15	5	17.08	5	21.35
6	31.38	6	21.35	6	25.62
7	36.61	7	25.62	7	29.89

Beets		Potatoes	
Yield per acre tons	*Acre-in. required*	*Yield per acre tons*	*Acre-in. required*
5	2.5	50	1.5
10	5.0	100	3.0
15	7.5	150	4.5
20	10.0	200	6.0
25	12.5	250	7.5
30	15.0	300	9.0
35	17.5	400	12.0

Duty is affected by the kind and variety of crops. Meadows require much water, grain crops and peas require a moderate amount, and cultivated crops, such as potatoes, require still less.

The average yield up to a certain limit represents, to some extent, a ratio between the quantity of crops and the quantity of water required. The average yields under good modern methods of farming should be considered in determining duty.

The kind and amount of cultivation affect greatly the irrigation requirements.

The method of delivery affects the use of water, and this conforms as nearly as possible to plant needs. A higher duty may be obtained where the irrigator pays at least maintenance charge in proportion to the actual amount of water used.

The skill and economy of the irrigator are important factors. During irrigation the irrigation farmer is worth more in manipulating his irrigation and watching it than he is on the other work ordinarily done on the farm.

The time of irrigation affects greatly the efficiency of the water applied. The whole purpose of irrigation is to provide a favorable moisture content. In the Oregon experiments, the moisture was applied according to moisture content of the soil. It was found that as much as 50 more bushels of potatoes could be secured by applying water at just thte right time.

From: "Net Duty of Irrigation Water," by Prof. W. L. Powers, Page 466 "*Engineering and Contracting*, May 11, 1921.

(C) *Relation Between Seepage Water and Irrigation.*—

With few exceptions, the occupants of the lower valley lands own the primary water rights, as they are the first to make use of the water. But there is sometimes a case of third-right owners taking all the supply away from the second-right owners. The second-right owners, however, usually take all the supply away from prior right owners, and also third-right take the same from second-right owners, thus producing conflicts between themselves. To solve the problems of this kind, Mr. Samuel Fortier, for the purpose of benefiting the irrigators in Ogden Valley, in 1895, suggested as follows:

First,—it is clearly shown that the diversion and use of water in the district of Liberty increases the available supply to the Eden District and possibly to the district beyond the canyon during the greater part of the irrigation period. We have here a case of third-right owners taking all the supply away from second-right owners and by this act (the West has firmly established both by custom and law, the principle of prior appropriation) conferring a favor upon the latter. In like manner, both third and second-right owners divert the waters legally belonging to prior right owners without injury to the latter. This would seem to be an instance in which water, like mercy, "blesseth him that gives and him that takes."

Second,—the diversion of immense quantities of water in the early part of the season when water is abundant and its application to the sandy and gravelly farms of this valley, store large volumes beneath the surface which are gradually drawn off by gravity to feed the river in the dry months. The great difference between outflow and inflow can be accounted for only in this way.

Third,—Water moves very slowly through sand and ordinary soils, but increases in speed with the size of the particle. With the present limited data, we have no means of finding out how long it takes water to seep from a porous field of North Huntsville to the river. If it takes 30 days, a large part of the water used around Huntsville July 15 would reach the lower irrigation about August 15; if it requires sixty days, it would reach the lower irrigations about September 15, which date might be too late to be of service.

Fourth,—It is folly to attempt to settle disputes of this character by having recourse to law. In the absence of any accurate measurements of either land or water, the court must base its decrees wholly upon testimony and the testimony is often as exaggerated and inaccurate as to be worse than worthless. One series of accurate measurements is worth infinitely more in arriving at an equitable decision than the testimony of hundreds of interested parties. The one system costs hundreds, where the other costs thousands. Yet men seem to prefer the latter.

Fifth,—if the ditches in Ogden Valley were all closed during August and September of each year, it is questionable whether the discharge of Ogden River would be much increased. The water has to reach the bottom of the valley either by percolating through the sand, gravel and cable-rock in the bed of the stream, or through the made ditches and the porous subsoil of the farms. The artificial channels are far better than the natural bed, being less porous; and this gain helps to make up the deficiency caused by its use on the fields.

Sixth—A large percentage of the volume which belongs by right to the lower irrigators is now wasted in Ogden Valley in its slow passage from east to west over, or beneath the surface of, deep porous beds. The loss from evaporation in this distance, although unknown in amount, must be great. To save this loss and to determine how long during each season the canal of this section shall be operated, would settle the whole question. If all the farmers taking water from Ogden River would unit with the upper irrigators in building a canal from South Fork to the foot of the valley, with short branches to tap the seepage and underflow from Middle Fork and Eden, a great increase would result.

(D) *Some Conclusions from Studying Seepage of Canals.*—

1. The losses from evaporation are relatively insignificant compared with the seepage losses from most canals. In the cases most favorable to evaporation and least favorable to seepage, the evaporation is not over 15 per cent.

2. In the cases of reservoirs, the seepage was less important than evaporation. This is different from the results found in ditches, not because the evaporation is less, but because the seepage is much more.

3. The losses are sometimes enough to cover the whole canal 20 ft. deep per day.

4. The loss in clay soils is less than in sandy or gravelly soils, but rarely as small as 3 inches daily.

5. The loss is greater when water is first turned in than after the bed has become saturated.

6. Sometimes the canals are found to gain for the whole or part of their length, or the canals may act as drains. This is more likely to be the case when the canal is deep in the ground, when crossing lines of drainage, or when located below other ditches or irrigation tracts.

7. The loss in carrying water in small quantities is relatively larger than in carrying large amounts. The increased depth of water means increased leakage, but the carrying capacity increases faster than the leakage.

8. From the standpoint of economy. it is wasteful to run a small head. It is more economical to run a large head for a short time. In the management of small ditches, the time system of distribution can be introduced to advantage, saving time and labor as well as water.

9. It is wasteful to use two ditches or laterals when one would serve.

10. The loss increases with higher temperatures, being about twice as much at 80° as at 32.°

11. The loss increases with greater depth of water, (but the exact relation needs further investigation).

12. This loss will be lessened by any process which forms or tends to form an impervious lining or coating of fine material, as of clay or silt. The silt, consisting of fine sand, improves many soils. Clay is better, and especially limy clay, the line with the clay forming an almost impervious coating.

13. Cement linings as used in California and Mexico are not warranted by the conditions in Colorado, nor would the weather conditions be favorable. Nor is the use of wooden stove piping for this purpose be likely to prove profitable in many places in the State, if at all on the larger canals at present. The silting process applied with discrimination will accomplish much at smaller cost.

14. On small laterals, glazed sewer pipes may save annoyance often connected with the carrying of water in later also for considerable distances, which, with the saving of water, may make their use an object.

15. Some particular sections in canals are subject to much greater loss than the canal as a whole. Hence water can be saved by locating the leaky place and remedying it. This may be desirable to do, while it would be unprofitable to treat the whole canal.

16. There are many places where it would be advantageous to combine two ditches, by this means saving not only the loss of water, but saving superintendence and maintenance charges. With increased confidence in the

accuracy of water measurement, reluctance to such considerations should lessen.

17. The depth of losses from laterals is probably greater than in the main ditches. The laterals are less permanent, are steeper, have less silt, and are more poorly cared for.

18. There must be some arrangement of ditches and laterals which is the most economical for given conditions, so that the aggregate of the losses of the whole system will be a minimum. Certainly the location and arrangement of the laterals for carrying water from the main ditch is worthy of consideration by the management of the main canal, and the importance increases with the size of the canal and the width of the strip it serves.

19. It is not to be understood that the whole of the loss from the ditches is lost to the public wealth of the State. Some, perhaps much, of the loss, may reappear as seepage in lower ditches or in the main stream and again be used. It is, however, lost to the particular ditch and incidentally is destructive to much land. With all practicable methods of prevention, there will still be abundant loss. It should be to the advantage of the individual ditch to prevent such loss as far as practicable.

20. A general statement of the total amount of loss of water must be made and accepted with reservation. It should appear that in the main canals from 15 per cent. to 40 per cent. is lost, and in the laterals as much more. It would thus appear that not much over one-half, certainly not over two-thirds of water taken from the stream, reaches the fields. In the most favorable aspect, the loss is great, and is relatively greatest when the loss can be least afforded, viz: when the water is low and the ditches are running with reduced head.

21. There are some 2,000,000 acres of land irrigated in Colorado, and the value of the water rights at a low estimate is as much as $30,000,-000 (the census estimates the water rights as worth $28,46 per acre). On this basis, the capital value of the water lost by seepage in the canals and ditches may be put at from six to ten millions of dollars.

Conclusions of Don H. Bark, after a Study of Seepage Water:

(1) Small laterals carrying 1 sec. ft. and less almost invariably lose a large part of water carried, and the percentage of loss decreases rapidly as the volume carried is increased, thus emphasizing the desirability of rotation systems where the necessity for carrying small amounts is eliminated.

(2) Since certain types of soil have a fairly uniform loss per square foot of canal bed, canals should be designed, other things being equal, with as small a wetted perimeter as possible in comparison to their cross sections.

(3) Porous irrigated land above a canal may cause it to gain instead of lose.

(4) Canals in (average southern Idaho soil, which is) a medium clay loam, should be designed to withstand a loss of 0.5 to 1.5 cubic feet per sq.ft. of canal bed in 24 hours; 0.5 cu.ft. per sq. ft. per day is a safe basic for impervious clay loam soil, about 1 cu. ft. per day for medium soil, and 1.5 to 2 cu. ft. per sq. ft. per day is a safe basis for somewhat pervious soils.

(5) One per cent per mile is a safe basis for the loss in medium southern Idaho soil, with capacities in excess of 200 sec.-ft.

(6) Canals in gravelly soil should be designed to withstand a loss of 2.5 to 5 cu. ft. per sq. ft. of canal bed in 24 hours, depending upon the porosity of the gravel, although it is probable that lining would be profitable if the higher loss were experienced. The procedure must be determined by local economic conditions.

(7) A project having a comparatively long main canal, constructed through earth and unlined, may lose from 20 to as high as 50 per cent of the water diverted before it reaches the farms, even in the impervious soils.

(E) *Diagraurs Showing Lesses in Canal.*—

Total diversion, use and waste, losses in sublaterals, and in main canals on six irrigation projects in the northwestern United States are shown in Figure 13.

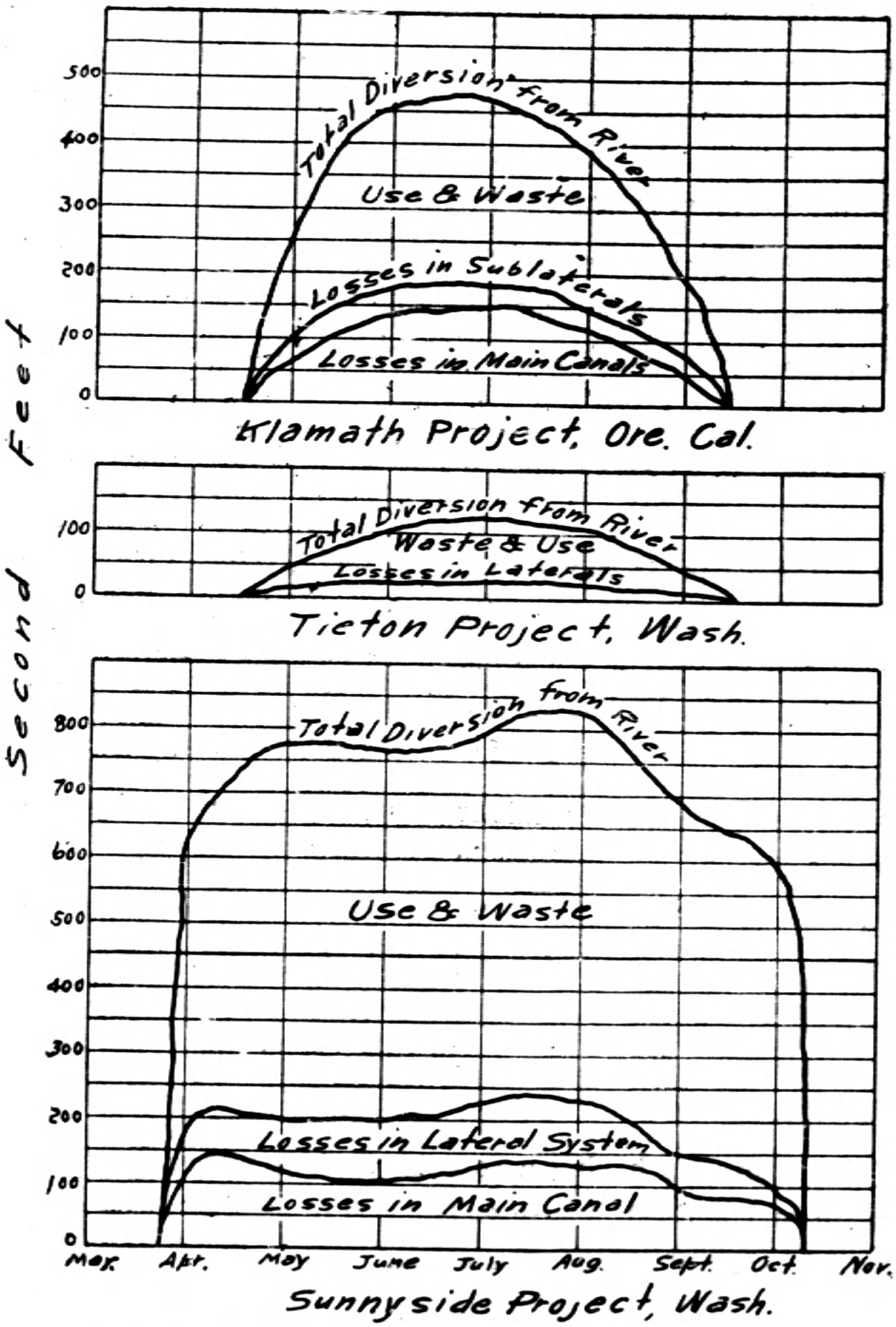


Fig. XIII TOTAL DIVERSION, USE AND WASTE, LOSSES IN SUBLATERALS AND IN MAIN CANALS ON SIX IRRIGATION PROJECTS IN THE NORTHWESTERN UNITED STATES

(F) *Table Showing Losses in Canal.*—

Some tables follow, showing losses from various canals and laterals:

Water Losses from Three Irrigation Reservoirs, Northwestern United States.

	Name of Canal	Location	Length of Section Tested (miles)	Disch. at Head of Sec. (Sec-ft)	% Lost per mile	Lost per sq. ft. of wetted area per day (cu-ft)	Date of Test	Date When Constructed Enlarged or 1st Used	Soil and other Conditions
1.	Moore Ditch	Sacramento Valley, Cal	0.8	116	9.4		July 1806	1864	Very gravelly bed
2.	Moore Ditch	Sec. Valley, Cal	4.0	116	1.0		,, 1806	1864	Heavy clay loam, trampled by stock
3.	Moore Ditch	,, ,, ,,	4.0	127	4.1		,, 1807	1864	Same as No. 2, not puddled by stock
4.	Capay-Winters Canal	,, ,, ,,	3.0	79	15.3		Aug. 1807	1903	Wash gravel bottom.
5.	Cap.-Winters	,, ,, ,,	15.5	43	1.1		,, 1807	1903	Clay loam
6.	Stony Creek	Orland, Cal	3.3	80	2.17		May 1807	1888	Canal sec. much eroded
7.	Kennewick,	Yakima Valley	9.0	123	2.8		Sep. 1804	1902	Gravelly porous soil
8.	Kennewick,	Yakima Valley Wash	9.0	79	1.4		Oct. 1806	1902	Same as No. 7, after puddling and silting
9.	Logan & Richmond,	Utah	0.7	59	4.7	2.5	May 1899		
10.	Wheatland No. 2	Wyo.	17.0	90	1.0		July 1900		
11.	Bear River	Utah	1.5	279	3.3		Jun. 1901	1889	Heavy rock & disintegrated limestone
12.	Bear River	,,	0.75	264	2.5		,, 1901	1889	Porous material
13.	Bear River	,,	3.25	258	.34		,, 1901	1889	Sidehill location heavy soapst, format'n
14.	Grand Valley	Colo.	2.25	260	1.4		July 1901	1884	Hvy. firm clay & Blk. shale
15.	Grand Valley (highline)	,,	21.25	140	.39		,, 1901	1883	Partly sidehill locten
16.	Lake	,,	13	456	.43		Jun. 1901	1892	Sandy loam
17.	Sunnyside,	Wash	8	612	0.7	1.80	,, 1908	1892	Volcanic ash
18.	Sunnyside,	,,	5	451	0.9	1.84	,, 1908	1892	Sand & volcanic ash
19.	Sunnyside,	,,	4	44	5.2	2.74	,, 1908	1892	Porous loam
20.	Various canals	India	959			1.00			Old canals
21.	Farmers Union	Idaho	3.3	125	2.09	1.79	,, 1910	1905	Sidehill, granite & sandwash formation
22.	Settlers Canal	,,	2.7	154	.42	.44	July 1909	1894	Cemented sd. & gravel
23.	Middleton Water Co.	,,	1.7	101	1.25	.83	,, 1909	1876	Clay & silt overlaid with ash
24.	Ridenbaugh	,,	6.8	65	3.1	2.48	,, 1912	1889	Clay loam underlaid with hardpan
25.	Ridenbaugh (high line)	,,	9.0	43	5.9	2.13	,, 1912	1910	Heavy lava ash with clay & sand
26.	Main USRS	Boise	6.6	617	.085	.12	Sssn 1912	1909	Volcanic ash, some sand & rock
27.	"G" Canal, Minidoka,	U.S.R.S. Idaho	18.0	Ave. 70	1.56	.78	,, 1913	1908	Clay & lava ash with some gravel
28.	"H" Canal, Minidoka	,, ,,	22.2	,, 136	.68	.77	,, 1913	1908 & 1913	Clay & lava ash with some gravel
29.	"J" Canal	ditto	25.0	,, 182	.69	.78	,, 1913	1908 & 1912	Clay & lava ash with some gravel
30.	Main north Minidoka	U.S.R.S. Idaho	7.8	,, 912	1.12	1.58	,, 1912	1907	Rock, sand & gravel
31.	Main south	ditto	13	,, 446	1.14	.92	,, 1912	1911	Rock, sand & clay
32.	C-2. USRS. Minidoka.	Idaho	4.8	,, 37	2.35	.60	,, 1912	1907	Heavy clay

Transmission Losses in Canals and Laterals
In the Modesto Irrigation District, Season of 1914

Mounth	Mean Flow of Intake Main Canal Sec-ft.	Transmission Loss in Main Canal Sec.-ft.	Transmission Loss in Main Laterals Sec.-ft.	Transmission Loss in Private Laterals Sec.-ft.	Flow Reaching Fields Sec.-ft.	Percent of Intake Capacity Reaching Fields
April	416.9	96.9	51.2	26.9	*161.9	38.8
May	629.5	101.8	84.5	46.3	396.9	63.0
June	670.6	121.6	87.8	46.1	415.1	61.9
July	583.2	113.0	75.2	39.5	355.5	61.0
August	400.0	108.0	46.7	24.5	220.8	55.2
Average	540.0	108.3	69.1	36.6	310.0	57.4
Percent	100.0	20.1	12.8	6.8	57.4	

*Estimated 80 ser.-ft. wasted on account of wet weather.

WATER LOSSES FROM THREE IRRIGATION RESERVOIRS, NORTHWESTERN UNITED STATES

Cold Springs Reservoir, 1908-11

(Maximum capacity, 50,000 acre-feet. Maximum water surface, 1550 acres)

	1908		1908-9		1909-10		1910-11	
	Acre-feet	%	Acre-feet	%	Acre-feet	%	Acre-feet	%
Influent	20,336	—	42,820	—	61,526	—	72,273	—
Effluent & Losses:								
Evaporation	2,400	12	4,295	10	5,333	9	6,252	9
Seepage	4,515	22	*4,021	9	*10,461	17	10,878	15
Use waste & Surplus	13,451	66	34,504	81	45,732	74	55,163	76
			865		503		182	

*Return flow

Clear Lake Reservoir, 1909-11

(Maximum capacity, 450,000 acre-feet. Maximum water area, 25,000 acres)

	1909-10		1910-11	
	Acre-feet	%	Acre-feet	%
Influent	141,000	—	225,500	—
Effluent and Losses:				
Evaporation	80,000	57	88,000	39
Seepage	48,000	34	24,000	11
Use, waste, and surplus	13,000	9	113,000	50

Deer Flat Reservoir, 1909-11

(Maximum capacity, 186,000 acre-feet. Maximum water area, 9,250 acres)

	1909		1909-10		1910-11	
	Acre-feet	%	Acre-feet	%	Acre-feet	%
Influent	64,000	—	130,000	—	230,000	—
Effluent:						
Evaporation	4,000	6	18,000	14	20,000	9
Seepage	55,000	86	80,000	62	140,000	61
Use, waste and surplus	5,000	8	32,000	24	70,000	30

The precents in each case are percentages of volume of influent.

世界之最大發電廠(節譯二月六日"The Electrical Times")

美國 Hell Gate 發電廠,爲全世界之最大發電廠,現在可發電六十五萬基羅華式,不久卽可發一百萬基羅華式.其初期之鍋爐十二具,爲 Spring Field 式,蒸汽壓力爲二百七十五磅,以後陸續增加.最近之擴充爲 Babcock & Wilcox 之 C. T. M. 式鍋爐二座,每座每小時能發蒸汽八十萬磅,(每具鍋爐約合八萬基羅華式) 每具鍋爐計:

	傳熱面積
鍋　爐 (Boiler)	52,306 方尺
蒸汽加熱器 (Superheater)	12,000 方尺
空氣加熱器 (Air Heater)	60,500 方尺
省煤器 (Economiser)	16,600 方尺
水管爐牆 (Water Wall)	4,590 方尺

蒸汽壓力爲二百七十五磅,熱度法倫表七百五十度,燃燒用煤粉機,每具鍋爐有磨煤機四具,每具每小時可磨煤十噸.

(振聲)

從三民主義來解析工人待遇

著者: 金芝軒

我們做工程師的,大約都有一藝之長,吃人家飯的固然不少,但爲黨國効勞,或自已做「老闆」的亦很多.進一步說,美國第一任總統華盛頓,是一位工程師,現在的總統胡佛,是到過我們中國的工程師,所以工程師是不算低等的職業.但是中國既有這許多人才,爲何實業辦得這樣不出色呢?其中爲國勢環境的關係,與一般人們各自爲政的心理,恐怕是一大緣由.但我以爲我們工程師對於人們的性質,尙沒有充分的研究,尤其是對於被我們使用的人方面,如何對待的方法,沒有精密的設施.如今我們試用三民主義做參考,將工人待遇一項,來討論討論,有不妥善的地方,還希閱者同志們,開導開導.

(一)什麼叫做工人

凡一合法的組織或團體,其中有掌「權」的人,與司「能」的人.不拘一公司或一工廠,其中司「能」的人,都叫做工人,換一句話說,凡屬用正當方法,使用其天賦的身體上能力,以謀生活,都是工人.

(二)工人的分析

人們因爲所得天地的氣機不同,與入世後環境的各異,知覺上因之有所區別,所以工人大致可照第一表分析起來:

第一表

工人	先知先覺	理想家	經理及主管員 工程師	賢.才.智
	後知後覺	宣傳家	主任 科長 工頭 領班	智.平
	不知不覺	實行家	員司 記錄 匠人 苦力	平.庸.愚

(三) 工人的資質

中山先生有言,人可以分爲「聖賢才智平庸愚劣」八種.但是在工人裏面,「聖」的人我們想不到,「劣」的人我們暫時不去管他,所以我們祇要算他是「賢才智平庸愚」六種.在第一表的下面,我們卽可以看出那一種人屬於那一類.工人的資質,旣有這許多的區別,我們可以從其資質上,攷察其他項不同之點.

(四) 工人的生活費

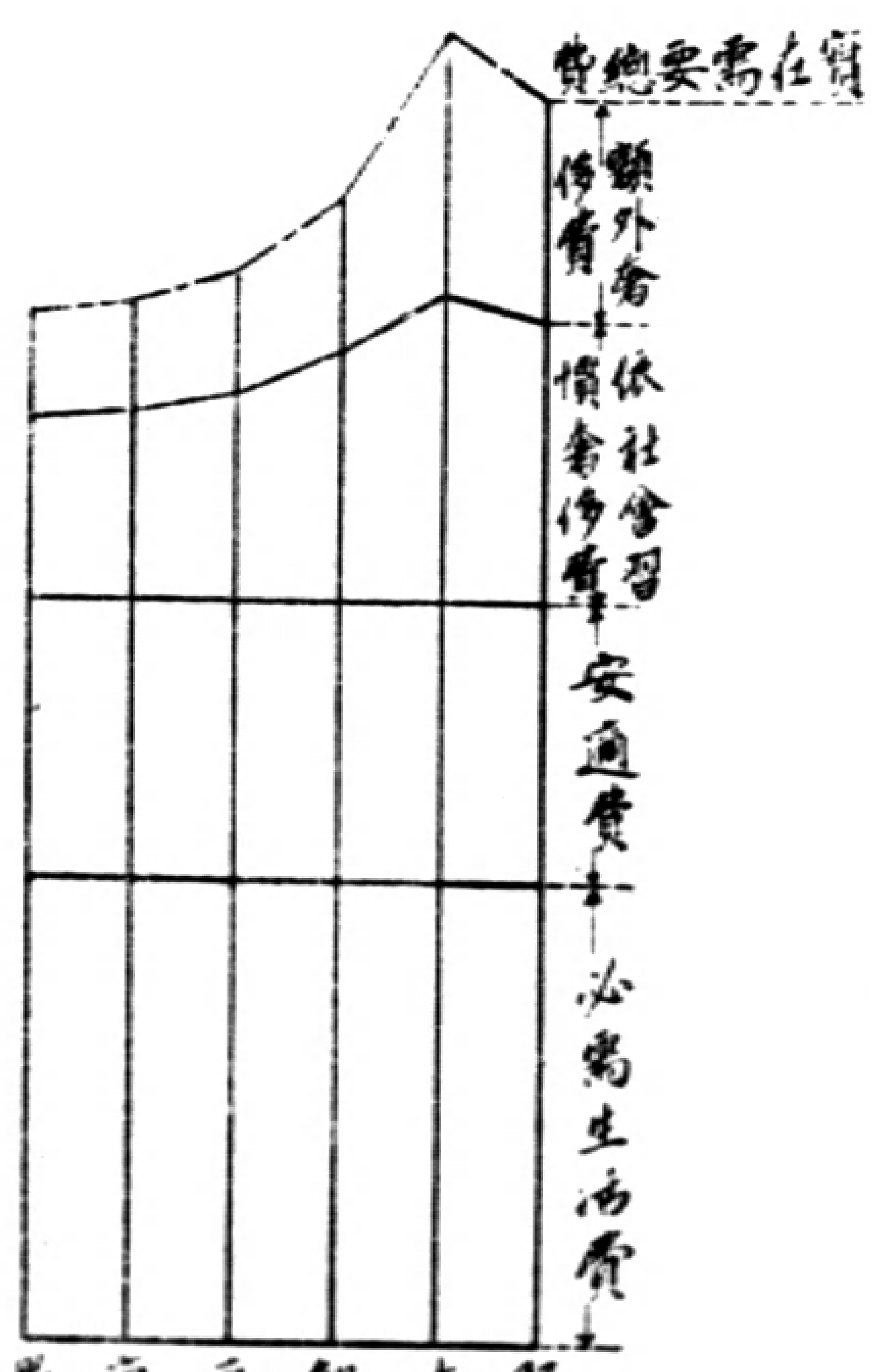
工人的生活費,當分下列幾種.

(甲) 必要的卽需要費 (就是沒有這費便要沒有生命的)

(乙) 次要的可分下列二種

安適費 (使工人無後顧之憂的)

奢侈費 (迎合社會習慣不能省去的各費)



爲易於明瞭起見,我們用下面第二表來區別各種人的費用:

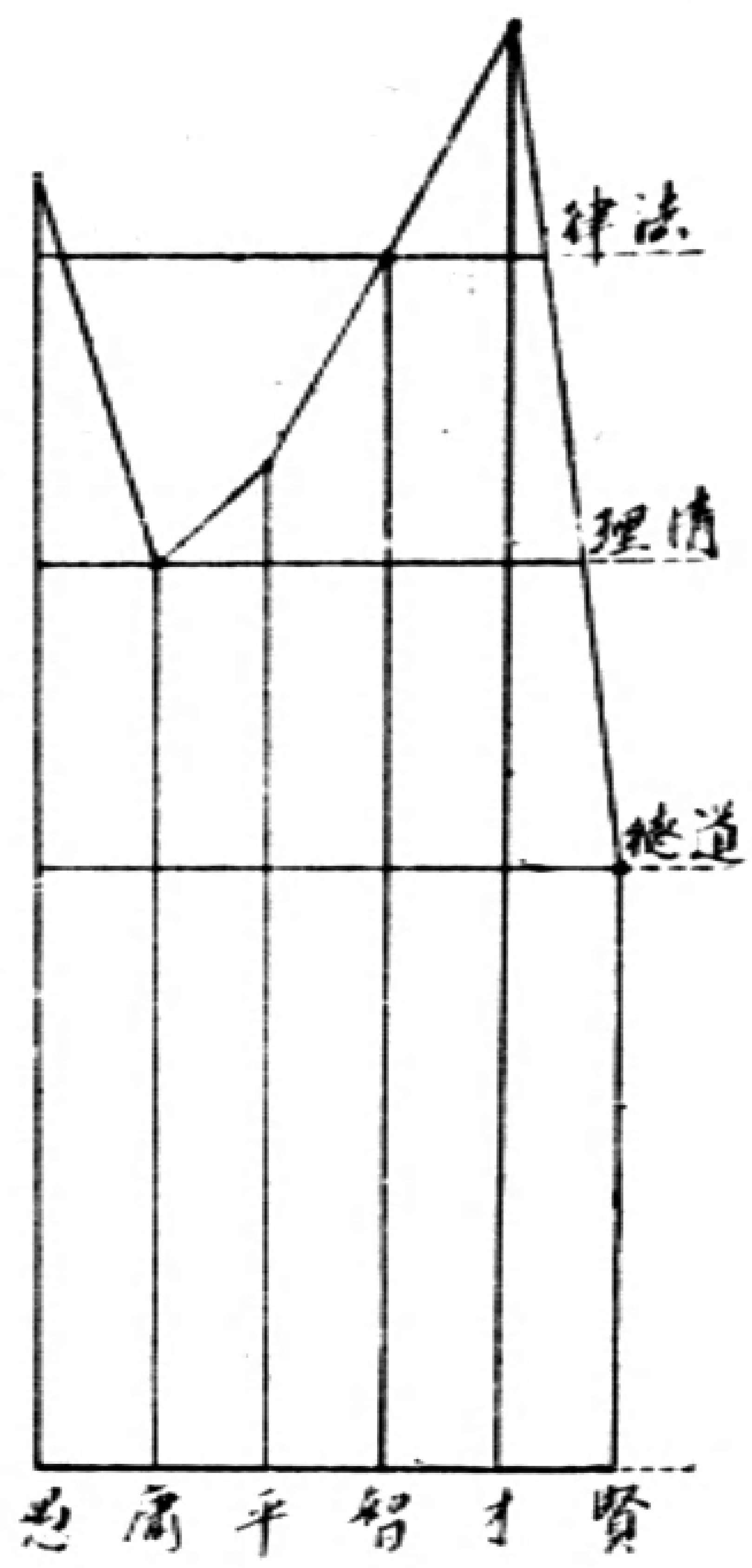
飯是大家要吃的,衣是大家要穿的,所以必需要費是相等的.妻子養活,父母養老,是人人有的.病與死雖是例外費用,預備亦是不可不有的.所以安適費,亦是相等的.因資質的不同,所以環境亦不同.依社會的習慣,奢侈費是不能相等的.此外因各人個性的不同,過分求好,過分求安適,因之各有額外奢侈費,這種費用是相差太遠了.從第二表裏看起來,就可以明白:才的人,需要費最高,賢的人次之.智平庸愚又各次之.

(五)工人的守法性

人們的道德性,與犯規可能性,各依其性質而不同,就是

賢的人	往往在道德線以內.
才的人	不但要越出道德線,且往往越出法律線.
智的人	道德不一定好,但常在法律線之內.
平的人	道德較智的好.
庸的人	道德較智的平的都好,在情理線之內.
愚的人	往往不知不覺而越出法律線.

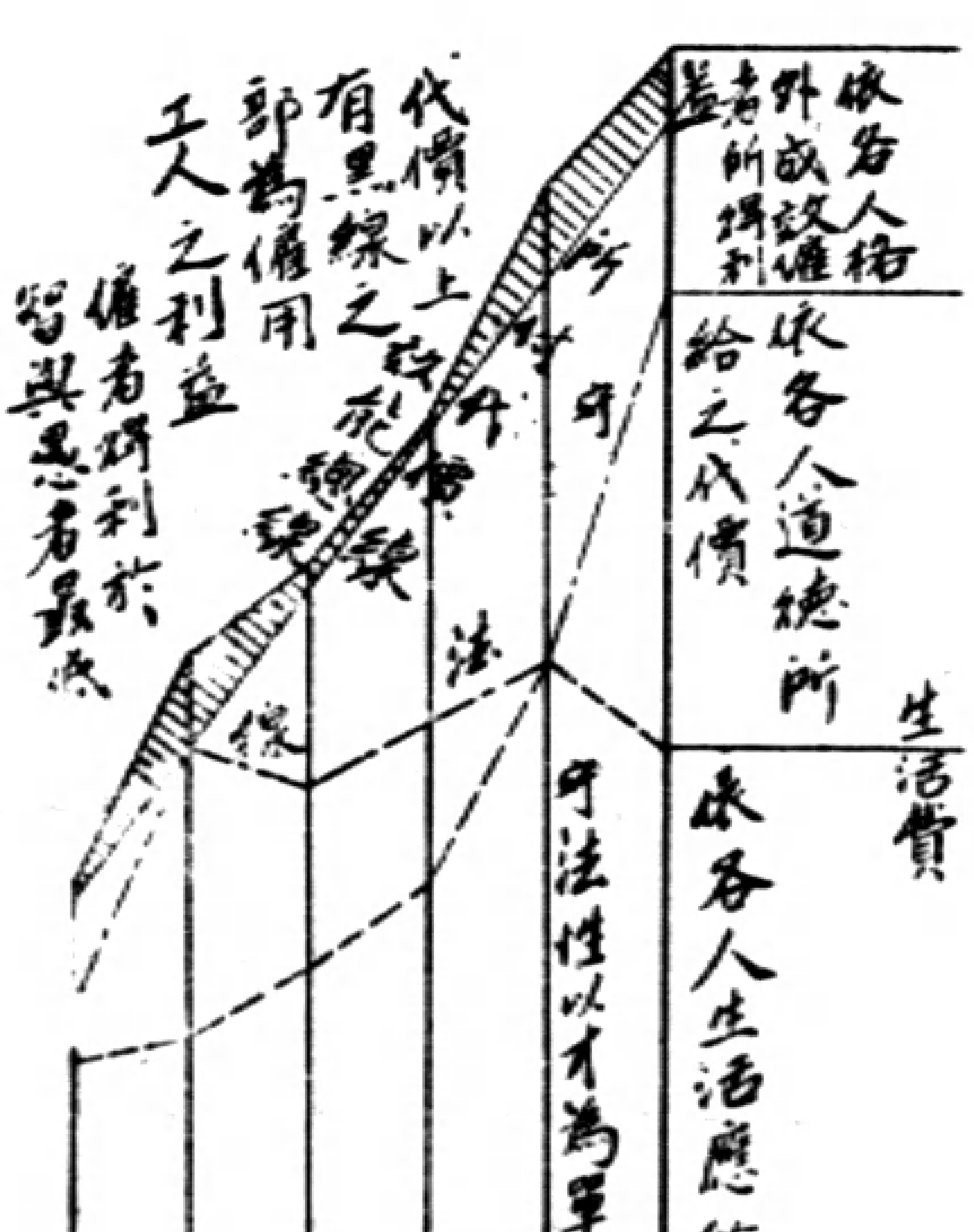
第三表



用表式來表明當易於明白.(如第三表)

(六)工人的待遇

第四表



(甲)工人待遇的分析

因為每一工人,有上述這許多地方要講究,所以定工人待遇的厚薄,不能不有個分析.但是這種高低,如何分法,又不能不將以上所講的,通盤核算.要曉得我們用工人,是要求工人做工的.進一步說,就是為國家及社會求進步的.所以我們先要尋出工人的能力與效率,然後可以曉得我們所付的代價應得如何分配.其分配次序,應如第四表:

日常必要生活費,加上做工之能力與效

率,再加上守法及道德性,三樣平均,求得效能總線,就是定待遇工人的程序,或就是定工資的標準.因爲僱用工人,是求生利的,所以所付工資,在效能總線之下,而遠在生活費線之上.倘用這法分配工資,那一定是很公平,而所得的成績,亦一定很好.

(乙) 代爲工人設想的辦法

在第四項內及第二表中所說,我們可以曉得不需要費是一樣的,安適費亦是一樣的,所不同者,是奢侈費.但是在一團體中之先知先覺者,如不爲別人設法,恐怕有一部人,將安適費當做奢侈費.照我鄙意,安適費須另外提出,立一保管團體,辦下列各事:

團體人壽保險.

團體儲蓄.

醫院養病房.

工人子弟學校及幼稚園.

此外則在奢侈費上謀其減少,當有下列之設備:

合作市場,減低無謂佣金.

合作娛樂設備.

合作衞生設備,設立合宜住宅.

以上說的,就是如何待遇工人的具體辦法,是理論的,現在我要引幾樁實事證明此說.

代工人儲蓄　從前我在漢口揚子廠的時候,在我部分的裏面,有許多工人;有的是北方人,有的是湖北本地人,有的是廣東人,有的是江浙人.但是我對於江浙二省的工人,是大同鄉,風俗情形,稍稍曉得.所以我即在有一年年初,加了他們工錢之後,在這加數上,抽一半出來,代他們儲蓄,規則辦得很嚴.到了後來,工人如有辭職者,少則得有盤費,多則得有整數可以寄回家裏.如是一來,不但工人本人受惠不淺,即是工人的家族,亦無不個個感激.我敢說

一句.有許多的父母坟墓,與自己妻室,都是在這裏面出來.可惜我後來到上海來做事,這事就告完了.

周家渡大飯廳　中華碼頭公司,周家渡碼頭,設有整齊清潔的大飯廳一處,內可容工人五百人,設有長桌與櫈,以廉價售飯菜與碼頭小工,進出門均自動,辦法極好.同時並設有盥洗所與便所,此亦爲工人謀利益之一良法.

待遇女工小孩的理想　待遇紡織廠及絲廠內女工與小孩,我亦有一法,我說僱用女工,是世界上不能免掉的事.男人的謀生力不足,不能不有妻子求正當的途徑,在社會上生活,女的惟有做工,但同時又不能不生產.所以在紗廠或絲廠內,我們往往看見許多很不康健及污穢不堪的小孩,在紗機或絲車的下面睡覺.在這種工作地方,空氣氣候,與周圍一切,都不宜於小孩的衛生.人誰不愛子女?我們做工程師,應想出個法子來,在廠中較靜僻的地方,造一宅房子,專爲預備不能行走與須哺乳的小孩睡覺.就我意思,室內可分上中下三層,每層上用竹或木分成小筐,大小高低,求其合於小孩之用,且設法不使小孩自筐內爬出,以免危險,室內用二三個女傭照料一切.早晨上工用牌子寄物式將小孩寄好.上午九時許工人出來喂奶一次,中飯放工可喂奶或領去.下午三時再喂奶一次,到六點鐘放工可以領去.如是則廠內不見小孩,工人心裏又十分安適.恐怕有許多女工,因爲小孩可以安適,做工亦要做得分外好了.

金君所著三民主義來解析工人待遇一篇,其中精義甚多,道前人所未道,讀者玩索,自有所得,大可譯成英文,登諸他邦工程雜誌.

編者誌

京滬鐵路熱水洗爐機件之新裝置

The Erection of Hot Water Washing-out Plant in N. S. R.

著者: 李時敏

引言　鐵路各種車輛之中,其最關重要者,厥爲機車(Loccn otive).蓋機車乃原動力之所自出,吾人日常所見之列車,拖帶至十餘節,奔馳軌道,聲震遠近,其所以能若此載重駛遠者,莫非一機車所生之力有以致之.是以一年之中,鐵路之耗費於機車者,如煤斤及修理費等,爲數亦最鉅.且機車之損壞,其輕者固可立刻修理,其重者則修理輒需時間,不免延誤車務,故各國工程師,均致力研究,避免重大損害之發生,以增進營業之效率.

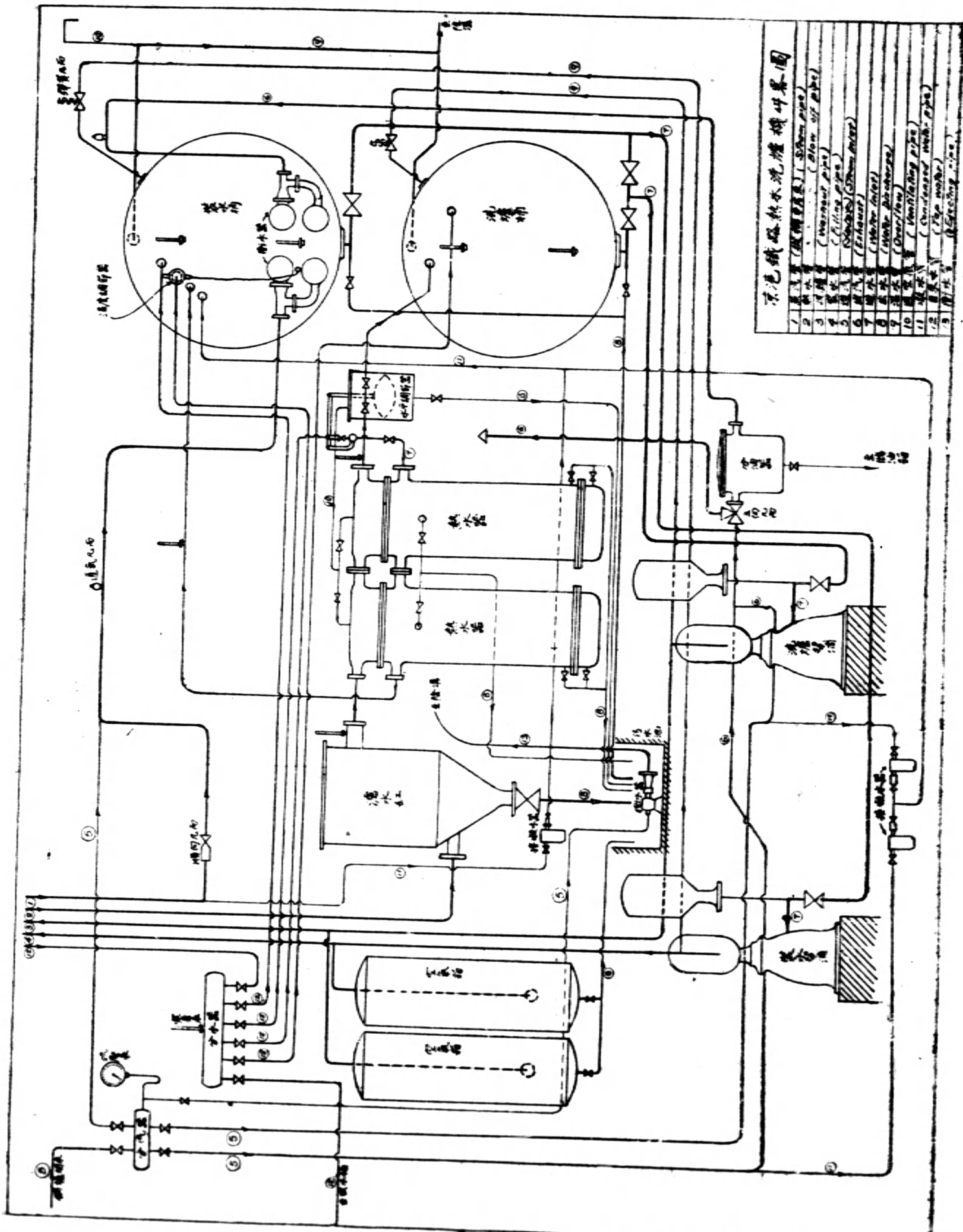
蒸汽機車之構造,實與普通工廠中用蒸汽做動力之機件相似,亦不外乎鍋爐,進水機,汽缸,飛輪等,不過機車上引擎之力,用以拖帶車輛,又以車行之速度變化無常,故加裝一倒順車及管理速度之機件而已.機車上最重要之部分爲鍋爐,其構造大小,以有標準軌道(Standard Gauge)之束縛,不能過大,但又必須能生多量之蒸汽,以供機車引擎之需要.當機車駛行迅速之時,其耗汽率實可驚人,每開行一次,其所蒸發之水,總在數萬磅以上,此巨量之水,其中總有不潔之物存留,一經蒸發,乃剩在爐內,或受熱而生沉澱,起泡沫及附黏爐之內面諸現象,其結果使鍋爐之效率大減,而煤斤之耗費日增.故必時常洗滌,去其污物,使爐內清潔,然後可用.此層在普通工廠中之鍋爐亦然,不過無機車鍋爐之頻煩耳.

冷水洗爐之缺點　機車當長途行駛後,回至機車房,若欲洗爐,通常總將其中之蒸汽,由頂上之一凡而(Valve)先行放入空中,然後又將其中之熱水,由下脚另一凡而放入煤灰漕中,此時鍋爐之外體,已漸漸冷却,於是將各洗爐塞(Washout Plugs)開去,若機車急待使用,則不待其內部冷却,即以冷水放

入衝洗鍋爐內部,一遇冷水,即起收縮,其結果每使爐撐(Stay)火管等,發生罅漏而火箱中之銅板等亦時常起凹凸破裂諸現象,必須經過修理,方克使用,實於鍋爐之壽命,大有妨礙.且自放蒸汽放熱水,冷水洗爐,裝冷水,生火,以至達到使用之壓力(普通爲18)磅),每次至少亦須十小時.在此時間,完全失其營業能力.鐵路當局,爲減少此種虛靡之時間,以應緊急之運輸起見,遂至減少洗爐之次數,間接使鍋爐效率退縮.如運輸繁劇,而機車缺乏者,此種現象,必不可免.欲謀補救,故有熱水洗爐機件.

熱水洗爐機件概述 根於上述冷水洗爐之缺點,可知欲謀補救,必須(一)利用機車中原有蒸汽及熱水,勿令其散失,間接即節省金錢.(二)用熱水洗爐,使機車內部不致起劇烈之收縮,以增進鍋爐之壽命.(三)用熱水裝入爐中,然後生火,使汽壓易於增高,以減省時間.此三條件,在熱水洗爐機件中,均可達到.其法即用機車中原有之蒸汽及熱水,使注入一裝水桶 Filling Tank 及洗爐桶. Washout Tank 桶內固有暖水,經其一熱,溫度更變高.洗爐桶之水專爲洗爐之用,裝水桶之水則爲裝入鍋爐之用.二桶各備有幫浦一具,以得相當之壓力.至其詳細,則因種類不同,機件各異,不能備述.

京滬路之熱水洗爐機件 京滬鐵路自國都南遷後,客運驟增,營業日盛.惟所有機車,頗都使用有年,不能生多量之蒸汽,以應繁重之車務.又以機車只五十餘輛,欲以應緊急之運輸,調度方面時感困難.故對於時間上,更不能多所空費,損壞上更不可時時遭逢.當局有鑒於此,故向德商禮和洋行,轉向德國 P.Fischer & Co.,購買此種熱水洗爐機件,以爲消極之補救.全部爲Fischer式,於去年八月機件運到,即動工造廠房基脚於北站機車房之旁,十月動工裝置機件,直至本年二月方竣事,試用之後,頗覺靈便,全部所費當在二十萬元左右,現已正式啓用,對於機車洗爐及調度,較前實經濟不少.查吾國各鐵路,其有此種裝置者,除北甯路唐山機廠外,實未之前聞.今京滬路繼之而起,不惜資本,裝此新器,亦可見當局之積極改進矣.茲將該項機件略述之於次:



該項機件可就其裝置之地位,分爲三部.(1)包括各種洗爐機件（參閱附圖),另裝於一室.(2)包括平常機車鍋爐二具,進水幫浦一具(Weir Feed Water Pump)盛水桶一具,别無他物,蓋所以生蒸汽,用以運動洗爐幫浦及裝水幫浦者也,亦另裝於一室.(3)包含蒸汽管,熱水管,洗爐管,裝水管,及自來水管之在機車房內者.此五種管子,其中自來水管蓋用以引自來水自機車房至（1）部機房分水器內,無大意義.其餘四管之中,蒸汽管,洗爐管,及裝水管,則沿機車房中直行之柱子用角鐵架裝於上面.計有二行,每行有四處,將此三管用丁字形管接出,沿柱子直下,經過一凡而,再接有一螺絲之頭,可用橡皮管套上,以便應用.至於熱水管,則沿直行柱脚之旁掘一漕,而將熱水管裝於漕中,上面用三和土板蓋好,亦分二行.每行有四處接出,與上面接出之管同一柱子,不過熱水管接出,係沿柱直上,亦裝一凡而,高離地面三呎六吋,以便於開閉也.至於（1）部機件,(參閱附圖)其最要者爲裝水桶及洗水桶,桶凡七呎七吋直徑,長有三十一呎六吋,可容水八千八百加侖.此外有裝水幫浦（較大)一具,洗爐幫浦一具,濾水缸 Washing Filter 一具,內置焦煤,可以吸收水中之污物而清潔之,熱水器 Heater 二具,使熱水經其中,被外面之冷水冷却,其中有無數小銅管,銅管之內通熱水,其外通冷水,水平調節器（Regulator）一具,用浮水球以調節冷水進熱水器之中,分油器 (Oil Separator) 一具,用以分出上述二幫浦廢汽內之油分,而利用其汽以熱裝水桶內之水.其油則另儲于箱中,各處所有放出之污水,均引至一污水池（Sink）用一小衝水機 (Steam injector) 衝去之.

機車長途行駛後,返至機車房,卸去燃煤,如欲洗爐,則（1）可將其中之蒸汽,由蒸汽管引至洗爐機房,經過單向凡而 (Non-reversible valve),再進衝水器

而入裝水桶,衝水器之作用,卽所以循環鼓動桶內之水,使溫度均勻增高.如桶內水溫太高,則溫度調整器(Thermostat),能使冷水從分水器入桶中.

(2) 蒸汽放完後,可將其中熱水,由熱水管引入濾水缸,濾後進入熱水器,被冷水冷却,再經過水平調節器之旁,以水平之理,使浮水球調節冷水之進熱水器,然後始入洗爐桶,至冷水自分水器經過浮水球所管之凡而,入熱水器,受熱後,則入裝水桶.

(3) 熱水放完後,此時機車鍋爐之內部,或尙太熱,故須斟酌待其稍冷,然後再用橡皮管接上洗爐管冲洗,此時洗爐桶內之水,經過洗爐帮浦,被壓至洗爐管以供使用.洗爐用水之溫度,通常在攝氏七十度左右.

(4) 鍋爐冲洗淸潔後,可立卽將各洗爐塞關好,接上裝水管,于是攝氏九十度左右之熱水,遂由裝水桶經過裝水帮浦而入爐中.裝好後卽可生火應用,因熱水溫度頗高,故生火較冷水爲易,而使用壓力之蒸汽,亦易達到矣.

上述四種手續,大約可於四五小時內竣事,較冷水洗爐,實少一半有餘.其二幫浦之廢汽,經過一三向凡而,可入分油器,(亦可通至空中),然後再入裝水桶右方之衝水器,以鼓動桶內之水,使溫度均勻.其出水管,雖通至機車房中,但若有時機車房不用水,則此水可經過裝有彈簧調節凡而之溢水管,而入原桶中,如此可免水壓太高.此外尙有接凝水器(Condensing Water Collector)三隻,則使凝水經此器而被衝入裝水桶.至在機車房內則裝有長距離寒暑表,及長距離水高表,所以表示裝水桶及洗爐桶內水溫及水面之高低.其餘機件,均可於圖明瞭,玆不多贅.此篇匆匆脫稿,對於機件名稱,譯文殊多不妥,倘蒙大雅指正,則幸甚.